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The Legal Meaning of Smart Contracts

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Abstract: This article investigates the legal dimension of smart contracts. In particular, it reviews their existing definitions in some of the main laws enacted and scholarly articles published to date, proposes its own version, to then move on to consider to what extent new legal categories are warranted to deal with this apparently totally new way of making legally binding agreements. It concludes by providing some final remarks with regard to relevant legal categories and attempts to advance a number of solutions to the legal questions raised by the application of smart contracts.

Résumé: Le présent article étudie la dimension juridique de contrats intelligents. En particulier, il passe en revue leurs définitions qui se trouvent dans certaines des lois essentielles promulguées et dans des articles académiques publiés jusqu'à présent, il propose sa version propre, et considère ensuite dans quelle mesure de nouvelles catégories juridiques sont justifiées pour traiter cette manière apparemment tout à fait nouvelle de passer des accords juridiquement obligatoires. Il conclut par quelques remarques finales concernant des catégories juridiques importantes et tente d'apporter certaines solutions aux questions juridiques soulevées par l'application de contrats intelligents.

Zusammenfassung: Der Beitrag untersucht die rechtliche Dimension von Smart Contracts. Konkret untersucht er die hierfür bestehenden Definitionen in einigen zentralen Gesetzen und wissenschaftlichen Aufsätzen, die bisher veröffentlicht wurden, schlägt eine eigene Definition vor und evaluiert dann, inwieweit neue rechtliche Kategorien für den Umgang mit dieser offenbar völlig neuen Art und Weise, rechtsverbindliche Vereinbarungen zu treffen, gerechtfertigt sind. Er schließt mit einigen abschließenden Bemerkungen zu den relevanten Rechtskategorien und versucht, einige Lösungen für die rechtlichen Fragen, die durch die Anwendung von Smart Contracts aufgeworfen werden, voranzutreiben.

1. Introduction and Definition of the Key Notions

1. This work investigates the legal dimension of smart contracts. In particular, it endeavours to understand to what extent this potentially breakthrough technology also implies a legal revolution: do smart contracts require the development of new

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legal avenues, or is it instead appropriate simply to adapt existing legal categories to the new reality? In either case, how are and should they be regulated?

Before beginning the actual analysis, I believe it is necessary to devote some space to defining the most relevant notions used in this work, i.e. blockchain and (decentralized) smart contracts. In fact, we can derive proper and (hopefully) sound legal consequences only from clear definitions.

Precision in this definition is important, since it will inevitably have consequences for the legal analysis of smart contracts; at the same time, a definition that is too strict would inevitably be inadequate for such a fast-moving field. Therefore it is necessary to give a precise but elastic definition, one that is capable of adapting to the next evolution of these technologies. I will then move on to outline the current legal framework (section 2), describe some relevant practical issues (section 3), identify the main legal questions raised by the subject (section 4), and offer some conclusive remarks (section 5).

1.1. *Blockchain*

2. For these reasons, it appears necessary to spend some words to define blockchain and distributed ledger technology in general.¹

An arguably appropriate definition, provided by the ECB, describes the blockchain as ‘the ledger (book of records) of all transactions, grouped in blocks, formulated with a (decentralized) virtual currency scheme’.²

According to a recently approved Arizona act, a blockchain is a ‘distributed ledger technology that uses a distributed, decentralized, shared and replicated ledger, which may be public or private, permissioned or permissionless, or driven by tokenized crypto economics or tokenless. The data on the ledger is protected with cryptography, is immutable and auditable and provides an uncensored truth’.³

The State of Vermont has defined blockchain as ‘a mathematically secured, chronological, and decentralized consensus ledger or database, whether maintained via Internet interaction, peer-to-peer network, or otherwise’.⁴

More generally, most virtual currencies are usually (and Bitcoin is the first example) based on the distributed ledger technology (DLT),⁵ i.e. a technology that,

1 A brief note on terminology is needed here: the terms blockchain (or block chain) and distributed/shared ledger are often used interchangeably.

2 ECB, *Virtual currency schemes – a further analysis* (ECB 2015), p 33.

3 Arizona House Bill 2417, <https://www.azleg.gov/legtext/53leg/1r/bills/hb2417p.pdf> (accessed 18 November 2018).

4 S. I.1. 12 V.S.A. S. 1913. legislature.vermont.gov/assets/Documents/2016/Docs/ACTS/ACT157/ACT157%20As%20Enacted.pdf (accessed 18 November 2018).

5 BIS, *CPMI report on digital currencies* (November 2015), pp 5 ff, www.bis.org/cpmi/publ/d137.pdf (accessed 18 November 2018); see also IMF, *Virtual Currencies and Beyond: Initial Considerations*, IMF Staff Discussion Note – SDN/16/03 (January 2016), pp 18 ff.

through computing and cryptography, has made it possible to keep and validate multiple copies of the same ledger (a sort of distributed database) across an IT network; each ledger keeps a copy of the digital database of all the transactions that have ever occurred (a transactions record), which is formed by a lot of blocks of encrypted electronic records, linked together and disseminated through a dense IT peer-to-peer network.

Anyone can check the database, but no one is able to modify it; thus, ‘this technology, in principle, enables a decentralized, rapid, resilient and rather secure means of recording any sort of transaction together with the history of previous transactions in a ‘distributed ledger’’. This scheme, originated with Bitcoin,⁶ commonly known as ‘blockchain technology’, is often based on publicly available open source software.

To sum up,

a block chain is a type of database that takes a number of records and puts them in a block (rather like collating them on to a single sheet of paper). Each block is then ‘chained’ to the next block, using a cryptographic signature. This allows block chains to be used like a ledger, which can be shared and corroborated by anyone with the appropriate permissions.⁷

3. The importance of blockchain technologies has been underlined also by the IMF, that recognizing the possible benefits of virtual currencies (i.e. increasing speed and efficiency in making payments and transfers), stated: ‘the distributed ledger technology underlying some VC schemes offers benefits that go well beyond VCs themselves’.⁸

Therefore, by applying blockchain technology to smart contracts, they would be not only self-executing and self-enforcing, without any need for intermediaries but, in addition, every transaction would be automatically recorded in the distributed database. Thus, blockchain-based smart contracts⁹ may be referred to as ‘decentralized smart contracts’, given the absence of a central database/register.¹⁰

6 See S. NAKAMOTO, *Bitcoin: A Peer-to-Peer Electronic Cash System* (2008), bitcoin.org/bitcoin.pdf (accessed 18 November 2018).

7 *Distributed Ledger Technology: beyond blockchain*, a report by the UK Government Chief Scientific Adviser, 2016, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/492972/gs-16-1-distributed-ledger-technology.pdf (accessed 18 November 2018), p 17.

8 *Virtual Currencies and Beyond: Initial Considerations*, IMF Staff Discussion Note – SDN/16/03 (January 2016), p 35.

9 It is worth pointing out that the notion of ‘smart contracts’ could encompass any automatically-executed machine-based agreement (such as purchasing a snack from a vending machine), whereas blockchain-based smart contracts are a much narrower notion (some analogies between the two might still be usefully applied, as will be pointed out in Part 4).

10 See M. L. PERUGINI & P. DAL CHECCO, ‘Smart Contracts: A Preliminary Evaluation’, (December 2015), ssrn.com/abstract=2729548 (accessed 18 November 2018); M. RASKIN, ‘The Law and Legality of Smart

1.2. (Decentralized) Smart Contracts

4. As has been observed, ‘a search of the term smart contract uncovers a myriad of definitions’¹¹ and ‘a consensus definition for smart contracts has yet to be reached’.¹²

Already more than twenty years ago, Szabo famously defined smart contracts as ‘a computerized protocol that executes the terms of a contract’¹³ and argued that ‘the general objectives of smart contract design are to satisfy common contractual conditions (such as payment terms, liens, confidentiality, and even enforcement), minimize exceptions both malicious and accidental, and minimize the need for trusted intermediaries. Related economic goals include lowering fraud loss, arbitration and enforcement costs, and other transaction

Contracts’, 1 *Georgetown L. Tech. Rev.* 2017, p 304, www.georgetownlawtechreview.org/the-law-and-legality-of-smart-contracts/GLTR-04-2017/ (accessed 18 November 2018); A. SAVELYEV, ‘Contract Law 2.0: «Smart» Contracts As the Beginning of the End of Classic Contract Law’, Higher School of Economics Research Paper No. WP BRP 71/LAW/2016, 26. *Information & Communications Technology Law* 2017 (2), pp 116–134, ssrn.com/abstract=2885241 (accessed 18 November 2018); L. H. SCHOLZ, ‘Algorithmic Contracts’, 20 *Stan. Tech. L. Rev.* 2017, p 128; J. SZCZERBOWSKI, ‘Place of Smart Contracts in Civil Law. A Few Comments on Form and Interpretation’, Proceedings of the 12th Annual International Scientific Conference New Trends 2017 (Private College of Economic Studies Znojmo, 2017), [ssrn.com/abstract=3099885](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3099885) (accessed 18 November 2018); G. JACCARD, ‘Smart Contracts and the Role of Law’, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3099885 (accessed 18 November 2018); E. TJONG TJIN TAI, ‘Formalizing Contract Law for Smart Contracts’, Tilburg Private Law Working Paper Series No. 6/2017s, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3038800 (accessed 18 November 2018); P. CATCHLOVE, ‘Smart Contracts: A New Era of Contract Use’ (1 December 2017), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3090226 (accessed 18 November 2018); R. O’SHIELDS, ‘Smart Contracts: Legal Agreements for the Blockchain’, 21 *N.C. Banking Inst.* 177 (2017); L. W. CONG & Z. HE, ‘Blockchain Disruption and Smart Contracts’ (January 10, 2018), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2985764 (accessed 18 November 2018); T. HINGLEY, ‘A smart new world: blockchain and smart contracts’, www.freshfields.com/en-gb/our-thinking/campaigns/digital/fintech/blockchain-and-smart-contracts/ (accessed 18 November 2018); Riiikka. KOULU, ‘Blockchains and Online Dispute Resolution: Smart Contracts as an Alternative to Enforcement’, 13 *SCRIPTed* 40 (2016); K. LAUSLAHTI, J. MATTILA & T. SEPPÄLÄ, ‘Smart Contracts – How will Blockchain Technology Affect Contractual Practices?’, ETLA Reports No 68 (9 January 2017), pub.etla.fi/ETLA-Raportit-Reports-68.pdf (accessed 18 November 2018).

- 11 P. CATCHLOVE, ‘Smart Contracts: A New Era of Contract Use’, p 6, [dx.doi.org/10.2139/ssrn.3090226](https://doi.org/10.2139/ssrn.3090226).
- 12 L. W. CONG & Z. HE, ‘Blockchain Disruption and Smart Contracts’, p 11, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3090226 (accessed 18 November 2018).
- 13 N. SZABO, ‘Smart Contracts’, (1994), www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/smart.contracts.html (accessed 18 November 2018); N. SZABO, ‘Formalizing and Securing Relationships on Public Networks’, in *First Monday* (1997), ojs.oi.org/ojs/index.php/fm/article/view/548/469 (accessed 18 November 2018); N. SZABO, ‘The Idea of Smart Contracts’, (1997), <http://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/idea.html> (accessed 18 November 2018); N. SZABO, ‘Secure Property Titles with Owner Authority’ (1998); see also MARK S. MILLER, ‘Computer Security as the Future of Law’ (1997), www.caplet.com/security/futurelaw/ (accessed 18 November 2018).

costs'.¹⁴ According to another definition by the same author, a smart contract is 'a set of promises, including protocols within which the parties perform on the other promises. The protocols are usually implemented with programs on a computer network, or in other forms of digital electronics; thus these contracts are 'smarter' than their paper-based ancestors. No use of artificial intelligence is implied'.¹⁵

More recently, other scholars and legal operators have defined smart contracts as:

- 'self-executing electronic instructions drafted in computer code';¹⁶
- 'a piece of computer code that is capable of monitoring, executing and enforcing an agreement';¹⁷
- 'software, with which computer code binds two, or a multitude, of parties in view of the execution of predefined effects, and that is stored on a distributed ledger';¹⁸
- 'digital contracts allowing terms contingent on decentralized consensus that are self-enforcing and tamperproof through automated execution';¹⁹
- 'an event-driven program, with state, that run on a distributed, decentralized, shared and replicated ledger (blockchain) and that can take custody over and transfer assets on the ledger';²⁰
- 'contracts that are represented in code and executed by computers'.²¹

Recently, Arizona approved a bill which contains a legal definition of smart contracts, very similar to the aforementioned above: 'an event-driven program, with state, that runs on a distributed, decentralized, shared and replicated ledger and that can take custody over and instruct transfer of assets on that ledger'.²²

Finally, the Joint Economic Committee of the Congress of the United States observed that 'smart contracts might sound new, but the concept is rooted in basic

14 N. SZABO, 'Smart Contracts' (1994), cited above, in the previous note.

15 N. SZABO, 'Smart Contract Glossary' (1995), www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/smart_contracts_glossary.html (accessed 18 November 2018), cited by R. KOULU, 13 *SCRIPTed* 40, 54 (2016).

16 R. O'SHEILDS, 'Smart Contracts: Legal Agreements for the Blockchain', 21 *N.C. Banking Inst.* 177 (2017), p 179.

17 T. HINGLEY, 'A smart new world: blockchain and smart contracts', cited above, note 10.

18 G. JACCARD, 'Smart Contracts and the Role of Law' (10 January 2018), p 4, cited above, note 10.

19 L. W. CONG & Z. HE, 'Blockchain Disruption and Smart Contracts', p 11, cited above, note 10.

20 J. J. SZCZERBOWSKI, 'Place of Smart Contracts in Civil Law. A Few Comments on Form and Interpretation', cited above, note 10.

21 E. MIK, 'Smart Contracts: Terminology, Technical Limitations and Real World Complexity' (17 August 2017), p 1, ssrn.com/abstract=3038406 (accessed 18 November 2018).

22 Arizona House Bill 2417, cited above, note 3.

contract law. Usually the judicial system adjudicates contractual disputes and enforces terms, but it is also common to have another arbitration method, especially for international transactions. With smart contracts, a program enforces the contract built into the code'.²³

In general, it may be said that there is a limited consensus on the core definition according to which, apart from some nuances, smart contracts are words written in computer language which are automatically executed by a machine; some add to the definition the requirement that such contracts run on blockchain or similar distributed ledger technologies²⁴ (and, thus, may be called decentralized smart contracts).²⁵

5. Finally, another important aspect of the definition regards the possibility of adding the concept of Artificial Intelligence to smart contracts. In other words, may smart contracts be partially written or executed by AI?²⁶

The word 'smart', as nowadays understood, may seem to refer to the concept of AI. However, as observed above, the original definition by Szabo explicitly provides that 'no use of artificial intelligence is implied'.²⁷ Similarly, other authors have stated that 'it is important to note that smart contracts are not merely digital contracts (many of which rely on trusted authority for reaching consensus and execution), nor are they entailing artificial intelligence (they are rather robotic, on the contrary)²⁸ and that 'a smart contract doesn't «think», like a lawyer does or - who knows? - an artificial intelligence might one day be able to do. Instead, smart contracts enforce the lines of computer code, which they have been programmed for'.²⁹ It has also been pointed out that 'smart contracts do not need artificial

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- 23 'The 2018 Joint Economic Report', Report of the Joint Economic Committee Congress of the United States on the 2018 Economic Report of the President, Ch. 9: 'Building a Secure Future, One Blockchain at a Time' (13 March 2018), p 210, www.congress.gov/115/crpt/hrpt596/CRPT-115hrpt596.pdf (accessed 18 November 2018).
- 24 E. TJONG TJIN TAI, 'Formalizing Contract Law for Smart Contracts', cited above, note 10: 'While systems for smart contracts in the general meaning of the term can be and have been created without relying on bitcoin or blockchain technology, contemporary interest in the marketplace focuses on smart contracts that do rely on a virtual currency with blockchain technology'.
- 25 See 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 VV.AA. '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, Volume 4: Papers presented at the Congress' (United Nations, Vienna 2017), p 105, www.uncitral.org/pdf/english/congress/17-06783_ebook.pdf (accessed 18 November 2018), p 107.
- 26 Even 'Artificial Intelligence' has been defined in various way and a consensus upon a certain definition has not been reached yet. See e.g. B. J. COPELAND, 'Artificial intelligence', *Britannica* online, www.britannica.com/technology/artificial-intelligence (accessed 18 November 2018).
- 27 N. SZABO, 'Smart Contract Glossary', cited above, note 15.
- 28 L. W. CONG & Z. HE, 'Blockchain Disruption and Smart Contracts', p 11, cited above, note 10.
- 29 G. JACCARD, 'Smart Contracts and the Role of Law', cited above, note 10, pp 3-4.

intelligence to work, regardless of what their name may suggest³⁰ and even that ‘the true intelligence of smart contracts can be questioned, as they do not contain artificial intelligence in themselves. A smart contract should thus be perceived as an automated mechanism which performs its defined functions as certain preconditions are met. The established term “smart contracts” is thus somewhat deceiving’.³¹

It shall be noticed that smart contracts are based on the logic of ‘If this ... then that’, where ‘this’ and ‘that’ are predetermined by the smart contract’s author.

However, some authors³² imply the possibility of including AI in the concept of smart contracts.

To sum up, it may be safe to assume that with the term ‘smart contract’ many authors refer to what we called ‘decentralized smart contract’, while normally AI is not necessarily considered to be involved.

6. Thus, we can define decentralized smart contract as any digital agreement which is (a) written in computer code (thus, a piece of software), (b) run on blockchain or similar distributed ledger technologies (thus, decentralized) and (c) automatically executed without any need for human intervention (thus, smart).

2. The Current Legal Framework

7. An international legal framework³³ specifically designed for blockchain technologies and smart contracts does not exist:³⁴ however, the topic is clearly under consideration at the legislative/regulatory level: as has been said, ‘today is all about blockchain brainstorming’³⁵ and at national/regional level, particularly in the US,³⁶ some regulations have been or are going to be enacted.

30 K. LAUSLAHTI, J. MATTILA & T. SEPPÄLÄ, ‘Smart Contracts - How will Blockchain Technology Affect Contractual Practices?’, cited above, note 10, p 3.

31 K. LAUSLAHTI, J. MATTILA & T. SEPPÄLÄ, ‘Smart Contracts - How will Blockchain Technology Affect Contractual Practices?’, cited above, note 10, p 17.

32 See e.g. R. O’SHIELDS, ‘Smart Contracts: Legal Agreements for the Blockchain’, 21 *N.C. Banking Inst.* 177 (2017), p 189; see also more generally L. H. SCHOLZ, 20 *Stan. Tech. L. Rev.* 2017, pp (128) at 135-136.

33 For an exhaustive picture of the current legal framework all over the world, see P. TASCA, *Digital Currencies: Principles, Trends, Opportunities, and Risks*, Deutsche Bundesbank and ECUREX Research, ECUREX Research Working Paper (7 September 2015) (version: October 2015), pp 43 ff.

34 See e.g. Aaheree MUKHERJEE, ‘Smart Contracts - Another Feather in UNCITRAL’s Cap’, *Cornell International Law Journal Online* (8 February 2018), cornellilj.org/smart-contracts-another-feather-in-uncitrals-cap/ (accessed 18 November 2018).

35 *Digital Transformation in Government and Blockchain Technology*, speech delivered by Minister for Cabinet Office Matt Hancock at D Digital Catapult, Kings Cross, London on the 26 April 2016, gov.uk/government/speeches/digital-transformation-in-government-and-blockchain-technology (accessed 18 November 2018).

36 See e.g. ‘The 2018 Joint Economic Report’, Report of the Joint Economic Committee Congress of the United States on the 2018 Economic Report of the President, Ch. 9: ‘Building a Secure Future,

As was observed, in fact, ‘the States of Delaware, Vermont, Nevada, Arizona, Hawaii, New Hampshire and Illinois in the United States have all sought legislation, or are seeking to pass legislation to recognize and capitalize upon the use of smart contracts and blockchain technology’.³⁷

In particular, the State of Arizona has enacted a detailed statute recalled above (Arizona House Bill 2417³⁸), providing in particular that (a) ‘a signature that is secured through blockchain technology is considered to be in an electronic form and to be an electronic signature’, (b) ‘a record or contract that is secured through blockchain technology is considered to be in an electronic form and to be an electronic record’ and that (c) ‘smart contracts may exist in commerce. A contract relating to a transaction may not be denied legal effect, validity or enforceability solely because that contract contains a smart contract term’.

The State of Vermont enacted a statute with detailed provisions on blockchain (section 1913. Blockchain Enabling³⁹), with regard to authentication, admissibility, and presumptions, providing e.g. that (a) ‘a fact or record verified through a valid application of blockchain technology is authentic’, (b) ‘the date and time of the recordation of the fact or record established through such a blockchain is the date and time that the fact or record was added to the blockchain’, (c) ‘the person established through such a blockchain as the person who made such recordation is the person who made the recordation’ and that, in any case, ‘a presumption does not extend to the truthfulness, validity, or legal status of the contents of the fact or record’.

In practice, ‘both States decided to recognize legal effects for the information that lies on a Blockchain or a smart contract, hence incorporating it explicitly as part of the legal system. Furthermore, this approach is also consistent with the recent reaction of several market authorities, stating that security law may apply to the sale of tokens during an Initial Coin Offering (ICO), incorporating them *de facto*’.⁴⁰

8. Nonetheless, most jurisdictions around the world still lack a specifically-tailored regulation: this may be due in part to the complexity of these technologies, and mostly to the more general inability of modern States’ legislative process to follow the rapid evolution of technology.

In addition, it must be said that, as blockchain is a (neutral) technology, it seems much more reasonable to wait and regulate the possible uses of it, rather than the technology itself, so as not to stifle innovation.

One Blockchain at a Time’, Section ‘Regulatory Questions’ (13 March 2018), cited above, note 23, pp 218 and ff.

37 P. CATCHLOVE, ‘Smart Contracts: A New Era of Contract Use’, p 2, cited above, note 10.

38 Arizona House Bill 2417, cited above, note 3.

39 S. I.1. 12 V.S.A. S. 1913, cited above, note 4.

40 G. JACCARD, ‘Smart Contracts and the Role of Law’, p 10, cited above, note 10.

9. As regards the need for a specific regulation, it has been noticed that ‘the growing interest in blockchain technology, independent from a VC scheme, *a priori* raises fewer policy concerns, because the technology would be used in a closed system administered by regulated financial institutions’.⁴¹

However, ‘although blockchain technology was initially meant to implement Bitcoin’s currency business model, it now seems to be emerging as a promising means to achieve a number of other goals. Blockchain technology could find its way into the mainstream financial markets. The technology may be used in a variety of applications where data have to be transmitted without risk of corruption. The handicap for Blockchain technology might be that it first appeared in the particularly sensitive and highly regulated field of currencies, having attracted the regulators’ attention while still at an immature stage, and with its potential not fully understood’.⁴²

Therefore, it is indeed possible that a regulation on virtual currencies indirectly provides some rules related to blockchain technologies, and this may well have negative effects on the blockchain.⁴³

Undoubtedly, these technologies are at the centre of the stage – for instance, the Bank of America recently filed 15 blockchain-related patents⁴⁴ while research on Patentscope showed 449 results for the term ‘blockchain’, 184 for the term ‘smart contract’ and 63 for the term ‘smart contracts’⁴⁵ – and, as a consequence, careful steps must be taken.

10. Speaking of smart contracts, their legal status is totally ‘unclear’,⁴⁶ and very little has been written to this regard;⁴⁷ I will try to address some potential issues in part 4. However, the fact that there is no specific regulation on such issues clearly does not mean that current laws and general principles of law may not be applicable to them, or that they are unregulated at all: smart contracts are indeed pieces of software.⁴⁸ To be sure, in the absence of specific regulations, these technologies must be regulated by existing laws.⁴⁹

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- 41 IMF, *Virtual Currencies and Beyond: Initial Considerations*, IMF Staff Discussion Note – SDN/16/03 (January 2016), p 24.
- 42 C. SCHEINERT, *Virtual currencies, Challenges following their introduction*, EPRS|European Parliamentary Research Service, Members’ Research Service, PE 579.110 (2016), p 10.
- 43 C. SCHEINERT, *Virtual currencies, Challenges following their introduction*, p 10, fn. 7.
- 44 C. SCHEINERT, *Virtual currencies, Challenges following their introduction*, p 10, fn. 9.
- 45 Patentscope, patentscope.wipo.int/search/en/search.jsf (accessed 15 March 2018).
- 46 *Virtual Currencies and Beyond: Initial Considerations*, IMF Staff Discussion Note – SDN/16/03 (January 2016), p 23.
- 47 See P. CATCHLOVE, ‘Smart Contracts: A New Era of Contract Use’, p 6.
- 48 A. SAVELYEV, 26. *Information & Communications Technology Law* 2017(2), p 20: ‘it is possible to argue that each Smart contract by its legal nature is also a computer program in a meaning of IP law’.
- 49 See e.g. P. TASCA, *Digital Currencies: Principles, Trends, Opportunities, and Risks*, p 26: ‘The general orientation is to adopt the current legislation already in place in order to deal with digital currencies in Europe’.

3. Smart Contracts and Blockchain in Action

11. Business practice might be severely affected by such new technologies for a number of reasons: firstly, a lot of companies have started to accept payments in Bitcoin (and other virtual currencies) all over the world;⁵⁰ secondly, blockchain technologies may allow significant cost savings,⁵¹ and potential applications to everyday business are on their way;⁵² lastly, what if instead of paper contracts, some businesses started to use smart contracts?⁵³

Moreover, what appears to be more appealing is that (in theory) smart contracts are automatically enforced without any need for a third party;⁵⁴ the reduction of transaction and litigation costs for undertakings may be substantial.

In fact, smart contracts are self-executed pieces of software and, apparently, there is no need for a central third party (i.e. judges, arbitrators) to administer them: there is (at least in theory⁵⁵) no way of breaching them.⁵⁶

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- 50 E.g. EY Switzerland: [www.ey.com/Publication/vwLUAssets/ey-news-release-switzerland-accepts-bit-coins-for-payment-of-its-services/\\$FILE/ey-news-release-switzerland-accepts-bitcoins-for-payment-of-its-services.pdf](http://www.ey.com/Publication/vwLUAssets/ey-news-release-switzerland-accepts-bit-coins-for-payment-of-its-services/$FILE/ey-news-release-switzerland-accepts-bitcoins-for-payment-of-its-services.pdf) (accessed 18 November 2018).
- 51 Investigating the possible advantages of the technology goes far beyond the purposes of this paper; I will just observe that businesses may consider adopting this technology for many different reasons (e. g. immutability, digitization, automation, paperless processes, rapidity, absence of middle-man, etc.).
- 52 See e.g. the R3 project: ‘R3 is a financial innovation firm that leads a consortium partnership with over 50 of the world’s leading financial institutions. We work together to design and deliver advanced distributed ledger technologies to the global financial markets’ (www.r3cev.com/about/, accessed 18 November 2018). In addition, as mentioned below in the article, the first blockchain-related patents are being filed.
- 53 The advantages and disadvantages of using smart contracts instead of a traditional paper contract should be evaluated on a case by case analysis, keeping in mind the objectives of each single agreement and the peculiarity of the situation. In any case, it has been observed that ‘it is quite possible to expect that at some moment of time Smart contracts will become routine technology, like Internet itself in the last decade of the 20th century’ (A. SAVELYEV, 26. *Information & Communications Technology Law* 2017(2), p 20).
- 54 A. SAVELYEV, 26. *Information & Communications Technology Law* 2017(2), p 18: ‘There is no need to seek for enforcement of Smart contract by addressing the claims to third party – judiciary or other enforcement agency. And it is one of the main “selling points” of this contractual form’.
- 55 But, in practice, huge scandals have already made the headlines, such as the ‘DAO case’, speaking of which it has been said that ‘to date, the largest application of this kind of thinking has been the creation of a decentralized autonomous organization or DAO in 2016. The idea was to create an investing entity that would not be controlled by any one individual, but by shareholders voting based on their stakes on a blockchain. The entity was funded with \$150 million. Soon after this money was raised, about \$40 million of those funds were diverted from the organization, using part of the code that no one had anticipated’ (M. RASKIN, 1 *Georgetown L. Tech. Rev.* 2017, 304, p 36) and that ‘recent example with the hack attack on Ethereum DAO in June 2016 shows that certain mechanism of reaching a consensus between the parties to Smart contract on certain unexpected (non-programmed) events is necessary’ (A. SAVELYEV, 26. *Information & Communications Technology Law* 2017(2), pp 22-23).
- 56 A. SAVELYEV, 26. *Information & Communications Technology Law* 2017(2), p 18: ‘Smart contract cannot be breached by a party to it’.

We can imagine a scenario in which two enterprises, through a (decentralized) smart contract, define and regulate their business relations and payment obligations so that they are automatically executed via Bitcoin. Platforms to draft and use smart contracts in everyday life already exist; the best-known example is Ethereum, ‘a decentralized platform that runs smart contracts: applications that run exactly as programmed without any possibility of downtime, censorship, fraud or third party interference. These apps run on a custom-built blockchain, an enormously powerful shared global infrastructure that can move value around and represent the ownership of property. This technology enables developers to create markets, store registries of debts or promises, move funds in accordance with instructions given long in the past (like a will or a futures contract) and many other things that have not been invented yet, all without a middle man or counterparty risk’.⁵⁷

Going back to the opening point of this paragraph, it seems rather likely that business practice will be affected by blockchain technologies and smart contracts. In any case, what is needed is at least a study-and-watch approach⁵⁸ to be ready when and if such innovations will come into the game of business practice. A similar position has been expressed, among others,⁵⁹ by the Bank for International Settlements, which has recognized that ‘digital currencies and distributed ledgers are an innovation that could have a range of impacts on many areas, especially on payment systems and services. These impacts could include the disruption of existing business models and systems, as well as the emergence of new financial, economic and social interactions and linkages.’⁶⁰ This bank concluded by saying that ‘central banks could consider – as a potential policy response to these developments – investigating the potential uses of distributed ledgers in payment systems or other types of FMIs’.⁶¹

Yet what about the legal issues raised by smart contracts?

4. Legal Questions

12. This paragraph will briefly outline and address some legal questions that may arise through the use of these technologies (in particular) with regard to private

57 www.ethereum.org/ (accessed 18 November 2018).

58 The same approach has been adopted by the ECB; see *Virtual currency schemes – a further analysis*, p 33.

59 See e.g. the *Special Address of CFTC Commissioner J. Christopher Giancarlo Before the Depository Trust & Clearing Corporation 2016 Blockchain Symposium* in which it was highlighted ‘The Need for a “Do No Harm” Regulatory Approach to Distributed Ledger Technology’.

60 BIS, *CPMI report on digital currencies* (November 2015), www.bis.org/cpmi/publ/d137.pdf (accessed 18 November 2018), p 17.

61 BIS, *CPMI report on digital currencies* (November 2015), cited above, in the previous note, p 18.

law, how such questions may be resolved on the basis of the current legislation, and how they should be addressed by policy makers.

The greatest problem is related to the legal status of such technologies: in fact, as already mentioned, some countries have already legislated in this field, while others are evaluating if, when and how to legislate.

With regard to problems arising from their legal status, in the absence of a specific regulation, authorities will likely (attempt to) apply current legislation.

13. Real trouble comes with what we called ‘decentralized smart contracts’, i.e., smart contracts based on blockchain technologies, which automatically execute any given agreement, providing proof of that performance in the distributed ledger.

In this regard, the first thing to notice is that, ‘using blockchain functions imposes some technical limits: as a matter of fact, indirect e-commerce performances are not digitally executable. Therefore, the scheme is not covering any agreement regarding goods or services that, even though purchased on the Internet, have a material consistence or are to be performed in the real world, like a book delivery or a maintenance service’.⁶²

This fact is due to the dichotomy between real and virtual worlds: let us imagine that, through a smart contract, A sells an object to B (who regularly pays the agreed price), but thereafter C steals the real object from B; at this point, on the blockchain there is no way to change the status of owner of B, who may well sell his virtual ‘title’ to D, who will never physically possess the object that he has purchased but, at the same time, will never be able to stop the payment automatically executed by the smart contract. This is why it seems possible to argue that smart contracts may function only with digital goods and digital inputs.⁶³

Given this dichotomy, it has been observed that since ‘discrepancies can occur between the two systems (legal/informatics) this may result in unfair and unlawful smart contracts being enforced’.⁶⁴

14. Nonetheless, even if the practical use of smart contracts was limited to virtual/digital goods, they would still be applicable to a lot of goods of the modern era. But what is the legal nature of smart contracts?

Are they assets protected by intellectual property laws? A form of pre-emptive self-help? Ordinary agreements (which would raise the issues of jurisdiction and applicable law)?

Once again, the possible reply depends on the chosen definition.

According to the definition given above, we have to consider three main characteristics: the software, the distributed ledger (database) and the automatic execution.

62 M. L. PERUGINI & P. DAL CHECCO, *Smart Contracts: A Preliminary Evaluation*, p 10.

63 M. L. PERUGINI & P. DAL CHECCO, *Smart Contracts: A Preliminary Evaluation*, pp 10 ff.

64 G. JACCARD, ‘Smart Contracts and the Role of Law’, p 8, cited above, note 10.

In any case, from a technical point of view, it seems that a smart contract is simply a piece of computer code or software. Thus, it seems appropriate to evaluate it firstly through the lens of intellectual property law.

4.1. *Assets Protected by Intellectual Property Laws?*

15. With regard to traditional intellectual property categories, it must be said that, generally speaking, smart contracts (and blockchain) may and should fall within the sphere of protection of copyright given that, as observed above, they are indeed pieces of software.⁶⁵

16. Moreover, protection through patents, provided that such technologies are new, involve an inventive step and are capable of industrial application, should also be considered as possible, – as shown by the rising number of patent applications that may be found regarding these technologies⁶⁶ – at least in those countries that allow the patentability of software and those that are recognized as patentable inventions assisted by software.

In this regard, it has been observed that

Some proponents also continue to advocate making blockchain technology accessible by offering the code under open source licenses or creating patent pools. And, as is the case with many promising new technologies, blockchain has also attracted patent trolls, as pointed out, among others, by the Chamber of Digital Commerce, a US advocacy group that promotes the emerging industry behind blockchain technology. The CDC recently launched the Blockchain Intellectual Property Council (BIPC), which aims to create an industry-led defensive patent strategy to combat blockchain patent trolling.⁶⁷

17. In addition, one may wonder if blockchain *per se* may be protected as a database, either through copyright protection if ‘by reason of the selection or arrangement of their contents constitute intellectual creations’⁶⁸ or – in the EU – through a *sui generis* right granted by the Directive 96/9/EC on the legal protection of databases if ‘there has been qualitatively and/or quantitatively a substantial investment in either the obtaining,

65 A. SAVELYEV, 26. *Information & Communications Technology Law* 2017(2), p 20: ‘it is possible to argue that each Smart contract by its legal nature is also a computer program in a meaning of IP law’.

66 A research on Patentscope showed 449 results for the term ‘blockchain’, 184 for the term ‘smart contract’ and 63 for the term ‘smart contracts’. See Patentscope, <https://patentscope.wipo.int/search/en/search.jsf> (accessed 15 March 2018).

67 B. CLARK, ‘Blockchain and IP law: a match made in crypto heaven?’, *Wipo Magazine* (February 2018), www.wipo.int/wipo_magazine/en/2018/01/article_0005.html (accessed 18 November 2018).

68 TRIPs Art. 10(2).

verification or presentation of the contents'.⁶⁹ Considering that the distributed database is created automatically according to mathematical functions, it may be said that copyright protection should not be granted and the same reasoning should apply to the *sui generis* right given the lack of any substantial investment (unless one would consider the energy necessary – sometimes called 'gas'⁷⁰ – to run the blockchain as a substantial investment); in any case, there would not be a need for a similar protection given that the purpose of the EU directive is to give incentives where needed⁷¹ and blockchain-based applications are up and running without them.

18. But does anybody own the blockchain?

Given the above-mentioned considerations regarding copyright, patents and *sui generis* right it is extremely difficult to answer the question, and there is a strong uncertainty as to who – if anybody – owns the blockchain.⁷²

The answer may well be different if the focus is moved to the platform which allows the creation, management and execution of smart contracts: in fact, while in most cases these platforms are currently either open source⁷³ or offered by non-profit organizations,⁷⁴ it is indeed possible that (access to) such platforms may be sold as a service offered to customers willing to pay a subscription cost.

In that case, either because the private blockchain at the core of the platform or the platform itself are patented, or because the software itself should be considered protected by copyright, the answer may be clearer and this would open up the stage to many more questions and problems regarding the relationship between the owner of the platform upon which smart contracts are run and its users.

19. With regard to the other two categories, some have recently argued, on the one hand, that 'smart contracts are simply a new form of pre-emptive self-help',⁷⁵ and on the other, it has been written that a 'smart contract can be regarded as a legally-binding agreement'.⁷⁶

69 Art. 7(1) of the Directive 96/9/EC on the Legal Protection of Databases.

70 See e.g. Ethereum: ethdocs.org/en/latest/contracts-and-transactions/account-types-gas-and-transactions.html?highlight=gas#what-is-gas (accessed 18 November 2018).

71 Recital 39 of the Database Directive: 'this Directive seeks to safeguard the position of makers of databases against misappropriation of the results of the financial and professional investment made in obtaining and collection the contents by protecting the whole or substantial parts of a database against certain acts by a user or competitor'.

72 B. CLARK, 'Blockchain and IP law: a match made in crypto heaven?', Wipo Magazine (February 2018), www.wipo.int/wipo_magazine/en/2018/01/article_0005.html (accessed 18 November 2018).

73 Such as Corda: www.corda.net/ (accessed 18 November 2018).

74 Such as Ethereum: www.ethereum.org/ (accessed 18 November 2018).

75 M. RASKIN, 1 *Georgetown L. Tech. Rev.* 2017, 304.

76 A. SAVELYEV, 26. *Information & Communications Technology Law* 2017(2), pp 10 and ff.

4.2. *A Form of Pre-Emptive Self-Help?*

20. Another interesting point that has been made by the scholarship is the idea that smart contracts are simply a new form of self-help measures,⁷⁷ namely that parties to a contract adopt in order to ensure the performance of their agreements without the need of judicial enforcement.⁷⁸ This is consistent with what usually happens, at least at the moment, in that two parties reach an agreement and thereafter translate (part of) it into a smart contract, and then leave the duty to perform it to the machine. In this case, all the relevant legal questions arising from smart contracts must be dealt with by the competent judge under the applicable contract law.

21. Once again, given the dichotomy between real and virtual worlds, what if a contractual clause refers to the real world? How can it be activated?

Some commentators have suggested that ‘if blockchain will allow financial transactions without banks, smart contracts may lead to contracts that no longer need courts to enforce them’.⁷⁹

However, even considering as a possible solution to the dichotomy problem the so-called ‘oracles’,⁸⁰ that would allow smart contracts to receive the necessary input from the outside world, it must be noted that there would always be the need of a trusted third party (i.e. the oracles instead of the courts or instead of arbitrators).

It has been correctly observed that ‘the rule relies in the end on judgement by third parties of off-line events, which moves the computational aspect to the real world and lessens the claim of a self-contained environment’.⁸¹

Therefore, if such contracts begin to be adopted in day-to-day business practice, there would appear to be a need for a general agreement (or at least an *ad hoc* provision to be included in the smart contract, even if it would clearly not be a self-enforceable provision) to be adopted between the parties that establishes, among other things, that, in case of need of judicial enforcement related to the general agreement itself, or to the smart contracts depending upon it, what is the applicable law and which judge has the jurisdiction. In fact, as was observed: ‘given

77 M. RASKIN, 1 *Georgetown L. Tech. Rev.* 2017, 304; in the abstract the author concludes that ‘smart contracts are simply a new form of pre-emptive self-help’.

78 M. RASKIN, 1 *Georgetown L. Tech. Rev.* 2017, pp 314 ff, and also K. D. WERBACH & N. CORNELL, ‘Contracts Ex Machina’, 67 *Duke Law Journal* 2017, pp 26 ff.

79 R. O’SHEILDS, ‘Smart Contracts: Legal Agreements for the Blockchain’, 21 *N.C. Banking Inst.* 177 (2017) p. 178 and fn. 5.

80 See the project Oraclize at www.oraclize.it/ (accessed 18 November 2018). For a definition of ‘oracle’ see e.g. blockchainhub.net/blockchain-oracles/ (accessed 18 November 2018): ‘An oracle, in the context of blockchains and smart contracts, is an agent that finds and verifies real-world occurrences and submits this information to a blockchain to be used by smart contracts’; see also <https://cointelegraph.com/explained/blockchain-oracles-explained> (accessed 18 November 2018).

81 E. TJONG TJIN TAI, ‘Formalizing Contract Law for Smart Contracts’s’, cited above, note 10, p 7.

that smart contracts can only do what they are programmed to do, a separate but connected written contract would provide a place to detail what will happen when unforeseen issues beyond the control of the parties occur.⁸²

22. Similarly, it has been suggested ‘to couple the use of smart contracts with a traditional written contract. The complementary use of a written contract, alongside the novel smart contract would enable a safe and controlled transition into a new era of contract use’.⁸³

In this regard, it has also been said that in using smart contracts ‘a conflict of legal provisions desists as legal systems do not collide. Mathematics is a universal human language. Thus, smart contracts are truly transnational and executed uniformly regardless of the differences in national laws’.⁸⁴

However, I do not agree with such a statement since, as I contend in this paper, smart contracts should be subject to contract law, and it is clear that the applicable law will have a strong influence on them; for example, with regard to illegality and unconscionability, every country has its own particular rules, and a contract may well be valid in one place and null and void in another.

4.3. Ordinary Agreements? The Issues of Jurisdiction and Applicable Law

23. Finally, with regard to the idea that smart contracts ‘can be regarded as legally-binding agreements’,⁸⁵ it has been said that smart contracts do not create obligations in a true legal sense.⁸⁶

This conclusion, though, seems difficult to agree with. Firstly, smart contracts, as some scholars have concluded, are indeed ‘agreement(s) between the parties’⁸⁷ expressed in digital code and I believe that they should be considered as self-sufficient legally-binding agreements. In fact, smart contracts can, at least in theory, meet all the requirements set forth under different national contract laws to be considered as contract in the legal meaning of the term. For example, in Italy a contract is defined as the agreement between two or more parties to establish, regulate or extinguish a legal relationship – with an economic dimension – among them, and its requirements are: (a) the agreement between the parties, (b) the *causa*, (c) the object and (d) the form (only when prescribed under penalty of nullity): such requirements, in practice, are quite easy to be met with traditional

82 P. CATCHLOVE, ‘Smart Contracts: A New Era of Contract Use’, cited above, note 10, p 16.

83 P. CATCHLOVE, ‘Smart Contracts: A New Era of Contract Use’, cited above, note 10, p 16.

84 A. SAVELYEV, 26. *Information & Communications Technology Law* 2017(2), pp 116-134.

85 A. SAVELYEV, 26. *Information & Communications Technology Law* 2017(2), pp 10 and ff.

86 A. SAVELYEV, 26. *Information & Communications Technology Law* 2017(2), pp 17 ff.

87 K. D. WERBACH & N. CORNELL, 67 *Duke Law Journal* 2017, pp 26 ff.

oral and/or paper-based contracts and the same must be said with regard to digital agreements in the form of smart contracts.

Moreover, smart contracts do clearly create obligations which stand independently from the digital code of the smart contracts: if for example there is a bug in a smart contract between A and B, and A has undertaken to transfer her property in exchange for an agreed sum of money to B, she would still be obliged to transfer her property to B even if the smart contract does not work (similarly, if a vending machine does not deliver the chosen good after the insertion of the coin, it is clear that the owner of the selling machine is still obliged to perform and deliver the goods). In addition, the above-mentioned dichotomy between real and virtual worlds must be taken into account.

In any case, by entering into a smart contract, parties undertake to perform the obligation therein encapsulated; in addition, since – as has been said – smart contracts are almost always the translation of an already reached precedent agreement, the obligations of parties would nonetheless be, at the very least, to begin the execution of the smart contract (i.e. to press the button that initiates the smart contract).

24. In general, in spite of the conceptual dissimilarities, there are in fact very few differences between the functioning of a smart contract and that of a mechanical vending machine, or that of software that suspends the supply of a service in case of missing payment (e.g. Netflix allows users to legally watch streaming videos in exchange for a monthly payment; in case of missing payments, the software will simply suspend the service, not allowing users to log in⁸⁸): the fact that the interruption is performed by humans, by software, or by smart contracts with a record in the blockchain, does not in practice seem to make a relevant legally speaking difference.

I therefore agree with the scholars who conclude that, ‘independently from being digitally expressed, every [smart] contract is ruled and guaranteed by the law and the parties will be free to file with the Court for compensation in case a void agreement has been performed or execution has been spoiled by a malfunctioning due to a bug in the system’⁸⁹ and that ‘smart contracts do fall within existing contract law principles’.⁹⁰ In other words, smart contracts ‘will not require any special set of new laws or regulations. Instead, the existing legal principles of contract law will be adapted and perhaps modified, either statutorily or judicially, to deal explicitly with smart

88 <https://help.netflix.com/legal/termsofuse?locale=en&country=IT> (accessed 18 November 2018): ‘If a payment is not successfully settled, due to expiration, insufficient funds, or otherwise, and you do not change your Payment Method or cancel your account, we may suspend your access to the service until we have obtained a valid Payment Method’.

89 M.L. PERUGINI & P. DAL CHECCO, ‘Smart Contracts: A Preliminary Evaluation’ (December 2015), p 25.

90 P. CATCHLOVE, ‘Smart Contracts: A New Era of Contract Use’, p 16, cited above, note 10.

contracts and other emerging technologies-albeit most likely with a substantial lag time between the adoption of the technology and adjustment of the law':⁹¹ smart contracts 'provide many benefits and aids to efficiency, productivity and certainty, but they do not sit apart from the law. If a smart contract was in force that was operating illegally, then the contract would be rendered voidable. In this regard, smart contracts face the same issues as traditional contracts in determining legality'.⁹²

To sum up, smart contracts will not 'replace contract law'.⁹³ The existing contract law framework is more than adequate to accommodate even this revolutionary form of deal-making, without the need to create new legal categories that, contrary to a common belief among regulators and policy-makers, are not truly warranted in this case.⁹⁴

25. Having reached such a conclusion one might wonder: 'what happens when the outcomes of the smart contract diverge from the outcomes that the law demands'?⁹⁵

Once again, the answer depends on the applicable (contract) law.

Of course, a national agreement, concluded by national businesses and to be performed only on national soil, would clearly be subject to the corresponding national law, and the jurisdiction would be determined according to the procedural law of that country.

But in relation to international trade, everything is different: it is self-evident that smart contracts may generate enormous problems if the applicable law and the competent jurisdiction are not clearly determined in the agreement; however, as observed above, smart contracts, by their very nature, cannot contain provisions not executable by software (such as the one regarding the applicable law), nor are they built with the intention to depend on third-party judicial enforcement, and, therefore, it is still hard to imagine how they could include provisions on jurisdiction and applicable law.⁹⁶

As observed above, it would therefore appear to be necessary, if such contracts have to be adopted in day-to-day trade practice, to adopt a general agreement (or at least an *ad hoc* provision) that establishes, among the other things, that, in case of need of judicial enforcement, related to the general agreement itself, or to

91 R. O'SHIELDS, 'Smart Contracts: Legal Agreements for the Blockchain', 21 *N.C. Banking Inst.* 177 (2017), p. 189.

92 For similar conclusions, see also P. CATCHLOVE, 'Smart Contracts: A New Era of Contract Use', cited above, note 10, pp 15-16.

93 K. D. WERBACH & N. CORNELL, 67 *Duke Law Journal* 2017, pp 26 ff.

94 For a similar position with regard to virtual currencies, See e.g. P. TASCIA, 'Digital Currencies: Principles, Trends, Opportunities, and Risks', p 26: 'The general orientation is to adopt the current legislation already in place in order to deal with digital currencies in Europe'.

95 M. RASKIN, '1 *Georgetown L. Tech. Rev.* 2017, 304, pp 25 ff.

96 See A. SAVELYEV, 26. *Information & Communications Technology Law* 2017(2), pp 20 ff.

the smart contracts depending upon it, what the applicable law is and which judge has the jurisdiction.

In relation to international trade, this problem may otherwise be without solution; trying to establish the applicable law of a smart contract, in the absence of an explicit choice by the parties, would trigger the well-known problems amplified by the advent of the Internet: should we apply the *lex loci delicti*? The *lex loci contractus*? The *lex loci rei sitae* (the place where the server on which the digital property actually exists)? The *lex loci protectionis*? Or should we use other criteria?

26. Similar problems would arise with regard to jurisdiction.

Therefore, there appears to be a great need for a solution to these uncertainties, or at least a model for a provision/law that deals with them, in order to avoid that, in a near future, if such contracts should truly begin to spread and businesses start to use smart contracts giving them too much confidence, in case of failure of the software, no one knows where to file a lawsuit, according to which law, and therefore how to predict its possible outcome.

Excessive faith in technology without adequate knowledge of the inevitably arising legal problems may cause a disaster.

4.4. Probative Value

27. In any case, independently of the legal nature of such contracts, another issue to be faced is the probative value of blockchain technology.

One possible solution may be to adopt legal presumptions, as the ones introduced by the State of Vermont discussed above.

But, in the absence of such legal presumptions or any other legal disposition, it is fair to assume that every judge will proceed in different ways according to the procedural law of his jurisdiction: he may appoint a court expert (but who? A computer engineer? A mathematician? A computer expert?), he may consider the data in the blockchain as a written proof or just as a simple clue or not as proof at all.

Once again, the applicable law will have the final answer.

4.5. General Data Protection Regulation

28. Finally, a few comments⁹⁷ regarding the relationship between blockchain and the EU Data Protection Regulation – Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural

97 For a preliminary evaluation see ‘Blockchain from a perspective of data protection law, A brief introduction to data protection ramifications’, <https://www2.deloitte.com/dl/en/pages/legal/articles/blockchain-datenschutzrecht.html> (accessed 18 November 2018).

persons with regard to the processing of personal data and on the free movement of such data, also known as ‘GDPR’.

We have seen that smart contracts run on blockchain, which is a distributed database, and, as such, is made of data. Among such data it seems possible to store almost any type of data (even illegal),⁹⁸ including personal data.

In addition, following the approach adopted by the ECJ in the well-known ruling in the case C-131/12 *Google v. Agencia Española de Protección de Datos* (AEPD), the GDPR introduced the so-called ‘right to be forgotten’ (Article 17 of the GDPR) which provides that data subjects have the right to obtain the deletion of their personal data. The problem is that once a piece of data is ‘chained in the blockchain, it is almost impossible to delete it.

What then?

This problem seems both technical and legal at the same time: I believe it is necessary to find some technical ways to make the blockchain compliant with GDPR’s requirements.

Considering that the GDPR has just become enforceable, it is probably too early for an assessment, but it would surely be wise to keep the topic under careful consideration in the coming months.

5. Conclusions

29. This article has attempted to outline the legal landscape arising from blockchain technologies and one of their foremost applications, such as decentralized smart contracts; it has tried to investigate if and to what extent such technologies may imply a legal revolution, or if it is sufficient to simply adapt the existing legal categories to them.

While I acknowledge that decentralized smart contracts and blockchain may become mainstream technologies, I believe that they are not going to prompt a legal revolution.

This article focuses on the issues related to private law. In this regard, the implementation of blockchain-based smart contracts creates problematic legal questions, particularly in relation to the applicable law and to jurisdiction. In fact, decentralized smart contracts are indeed designed with the purpose of avoiding the need of an intermediary to assure the exact performance of a contract, and to be self-sufficient and autonomous; however, sometimes, either due to a bug, or for other reasons related to the dichotomy between real and virtual worlds, the

98 See e.g. M. STOCKLEY, ‘Bitcoin’s blockchain tainted with links to child abuse imagery’ (21 March 2018), nakedsecurity.sophos.com/2018/03/21/bitcoins-blockchain-tainted-with-links-to-child-abuse-imagery/ (accessed 18 November 2018).

intervention of a third party may be necessary to correct them, and to reach the required lawful outcomes of the given contract.

Nonetheless, considering that smart contracts can arguably be deemed actual contracts in their legal meaning, or at the least some form of self-help technology chosen by parties to ensure compliance with contractual obligations, it seems that most of the legal questions arising with smart contracts can and should be dealt with under current contract law provisions; however, it is necessary to identify which national contract law applies to decentralized smart contracts, and this issue may be resolved through an *ad hoc* provision in the agreement, or through the enactment of legal rules applicable to the most problematic aspects of smart contracts, i.e. applicable law and jurisdiction.

