BLOCKCHAIN-BASED SMART CONTRACTS AND CONFLICT RULES FOR BUSINESS-TO-BUSINESS OPERATIONS

BLOCKCHAIN-BASED SMART CONTRACTS Y NORMAS DE CONFLICTO PARA OPERACIONES ENTRE PROFESIONALES

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ABSTRACT: In recent years, the irruption of blockchain technology has enhanced the impact of smart contracts in the international trade scenario, although not without raising some problems, particularly, in terms of Private International Law. This paper, thus, addresses such problems when it comes to determining the applicable law from a business-to-business perspective leaving aside the particular problems raised by the conflict-of-law rules oriented to protect the weaker party to a contract. The analysis, however, starts with a general approach to the two concepts which are the object of this paper: smart contracts and blockchain technology.

RESUMEN: En los últimos años, la irrupción de la tecnología blockchain ha incrementado la proyección de los smart contracts en el escenario del comercio internacional, no sin plantear algunos problemas, en particular, por lo que respecta al Derecho internacional privado. Este artículo, por lo tanto, aborda tales problemas en el ámbito del conflicto de leyes desde una perspectiva business-to-business, dejando de lado los problemas planteados por las normas de conflicto orientadas a proteger a la parte débil del contrato. El análisis, sin embargo, empieza con una aproximación general a los dos conceptos objeto de este artículo: los smart contracts y la tecnología blockchain.

KEYWORDS: Blockchain; Smarts Contracts; Bitcoin; ETHEREUM; Private International Law; Conflict rules; Rome I Regulation.

PALABRAS CLAVE: Blockchain; Smart contracts; Bitcoin; ETHEREUM; Derecho internacional privado; normas de conflicto; Reglamento Roma I.

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I. INTRODUCTION

When anyone is using a vending machine in order to acquire a given product, let's say, a bottle of water, that person is entering into a smart contract, in its most traditional meaning. Indeed, the costumer acquires the selected product by the mere action of introducing coins into the vending machine. This example illustrates the automated execution of the selling obligation as a result of the occurrence of the condition of paying the price by the buyer. Nick Szabo, the legal scholar and cryptographer that coined the above-mentioned expression of smart contracts for the first time in 1994[1], used this concrete example two years later[2] to illustrate how an automated contractual obligation works.

Now, in the 21st century, the irruption of distributed digital ledgers[3] has enhanced smart contracts' functionalities to such an extent that major industries such as insurance, health, energy, finance and telecommunications, among others, are utilizing blockchain-based smart contracts to either transact[4] or develop projects aimed at implementing such a technology.[5] To introduce just one example, blockchain-based smart contracts can enable one party to deploy a smart contract on a given blockchain which, in exchange for a cryptoasset, performs algorithmic investment.[6]

Beyond the technological and computational analysis, legal research on blockchain-based smart contracts has also been conducted in recent years, although most of it has focused mainly on the compatibility of smart contracts with Contract Law, while little attention has been paid to smart contracts and Conflict of Laws.[7] The still-emerging concept of

[1] SZABO, N., "Smart Contracts", 1994, available at: https://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/smart.contracts.html.

[2] SZABO, N., "Smart Contracts: Building Blocks for Digital Markets", 1996, available at: https://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/smart_contracts_2.html.

[3] Satoshi Nakamoto, an alias for a person or people behind it, invented the first decentralized public digital ledger for transacting with Bitcoin, a virtual currency; NAKAMOTO, S., "Bitcoin: Peer-to-Peer Electronic Cash System", October 2008, available at: https://bitcoin.org/bitcoin.pdf.

[4] For instance, see SMART CONTRACTS ALLIANCE and DELOITTE, "Smart Contracts: 12 Use Cases for Business & Beyond", 2016, p. 9, available at: https://digitalchamber.org/wp-content/uploads/2018/02/Smart-Contracts-12-Use-Cases-for-Business-and-Beyond_Chamber-of-Digital-Commerce.pdf; EUROPEAN PARLIAMENT, *Blockchain for supply chains and international trade. Report on key features, impacts and policy options*, May 2020, available at: https://www.europarl.europa.eu/RegData/etudes/STUD/2020/641544/EPRS_STU(2020)641544_EN.pdf.

[5] CBINSIGHTS, "Banking is Only the Beginning: 58 Big Industries Blockchain Could Transform", April 2, 2020, available at: https://www.cbinsights.com/research/industries-disrupted-blockchain/; ORTEGA GIMÉNEZ, A., *"Smart Contracts" y Derecho internacional privado,* Pamplona, 2019, pp. 37-42.

[6] UK JURISDICTION TASKFORCE, "Legal statement on cryptoassets and smart contracts", November 2009, pp. 33-34, available at: https://technation.io/about-us/lawtech-panel/. Besides, on this type of smart contract, see also TJONG TJIN TAI, T., "Implementing Excuses", in DIMATTEO, L. A., CANNARSA, M. and PONCIBÒ, C. (eds.), *The Cambridge Handbook of Smart Contracts, Blockchain Technology and Digital Platforms*, Cambridge University Press, Cambridge, 2020, pp. 82-83 (pp. 80-101).

[7] On Smart contracts and conflict of laws, see RÜHL, G., "The Law Applicable to Smart Contracts, or Much Ado About Nothing", Blog post, https://www.law.ox.ac.uk/business-law-blog/blog/2019/01/law-

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smart contract may be one of the main reasons for this situation, not to mention the fact that if this concept is tied to blockchain technology, this, in turn, may adopt different connotations.

This paper is, therefore, situated within this context. It seeks to display the main problems encountered by blockchain-based smart contracts in the process of ascertaining their applicable law in accordance with the general connecting factors laid down in Articles 3 and 4 of the Regulation (EC) No 593/2008 of the European Parliament and the Council of 17 June 2008 on the law applicable to contractual obligations (Rome I)[8] (hereinafter, Rome I Regulation). Therefore, the current paper does not address the other specific conflict-of-law rules set out in the same Regulation such as, for example, rules on consumer, employee, insurance or transport contracts. Likewise, non-contractual aspects raised by smart contracts, such as damages that they may be caused to third parties for inaccurate data storage[9] or the fraud or theft that developers and/or the nodes involved in the blockchain may commit against the users of such network in the absence of a contractual relationship[10], or when the smart contract satisfies a payment to the wrong recipient[11], are beyond the scope of this paper.

All things considered; this research starts with a brief explanation of the meaning of the concept of blockchain-based smart contracts (paragraph II). After this opening explanation, the second part deals with the law applicable to these contracts starting with the distinction between the material and formal validity of blockchain-based smart contracts and then goes on to explore some of the most relevant problems that the general connecting factors embedded in Articles 3 and 4 of the Rome I Regulation may give rise to when applied to smart contracts (paragraph III). Finally, this paper concludes with some final remarks (paragraph IV).

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applicable-smart-contracts-or-much-ado-about-nothing, consulted 24/02/2020; RÜHL, G., "Smart (legal) contracts, or: Which (contract) law for Smart contracts?", in CAPPIELLO, B. and CARULLO, G. (eds.), *Blockchain, Law and Governance*, *Springer*, 2021, and available at SSRN: https://ssrn.com/abstract=3552004; GUILLAUME, F., "Aspects of private international law related to blockchain transactions", in KRAUS, D., OBRIST, T. and HARI, O. (eds.), *Blockchains, Smart Contracts, Decentralized Autonomous Organizations and the Law*, Edward Elgar, Cheltenham/Northampton, 2019, pp. 49-82; GUILLAUME, F., "Blockchain: le pont du droit international privé entre l'espace numérique et l'espace physique", in PRETELLI, I. (ed.), *Le droit international privé dans le labyrinthe des plateformes digitales*, Schulthesse Éditions Romandes, Genève/Bâle/Zurich, 2018, pp. 163-189; ZIMMERMANN, A. S., "Blockchain Networks and Private International Law", Blog post accessible at https://conflictoflaws.net/2018/blockchain-networks-and-european-private-internationale-law/; INTERNATIONAL SWAP AND DERIVATIVES ASSOCIATION, *Private International Law Aspects of Smart Derivatives Contracts Utilizing Distributed Ledger Technology*, 13 January 2020, available at: https://www.isda.org/2020/01/13/private-international-law-aspects-of-smart-derivatives-contracts-utilizing-distributed-ledger-technology/.

[8] Regulation 593/2008 [2008], *OJ* L177/6.

[9] ZETZSCHE, D., BUCKLEY, R. P. and ARNER, D. W., "The Distributed Liability of Distributed Ledgers: Legal Risks of Blockchain", *European Banking Institute Working Paper Series*, 2017, no. 14, p. 28.

[10] ZETZSCHE, D., BUCKLEY, R. P. and ARNER, D. W., *supra, loc. cit.*, p. 34.

[11] GUILLAUME, F., "Aspects of private international law related to blockchain transactions", *supra, loc. cit.*, pp. 67-68.

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II. BLOCKCHAIN-BASED SMART CONTRACTS' LEGAL IMPLICATIONS

1. Definition of blockchain-based smart contracts

Let us take as an example the case of a flood insurance contract whereby the insurer is obliged to satisfy a certain indemnity to the insured party in exchange for a premium, providing that the insured party sustains losses, covered by that insurance policy, as a result of water damages caused by the flooding, or another example would be a contract of carriage whereby an airline company obliges itself to pay the passenger a certain amount of money if the flight is delayed. Now, let us imagine that a software code performs by automation the payment's contractual obligations of the abovementioned contracts replacing, thus, any human intervention in relation to that particular obligation. These two latter case scenarios show the existence of a smart contract (self-executing computer code) underlying the contractual agreement. Indeed, the payment obligation in both contracts can be satisfied using the smart contract (self-executing computer code) by means of transferring the respective amounts of money from the payers' (either the insurer company or the airline) crypto wallets (cyber accounts) to the addressees' (either the insured party or the passenger) crypto wallets (cyber accounts). In addition, the communication of the loss, that is to say, the notification of the flood and the delay of the flight respectively, to the smart contract (self-executing computer code) could also be automated if oracles were used.[12]

These examples illustrate that the starting point of any approach to the concept of smart contract lies in the technological factor: a self-executing computer code. Thus, the concept of smart contract refers to the existence of a computer or software code[13] capable of executing a given protocol upon the occurrence of particular conditions.

What is more, nowadays most of the proposals for a definition of the term "smart contract" integrate the blockchain technology into the definition itself because this technology has enhanced the functionality of smart contracts in comparison to the original examples of such contracts. Thus, blockchain technology has rendered smart contracts

[12] Oracles are third-party services that provide external information to the blockchain-based smart contract in order to help all of the conditions and terms of the smart contract to execute properly. An example of an oracle platform is, for instance, Provable Oracle Blockchain (https://provable.xyz/).
For the concept and functions of oracles see, among others, TUR FERNÁNDEZ, C., *Smart contracts. Análisis jurídico*, Reus, 2018, pp. 112-114; CARIA, R. de, "Between Law and Code", in DiMATTEO, L. A., CANNARSA, M. and PONCIBÒ, C. (eds.), *The Cambridge Handbook of Smart Contracts, Blockchain Technology and Digital Platforms*, Cambridge University Press, Cambridge, 2020, p. 29 (pp. 19-36); TJONG TJIN TAI, E., "Implementing Excuses", *supra, loc. cit.*, pp. 83-84; MIK, E., "Blockchains. A Technology for Decentralized Marketplaces", in DiMATTEO, L. A, CANNARSA, M. and PONCIBÒ, C. (eds.), *The Cambridge Handbook of Smart Contracts, Blockchain Technology and Digital Platforms*, Cambridge University Press, Cambridge, 2020, pp. 175-176 (pp. 160-182).

[13] See, for instance, TANK, M., WHITAKER, D. and FRY, P., "Chapter 2: Smart Contracts, Blockchain and Commercial Law", in SMART CONTRACT ALLIANCE, *Smart Contracts: Is the Law Ready?*, September 2018, p. 37 (pp. 36-49), available at: https://digitalchamber.org/smart-contracts-whitepaper/; LOW, K. F. K. and MIK, E., "Pause the Blockchain Legal Revolution", *International and Comparative Law Quarterly*, Vol. 69, January 2020, p. 165 (pp. 135-175).

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self-executing, immutable and permanent, if we consider the general characteristics attributable to blockchain technology.

In this regard, some of the current definitions of a smart contract describe such a contract as a "piece of special purpose code that executes a complex set of instructions on the blockchain"[14], or as "a piece of code which is stored on a Blockchain, triggered by Blockchain transactions[15], and which reads and writes data in that Blockchain's data base"[16] or, even, as "immutable computer programs that run deterministically in the context of an Ethereum Virtual Machine as part of the Ethereum network protocol" in the Ethereum network context.[17] The same meaning has been laid down in some legal systems such as in Arizona, whose provision 44-7061 E2 declares that a ""smart contract" means 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".[18]

Additionally, the term smart contract may also have legal implications when it stands for a contractual agreement. Indeed, as can graphically be pointed out "there is a Frankenstein dimension to a smart contract: an instrument that fuses something innately human, entering into and enforcing agreements, with something mechanical, derived from scientific experiments"[19]. This statement indicates the two most significant elements intertwined in the smart contract concept from a legal view: an agreement between two or more parties and a computer code. In other words, the will of the parties is expressed in computer code. This approach was adopted by N. Szabo when defining, for the first time, smart contracts as a "set of promises specified in digital form including protocols within which the parties perform on these promises" and that was illustrated by the example of the vending machine as explained at the introduction of this paper.[20] In this same vein, some authors have coined the expression smart *legal* contracts[21] to refer to contractual agreements expressed in the smart contract self-executing computer code.

[14] TAPSCOTT, D., and TAPSCOTT, A., *Blockchain Revolution: How the Technology Behind Bitcoin and Other Crytocurrencies is Changing the World*, Portfolio/Penguin, New York, 2018, p. 46. In the same vein, see TUR FERNÁNDEZ, C., *supra, op. cit.*, p. 60.

[15] In terms of blockchain, the term "transaction" does not hold legal connotations. Particularly, in the context of the Ethereum blockchain, an Ethereum transaction is "basically a request to access a particular account with a particular Ethereum address"; ANTONOPOULOS, A. M. and WOOD, G., *Mastering Ethereum: Building Smart Contracts and Dapps*, O'Reilly, 2018, p. 62.

[16] GREENSPAN, G., "Beware of the impossible Smart Contract", 12 April 2016, *Blockchain News*, available at: https://www.the-blockchain.com/2016/04/12/beware-of-the-impossible-smart-contract.

[17] ANTONOPOULOS, A. M. and WOOD, G., *supra, op. cit.*, p. 127.

[18] House Bill 2417/2017 available at: https://www.azleg.gov/legtext/53leg/1r/bills/hb2417p.pdf.

[19] WERBACH, K. and CORNELL, N., "Contracts *ex machine"*, Vol. 67, *Duke Law Journal*, 2017, p. 364 (pp. 313-382).

[20] SZABO, N., "Smart Contracts: Building Blocks for Digital Markets", *supra, loc. cit.*

[21] This same term has already been used by other scholars such as STARK, J., "Making sense of Blockchain Smart Contracts", June 7, 2016, available at: https://www.coindesk.com/making-sense-smart-contracts; TUR FERNÁNDEZ, C., *supra. op. cit.*, p. 60 and pp. 140-141.

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Additionally, other legal scholars have referred to smart contracts as agreements the execution of which is automated[22], among many other references and definitions.

Unlike traditional digital contracts in which the execution is subject to human behavior[23], what makes blockchain-based smart contracts attractive for traders is their self-executing nature. Which means that the performance of the coding contractual clauses and terms takes place automatically through the nodes (computers) that run the blockchain network without requiring the intervention of the contracting parties or any other third parties, such as lawyers, agents, banks, notaries or other public or private entities. In the same vein, smart contracts are also deterministic because they only execute what has been coded. To put it another way, the digital code determines what the smart contract may or may not execute.[24] This is to say, the result of the performance is previously prescribed by the code, and by the protocol underlying such a code, and it is the same for everyone who runs it.[25] This characteristic reveals that only the contracts likely to be executed entirely on-line fit into the concept of smart contracts as self-executing contracts. In this regard, contracts that entail a payment as an exchange of an asset or service provided on-line are the ones that best suit this category of contracts. However, smart contracts can also be used to execute only some of the obligations of a conventional contractual agreement like the payment obligation, as will be examined below. From this, it also follows that blockchain-based smart contracts are not a new substantive category of contracts, but rather a form that the contracting parties may adopt to externalize and perform their contractual obligation.

The smart contract's self-executing and deterministic nature, in its purest and technological sense, obliges contracting parties to envisage all possible legal situations as well as ensuring the performance of the contracting parties' obligations as a result of the smart contract's performance being automated (run by the nodes of the blockchain network). Consequently, strictly speaking, in terms of technology or computation, a breach of smart contract is not possible.[26] This is what, in the legal scenario, has been interpreted as an absence of the law to be involved in this digital world. Let us take again the example of the case of a flood insurance smart contract whereby the insurer is obliged to satisfy a certain indemnity to the insured party, in exchange for a premium, if the insured party sustains losses, covered by the insurance policy, as a result of water damages caused by the flooding. In this situation, the contract cannot be breached if the contracting parties' obligations are exclusively dependent on the smart contract as a self-

[22] RASKIN, M., "The Law and Legality of Smart Contracts", Vol. 1, *Georgetown Law Technology Review*, 2017, p. 309 (pp. 305-341).
[23] For an analysis of the evolution of digital agreements, see WERBACH, K. and CORNELL, N., *supra, loc. cit.*, pp. 320-324.
[24] CATCHLOVE, P., "Smart Contracts: A New Era of Contract Use", December 2017, p. 16, available at: SSRN: https://ssrn.com/abstract=3090226, p. 16.
[25] ANTONOPOULOS, A. M. and WOOD, G., *supra, op. cit.*, p. 128.
[26] WERBACH, K., "Trust, but Verify: Why the Blockchain Needs the Law", Issue 33, *Berkeley Technology Law Journal*, 2018, pp. 528-529 (pp. 489-552); WERBACH, K. and CORNELL, N., *supra, loc. cit.*, pp. 331-333; SAVELYEV, A., "Contract Law 2.0: "Smart" Contracts as the beginning of the end of classic Law", *Working Papers, Series: Law*, National Research University, Higher School of Economics, WP BRP 71/LAW/2016, p. 15, available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2885241.

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executing contract, insofar as all of these obligations are automated and, therefore, do not depend on the contracting parties will and subsequent actions any more. As a result, on a theoretical level, non-enforcement by courts or arbitrators is needed since the smart contract cannot be breached insofar as the smart contract will automatedly proceed to satisfy the indemnity to the insured party once such a contract receives the external input (through the oracle) of the flooding on the insured party's property. Moreover, even in the event of having a judicial decision holding a smart contract to be enforceable, this judgment could not undo the results of the automated contractual obligations[27] because their execution depends exclusively on a software program that cannot be altered once it has been stored on the blockchain. Therefore, in this scenario, a new smart contract should be concluded between the original parties in order to enforce the aforementioned agreement undoing the effects of the previous smart contract.[28] In other situations, the collaboration of a participant in the blockchain network would be required to ensure the enforcement of the judicial decision.

In order to illustrate how the software coding language of a smart contract blends the two technological and legal approaches of this term, we might examine the case of a "Safe remote purchase"[29]. This example, retrieved from the website Solidity[30], illustrates the problematic issue of dealing with the risk of the arrival of the goods at the buyer's premises. In this scenario, the smart contract is an escrow agreement drawn up to protect both parties. Thus, both of them must place into the smart contract twice the value of the goods sold. The seller will not recoup the given amount plus the value of the goods until the buyer confirms the receipt of the goods. On occurrence of this confirmation, the buyer will also get half of the value placed back. The smart contract itself will proceed to transfer both amounts of money without the intervention of either the counterparties or other third parties (self-executing function). Pursuant to the above-mentioned transaction, the digital coded agreement is represented as follows:

```
// SPDX-License-Identifier: GPL-3.0
pragma solidity ^0.7.0;

contract Purchase {
    uint public value;
    address payable public seller;
    address payable public buyer;
```

[27] WERBACH, K. and CORNELL, N., *supra, loc. cit.*, p. 333.
[28] LEHMANN, M., "Who Owns Bitcoin? Private Law Facing the Blockchain", Volume 21, *Minnesota Journal of Law, Science & Technology*, 2020, Issue 1, p. 120 (pp. 93-136).
[29] The example is accessible on: https://docs.soliditylang.org/en/v0.7.4/solidity-by-example.html#safe-remote-purchase.
[30] Solidity is the computational language mostly used by Ethereum as a public blockchain interface. Other high-level smart contract programming languages executed by Ethereum are LLL, Serpent and Mutan, ANTONOPOULOS, A. M. and WOOD, G., *supra, op. cit.*, p. 300. On Ethereum see: https://ethereum.org/en/.

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```
enum State { Created, Locked, Release, Inactive }
// The state variable has a default value of the first member,`State.created`
State public state;

modifier condition(bool _condition) {
        require(_condition);
        _;
}
modifier onlyBuyer() {
        require(
                msg.sender == buyer,
                "Only buyer can call this."
        );
        _;
}
modifier onlySeller() {
        require(
                msg.sender == seller,
                "Only seller can call this."
        );
        _;
}
modifier inState(State _state) {
        require(
                state == _state,
                "Invalid state."
        );
        _;
}
event Aborted();
event PurchaseConfirmed();
event ItemReceived();
event SellerRefunded();

// Ensure that `msg.value` is an even number.
// Division will truncate if it is an odd number.
// Check via multiplication that it wasn't an odd number.
constructor() public payable {
        seller = msg.sender;
        value = msg.value / 2;
        require((2 * value) == msg.value, "Value has to be even.");
}
/// Abort the purchase and reclaim the ether.
/// Can only be called by the seller before
/// the contract is locked.
function abort()
```


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```
        public
        onlySeller
        inState(State.Created)
{
        emit Aborted();
        state = State.Inactive;
        // We use transfer here directly. It is
        // reentrancy-safe, because it is the
        // last call in this function and we
        // already changed the state.
        seller.transfer(address(this).balance);
}
/// Confirm the purchase as buyer.
/// Transaction has to include `2 * value` ether.
/// The ether will be locked until confirmReceived
/// is called.
function confirmPurchase()
        public
        inState(State.Created)
        condition(msg.value == (2 * value))
        payable
{
        emit PurchaseConfirmed();
        buyer = msg.sender;
        state = State.Locked;
}
/// Confirm that you (the buyer) received the item.
/// This will release the locked ether.
function confirmReceived()
        public
        onlyBuyer
        inState(State.Locked)
{
        emit ItemReceived();
        // It is important to change the state first because
        // otherwise, the contracts called using `send` below
        // can call in again here.
        state = State.Release;

        buyer.transfer(value);
}
/// This function refunds the seller, i.e.
/// pays back the locked funds of the seller.
function refundSeller()
        public
        onlySeller
```


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```
            inState(State.Release)
        {
            emit SellerRefunded();
            // It is important to change the state first because
            // otherwise, the contracts called using `send` below
            // can call in again here.
            state = State.Inactive;

            seller.transfer(3 * value);
        }
}
```

2. Blockchain technology improves smart contracts' functionalities

As noted above, blockchain technology has made smart contracts self-executing, immutable and permanent. This sort of technology was created by Satoshi Nakomoty so as to promote and transact with the virtual currency Bitcoin.[31]

Pursuant to its literal meaning, blockchain is a chain of blocks. However, when it comes to technological and computational perspectives, the unequivocal definition disappears in favor of different ones with specific connotations depending on the features attributable to each of them.[32] Thus, blockchain may be defined as a computational tool, program, software or database used for being run either as a ledger[33] storing data, normally in an immutable way, or as a transactional platform on which to operate and record the transactions concluded therein.[34] The main difference between both approaches to the term blockchain lies in the fact that the first approach denies the idea that blockchain can move assets since it only registers changes of state. Nevertheless, the evolution of this technology has combined the two approaches, thus referring to the term blockchain as "a

[31] NAKAMOTO, S., "Bitcoin: Peer-to-Peer Electronic Cash System", 2008, available at: https://bitcoin.org/bitcoin.pdf. The identity, whether it is a natural person or a legal entity, of Satoshi Nakamoto remains still anonymous.
In July 2020, the total USD value of Bitcoin in circulation was approximately of 173.768$ billion. The Bitcoin network, using Bitcoin as its cryptocurrency, was also the blockchain most widely used during the year 2019 as the amount of 155,490,287$ spent on the network in fees by the users indicates; "Market Capitalization" available at: https://www.blockchain.com/charts/market-cap. Besides, "Bitcoin's price nearly doubled in 2019 despite dampened media coverage. Goldman Sachs named it the best-performing asset in 2019. However, since the coronavirus sell-off, BTC is down ~30% YTD", CBINSIGHTS, *The Blockchain Report 2020*, 2020, p. 4, available at https://www.cbinsights.com/research/report/blockchain-report-2020/

[32] For instance, for the characteristics attributable to Ethereum see ANTONOPOULOS, A. M. and WOOD, G., *supra, op. cit*., p. 2. In relation to Bitcoin blockchain's characteristics see, among others, ANTONOPOULOS, A. M., *Mastering Bitcoin*, O'Reilly, 2019, pp. 1-2, p. 25, p. 158, p. 196 and p. 200.

[33] See MIK, E., *supra, loc. cit*., p. 162 and p. 170. This interpretation makes the difference between the register or ledger itself and the program running the transactions on the blockchain very clear, as is the case with Ethereum in which Ethereum Virtual Machine, as a computation engine, is in charge of running the transactions to update the Ethereum state. See on this aspect, ANTONOPOULOS, A. M. and WOOD, G., *supra, op. cit*., p. 297, p. 300 and p. 303.

[34] GUILLAUME, F., "Aspects of private international law related to blockchain transactions", *supra, loc. cit*., p. 49.

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species of distributed databases that are maintained by a network of geographically dispersed computers, or 'nodes'".[35] Therefore, the blockchain ecosystem may cover the ledger, the network and the consensus protocol.[36]

Originally, Satoshi Nakamoto built up the Bitcoin blockchain network as a digital decentralized (peer-to-peer) network composed of distributed nodes[37] (computers) that store a full, public and identical record of timestamped transactions (bitcoin) made in the blockchain as a result of all of them being validated by the above-mentioned nodes[38] and being incorporated (through the mining[39] process) permanently into time-ordered blocks. One of the Bitcoin network's purposes was avoiding the so-called double-spending problem[40] whereby one party could dispose of its bitcoins more than once without any trusted third party controlling bitcoin issuances and transfers of them. Making the blockchain immutable (unmodifiable) avoids this problem.

Bitcoin network is a permissionless, public and decentralized blockchain because anyone willing to transact in the blockchain can join the network without disclosing his or her identity and also any user may read the cryptographed transactions stored therein (transparency). As a consequence, the whole community of nodes (decentralized community) controls the transaction process, thereby rendering the network tamper-proof. The same characteristics are attributable to another blockchain especially created to run smart contracts -the Ethereum blockchain.[41] The main difference, thus, between both sorts of blockchain lies in the fact that while Bitcoin blockchain is principally a digital currency payment network, Ethereum was primarily created to execute smart contracts,[42] without neglecting its capacity to accommodate payments as well.

As for the permissionless and public features, users of blockchain networks, rather than trusting the authority of a trusted third party (intermediaries such as, for instance, a lawyer, a notary, a bank or other public or private authorities), can place their trust in the

[35] LOW, K. F. K. and MIK, E., *supra, loc. cit.,* p. 137.
[36] WERBACH, K. and CORNELL, N., *supra, loc. cit*., p. 326.
[37] The functionalities that nodes may carry out depend on the particular blockchain on which they operate. For instance, they may be "full nodes" capable of validating and storing all the transactions run on the network or just able to deploy some of their functions.
[38] The nodes collect fees as a reimbursement for their validation work.
[39] Technically speaking, this term refers to the programming process whereby the nodes (computers connected to the network) incorporate the transaction on a new block which, in turn, is added to the chain. The programming process consists of "finding a solution to the Proof-of-Work algorithm that makes the block valid", ANTONOPOULOS, A. M., *supra, op. cit*., p. 192. In its operational meaning, "mining is the process of hashing the block header repeatedly, changing one parameter, until the resulting hash matches a specific target", ANTONOPOULOS, A. M. and WOOD, G., *supra, op. cit*., pp. 321-322 in relation to the mining process on Ethereum.
[40] NAKAMOTO, S., *supra, loc. cit*., p. 12 available at: https://bitcoin.org/bitcoin.pdf.
[41] See https://ethereum.org/en/. And as a general and complete guide on Ethereum, see also ANTONOPOULOS, A. M. and WOOD, G., *supra, op. cit*.
[42] ANTONOPOULOS, A. M. and WOOD, G., *supra, op. cit*., pp. 1-3; IDELBERGER, F., "Connected contracts reloaded – Smart contracts as contractual networks", in GRUNDMANN, S. (ed.), *European Contract Law in the digital age*, Intersentia, Cambridge/Antwerp/Portland, 2018, p. 207 (pp. 205-235).

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computer code underlying the blockchain technology.[43] This, in turn, corresponds to saving in transaction costs. Indeed, permissionless blockchains like Bitcoin and Ethereum are decentralized in the sense that the governance of the blockchain is spread out over the nodes with all of them being equal (peer-to-peer). Indeed, none of them centralizes the governance of the blockchain[44], this is to say, there is no central administrator or designated authority. And the consensus[45] is the mechanism utilized by the nodes in order to approve and incorporate (mining) the transactions into the time-ordered block. Therefore, blockchain technology presents itself as a self-regulatory system not dependent on States, but only on the computer protocol and nodes that comprise the blockchain network.[46]

Furthermore, the trust in the code also justifies the pseudonymous character of permissionless blockchains such as Bitcoin or Ethereum. Indeed, users of either of these do not have to identify themselves when acting on the networks. They only have to download the appropriate software of the blockchain and the type of client they wish to run. In order to guarantee their anonymity and operate inside the blockchain, all the clients (users) hold two keys (private and public) that allow them to be identified through a public address but without ever revealing their private identities at any time. It is, needless to say, this very anonymity and, to some extent, untraceability[47] that may render obtaining legal remedies particularly difficult[48] (this situation is qualified as "Know Your Customer"), as I will analyze below when dealing with the law governing blockchain-based smart contracts.

Conversely, clients of permissioned blockchains such as, for example, Hyperledger[49] or R3 Corda[50], must satisfy the requirements established by the entity or organization controlling the blockchain in order to access the aforementioned blockchains. Thus, these clients are completely known, since they have to disclose their identities. This condition enables us, among other aspects, to hold them accountable for their acts and, in turn, has

[43] MIK, E., *supra, loc. cit.*, p. 163.
[44] ANTONOPOULOS, A. M., *supra, op. cit.*, p. 139.
[45] The consensus protocol may vary depending on the blockchain. The most well-known consensus protocol is proof-of-work, used in the Bitcoin Blockchain and Ethereum Blockchain. However, proof-of-stake is going to be implemented in Ethereum, thereby replacing proof-of-work. On this aspect, see: https://docs.ethhub.io/ethereum-roadmap/ethereum-2.0/proof-of-stake/.
[46] See, among others, MÖSLEIN, F., "Conflict of Laws and Codes: Defining the Boundaries of Digital Jurisdictions", July 2018, pp. 3-5, available at SSRN: http:ssrn.com/abstract=3174823; GUILLAUME, F. F., "Aspects of private international law related to blockchain transactions", *supra, loc. cit.*, pp. 71-72; LEHMANN, M., *supra, loc. cit.*, p. 117.
[47] With regard to traceability, it is noteworthy that an "Internet service provider like Time Warner that assign IP addresses do keep records linking identities to accounts. Likewise, if you get a bitcoin wallet from a licensed online exchange such as Coinbase, that exchange is required to do its diligence under AML/KYC requirements. […] So governments can subpoena ISPs and exchanges for this type of user data. But they can't subpoena the blockchain", TAPSCOTT, D., and TAPSCOTT, A., *supra, op. cit.*, p. 44.
[48] MÖSLEIN, F., *supra, loc. cit.*, p. 16.
[49] See https://www.hyperledger.org/.
[50] See https://www.r3.com/corda-platform/.

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made permissioned blockchains especially interesting for supporting commercial operations.[51]

Finally, Bitcoin, Ethereum and public blockchains in general also stand out because of the immutability or irreversibility of the information recorded in them. In this regard, the data or value stored on the blockchain remains immutable for the sake of the protection of the parties involved in the operation, but also of third parties interested in it, because, as a general rule, no one party, either unilaterally or by agreement, holds the right to edit, update or reverse transactions already recorded on the blockchain. This being said, the original contracting parties could reach a new agreement in order to reverse or extend the previous one. What is more, as regards the Ethereum blockchain in particular, its protocol contemplates the self-destruction function aimed at deleting the smart contract only if the smart contract code embeds such a possibility[52]. By contrast, permissioned blockchains allow the central administrator or the designated authority to alter or modify the transactions already stored.[53]

Nevertheless, immutability may pose some doubts concerning, among others, its alignment with the General Data Protection Regulation[54] and the right to be forgotten.[55] Thus, some computer scientists[56] have invented a solution especially designed for permissioned blockchains insofar as a trusted third party will be in charge of the editing. "The invention modifies existing blockchain technology to allow designated authorities to edit, rewrite or remove previous blocks of information without breaking the chain".[57]

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[51] See GARCÍA GONZÁLEZ, L. C., POLO TOLÓN, M. and MOLERO MANGLANO, I., "Capítulo 12: Tecnologías blockchain", in PREUKSCHAT, A., *Blockchain: la revolución industrial de internet,* Gestión 2000, Grupo Planeta, 2017, Location 3521; BitFury GROUP, "Public versus Private Blockchains, Part 1: Permissioned Blockchains, White Paper", October 20, 2015, p. 3, available at: https://bitfury.com/content/downloads/public-vs-private-pt1-1.pdf; MEKKI, M., "Blockchain: l'exemple des smart contrats entre innovation et précaution", May 2018, p. 2 and p. 10, accessible at: https://www.mekki.fr/files/sites/37/2018/05/Smart-contracts.pdf; MIK, E., *supra, loc. cit.*, p. 164; EUROPEAN PARLIAMENT, *Blockchain for supply chains and international trade. Report on key features, impacts and policy options*, May 2020, p. 6, pp. 68-69 and p. 114 available at: https://www.europarl.europa.eu/RegData/etudes/STUD/2020/641544/EPRS_STU(2020)641544_EN.pdf.

[52] ANTONOPOULOS, A. M. and WOOD, G., *supra, op. cit.*, pp. 143-145; MARINO, B. and JVELS, A., "Setting Standards for Altering and Undoing Smart Contracts", *RuleML*, 2016, p. 158 (pp. 151-166), available at: https://www.arijuels.com/publications/ .

[53] See MIK, E., *supra, loc. cit.*, pp. 171-172.

[54] Regulation (EU) 2016/679 of the European Parliament and of the Council, of 27 April 2016, on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), *OJ* L 119/1.

[55] For example, see TAMARGO, M., "Conflicto entre la tecnología blockchain y la normativa de protección de datos", *Economist and Jurist*, 4 August 2020, available at: https://www.economistjurist.es/noticias-juridicas/conflicto-entre-la-tecnologia-blockchain-y-la-normativa-de-proteccion-de-datos/

[56] ATENIESE, G., MAGRI, B., VENTURI, D. and ANDRADE, E., "Redactable Blockchain - or – Rewriting History in Bitcoin and Friends", May 11, 2017, p. 6, available at: https://eprint.iacr.org/2016/757.pdf .

[57] LUMB, R., TREAT, D., and JELF, O., "Editing the Uneditable Blockchain. Why distributed ledger technology must adapt to an imperfect world", 2016, p. 7, available at: https://www.accenture.com/_acnmedia/pdf-33/accenture-editing-uneditable-blockchain.pdf#zoom=50

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It is, however, this very solution which undermines the disintermediation characteristic attributable to some blockchain technologies.[58]

III. THE LAW APPLICABLE TO BLOCKCHAIN-BASED SMART CONTRACTS

1. Relevance of determining the law applicable to blockchain-based smart contracts

It is been occasionally said that smart contracts could replace lawyers[59], albeit this is an overstatement considering that any contract properly performed does not require the assistance of lawyers, or that its mathematical universal language ensures uniform execution of these kinds of contracts thereby making the differences in national laws irrelevant[60] and even rendering useless the recourse to any law. The self-executing nature of blockchain-based smart contracts has led to such interpretations insofar as once they have been digitally coded and stored in the blockchain, their performance depends exclusively on the conditions or transactions[61] encoded in the particular smart contract, on the blockchain and, when necessary, on the so-called oracles.[62]

In any event, though, the contracting parties retain the right to access justice in order to have their contractual agreements enforced by either judicial or arbitral authorities regardless of them having opted for automatizing their contractual relationship insofar as the existence and material validity of the contractual obligation does not depend on the technology. To sum up, "smart contracts may be outside the law, but they are not above the law".[63]

As a result, with regard to the enforcement of smart contracts, the reasons that may lead contracting parties to seek recourse to justice may be associated with different reasons. For instance, a deficient performance of the smart contract due to software programming bugs that affect the digital code or result in a failure in the system that produces an unexpected result or discrepancies between the conventional contractual terms and

[58] GARCÍA-TERUEL, R. M., "Legal challenges and opportunities of blockchain technology in the real estate sector", Vol. 12, *Journal of Property, Planning and Environmental Law,* 2020, Issue 2, p. 141 (pp. 129-145).

[59] OZELLI, S., "Smart Contracts are Taking Over Functions of Lawyers: Expert blog", January 12, 2018, available at: https://cointelegraph.com/news/smart-contracts-are-taking-over-functions-of-lawyers-expert-blog.

[60] SAVELYEV, A., *supra, loc. cit.,* p. 21.

[61] In the Ethereum scenario, smart contracts can only be run if they are called by transactions; ANTONOPOULOS, A. M. and WOOD, G., *supra, op. cit.,* p. 125 and p. 128. And an Ethereum transaction is "basically a request to access a particular account with a particular Ethereum address"; ANTONOPOULOS, A. M. and WOOD, G., *supra, op. cit.,* p. 62.

[62] On oracles see *supra*, footnote 12.

For the concept and functions of oracles see, among others, TUR FERNÁNDEZ, C., *supra, op. cit.,* pp. 112-114; CARIA, R. de, *supra, loc. cit.,* p. 29; TJONG TJIN TAI, E., "Implementing Excuses", *supra, loc. cit.,* pp. 83-84; MIK, E., *supra, loc. cit.,* pp. 175-176.

[63] PONCIBÒ, C. and DiMATTEO, L. A., "Contractual and Noncontractual Remedies", in DiMATTEO, L. A., CANNARSA, M. and PONCIBÒ, C. (eds.), *The Cambridge Handbook of Smart Contracts, Blockchain Technology and Digital Platforms,* Cambridge University Press, Cambridge, 2020, p. 121 (pp. 118-140).

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conditions and their digital version, when two versions of the contractual terms exist.[64] In addition, there is also the possibility of including certain provisions in the smart contract to be executed at some time in the future that cannot eventually be performed[65] in the case of a contracting party being bankrupted, for example, or even when a situation arises in which either of the two parties to the smart contract may have been induced by fraud, duress or undue influence to conclude the contract.[66] Even though all of these foregoing operations are effective pursuant to the blockchain, because blockchain technology keeps itself external to these technical and legal problems, the recourse to judicial or arbitral authorities remains available for the aggrieved party and, as a consequence, questions regarding the competent jurisdiction and the applicable law may arise. In this context, the nature of the blockchain-based smart contract may determine the answer to these questions, as will be explained in the following paragraph in relation to the governing law. What remains, clear, however, is that programming language does not render conflict-of-law rules useless[67], and as a consequence, the questions to be answered are: to what extent do the current conflict-of-law rules accommodate blockchain-based smart contracts in their substantive scope? and can they be appropriate for designating the law which governs them?

2. Material versus formal validity of blockchain-based smart contracts

Consequently, when it comes to determining the law applicable to blockchain-based smart contracts, a first distinction must be drawn between substance and form, in spite of the opinion that substance and form are closely and logically related.[68] What is more, most of the time it is very difficult to draw the distinction between form and substance.[69] And, blockchain-based smart contracts illustrate such a level of complexity in the sense that these contracts are conceived as digital self-executing contracts that unavoidably require the contractual terms and conditions to be computationally drawn up in order for the software to execute such contractual clauses. Therefore, the computer code language or computational language is a formal requirement which is inextricably related to the essence and effectiveness of blockchain-based smart contracts themselves, insofar as if

[64] See, for instance, CARIA, R. de, *supra, loc. cit.,* p. 36; SAVELYEV, A., *supra, loc. cit.,* p. 14; INTERNATIONAL SWAP AND DERIVATIVES ASSOCIATION, *supra, loc. cit.,* p. 22; UK JURISDICTION TASKFORCE, *supra, loc. cit.,* p. 31; GUILLAUME, F., "Aspects of private international law related to blockchain transactions", *supra, loc. cit.,* pp. 66-67.

[65] FARREL. S., MACHIN, H., and HINCHLIFFE, R., "Lost and found in smart contract translation - considerations in transitioning to automation in legal architecture", in UNCITRAL, *Modernizing International Trade Law to Support Innovation and Sustainable Development,* Vienna 4 – 6 July 2017, Volume 4: Papers presented at the Congress, United Nations, Vienna, 2017, p. 100 (pp. 95-104).

[66] LEHMANN, M., *supra, loc. cit.,* p. 103.

[67] By contrast, it has been suggested that conflict-of-laws provisions are not needed, "since there are no collisions of various legal systems. Mathematics is universal human language. Thus, Smart contracts are truly transnational and executed uniformly regardless of the differences in national laws"; CATCHLOVE, P., *supra, loc. cit.,* p. 21.

[68] VERSCHRAEGEN, B., "Article 11", in MANKOWSKI, M., *Rome I Regulation -Commentary*, European Commentaries on Private International Law, Volume II, Sellier European Law Publishers, Ottoschmidt, Köln, 2017, p. 695 (pp. 671-716).

[69] VERSCHRAEGEN, B., *supra, op. cit.,* p. 691.

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that computational language is lacking, then the contract will not produce the expected self-executing effects (automation).[70]

However, the elements needed for a binding contract to exist are, generally speaking, the consent of the contracting parties to be bound, the existence of a valid object and consideration or cause. In terms of European Union conflict rules, all of these abovementioned elements refer to the existence and substance of the contract as governed by the law, and which would govern the contract if it were valid (Article 10.1 of the Rome I Regulation).[71] Particularly, when it comes to the question as to whether smart contracts are covered by the Rome I Regulation, the answer will depend on whether they are included in the material scope of application of such a Regulation and, therefore, within the concept of "contractual obligation". In this regard, the Court of Justice of the European Union is developing an autonomous interpretation of the concept of "contractual obligation". Indeed, the Court of Justice has given several judgments for laying the foundations of an autonomous concept of contractual obligation within the context of jurisdiction that should govern in the conflict of laws field as well.[72] Pursuant to this interpretation, the Court of Justice has stated that the expression "matters relating to contract" is not to be understood as covering a situation in which there is no obligation freely consented by one party towards another or assumed by two parties and on which the claimant's action is based.[73] "The conduct complained of may be considered a breach of contract, which may be established by taking into account the purpose of the contract".[74]

By contrast, the form of the contract refers to "every external manifestation required on the part of a person expressing the will to be legally bound, and in the absence of which such expression of will would not be regarded as fully effective"[75]. In terms of blockchain-based smart contracts, the form (Article 11 of the Rome I Regulation), then, should cover aspects such as, for example, the computational language needed for running the smart contract; whether cryptographic signatures of the contracting parties to the smart contract are required; the requirement of whether, in addition to the digital coding

[70] For example, FELIU REY, J., "*Smart Contract*: Concepto, ecosistema y principales cuestiones de Derecho privado", *Diario La Ley mercantil*, nº 47, mayo 2018, pp. 4-6 (15pp.).

[71] However, Article 10.2 of the Rome I Regulation makes applicable the law in force in the country of the habitual residence of the party alleging that he did not consent.

[72] See for instance, Recital 7 of the Rome I Regulation calling for consistency between the substantive scopes of application and provisions of this Regulation itself and the Council Regulation (EC) No 44/2001 of 22 December 2000 on jurisdiction and recognition and enforcement of judgments in civil and commercial matters, nowadays replaced by the Regulation (EU) 1215/2012 of the European Parliament and of the Council of 12 December 2012, on jurisdiction and the recognition and enforcement of judgments in civil and commercial matters (*OJ* L351/1).

[73] See, for example, Judgment 17 June 1992, *Handte*, C-26/91, ECLI:EU:C:1992:268, paragraph 15; Judgment 17 September 2002, *Tacconi*, C-334/00, ECLI:EU:C:2002:499, paragraph 23; Judgment 5 February 2004, *Frahuil*, C-265/02, ECLI:EU:C:2004:77, paragraph 24; Judgment 18 July 2013, *ÖFAB*, C-147/12, ECLI:EU:C:2013:490, paragraphs 32 and 33 and Judgment 10 September 2015, *Holterman Ferho Exploitatie and Others*, ECLI:EU:C:2015:574, paragraph 52.

[74] Judgment of 13 March 2014, *Brogsitter*, C-548/12, ECLI:EU:C:2014:148, paragraphs 24 and 29.

[75] Report on the Convention on the law applicable to contractual obligations by Giuliano, M. & Lagarde, P. [1980] *OJEC* C 282/29.

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contract, a human readable language copy is needed or whether a certain amount of copies are also requested. In respect of all of these aspects, the issue of human readable language has aroused especial attention since some authors subject it to the law governing the formal validity (Article 11 of the Rome I Regulation), whereas others consider the *lex causae* more appropriate to govern it[76]. The reasons in favor of submitting natural language to the *lex causae* refers to the close connection between the purposes sought by language, such as to ensure reflection and caution, to reinforce the contracting parties' feeling to be bound and to ease the evidence of the contractual obligations assumed and, on the other hand, the existence and effectiveness of the contract itself.[77] However, this justification is the same as the justification upon which the *ad solemnitatem* form is based.

As far as blockchain-based smart contracts are concerned, though, the computational language requirement should be governed by the law as appointed by the conflict-of-law rule laid down in Article 11 of the Rome I Regulation for the formal validity of contractual obligations. Indeed, computational language does not interfere in the existence of the contractual obligations insofar as these obligations are concerned and, as a consequence, contractual relationships do exist provided that they comply with the conditions required by the law governing the contract if it were valid (Article 10.1 of the Rome I Regulation). This is also why the contracting parties' right to obtain legal remedies remain intact regardless of the existence of the computer code or its correct functioning.

To sum up, insofar as a given smart contract accords with the interpretation given by the Court of Justice, that is to say, that such a contract represents either an obligation freely assumed by one party towards another or the agreement between two or more parties, this contract could be subject to the conflict-of-law rules laid down in the Rome I Regulation in order to determine the law governing the controversial contractual agreement externalized on a blockchain-based smart contract. In addition, the putative law of the contract will apply to the existence and material validity of such a contract (Article 10.1 of the Rome I Regulation). Therefore, this law applies, among others, to the contracts' formation even though the admissibility of blockchain-based smart contracts as a formal tool for expressing the contracting parties' declarations, is subject to the law governing the formal validity (Article 11 of the Rome I Regulation). This difference between formation of the contract and admissibility of an electronic form of the contracting parties' declarations can be found, for instance, in Article 11 of the UNCITRAL Model Law on Electronic Commerce, of 1996[78] whereby "in the context of contract formation, unless otherwise agreed by the parties, an offer and the acceptance of an offer may be expressed by means of data messages. Where a data message is used in the formation of a contract, that contract shall not be denied validity or enforceability on the sole ground that a data message was used for that purpose". From a Spanish Law perspective, Article 23.1 of the Information Society Services Act establishes that contracts concluded by

[76] VERSCHRAEGEN, B., *supra, loc. cit.,* pp. 694-695; LOACKER, L. D., "Article 11 Rome I", in CALLIESS, G.-P., *Rome Regulations – Commentary,* 2nd Edition, Wolters Kluwer, The Netherlands, 2015, pp. 290-291 (pp. 276-306).
[77] VERSCHRAEGEN, B., *supra, loc. cit.,* p. 695.
[78] The text of the UNCITRAL is available at: https://uncitral.un.org/sites/uncitral.un.org/files/media-documents/uncitral/en/19-04970_ebook.pdf.

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electronic means will produce the legal effects recognized by the legal system, when consent and the other conditions required for its validity concur.[79]

As a consequence, the *favor validitatis* principle underlying the conflict-of-law rule contained in Article 11 of the Rome I Regulation ensures the effectiveness of the blockchain-based smart contracts, in particular when the law applicable to the formal validity does not correspond to the *lex contractus*, since Article 11 of the Rome I Regulation enables the application of other laws other than the *lex contractus*. In this sense, it is worth noting that some national legislations have already and expressly recognized the admissibility of blockchain-based smart contracts as a way of externalizing legal binding agreements. For example, in the United States some States[80] have already passed legislation on this particular issue, which also include definitions of the terms "blockchain" and "smart contract". In Europe, States such as Italy[81] and Malta[82] have expressly embedded the concepts of "distributed ledger technology" and "smart contracts", whereas others[83] have merely recognized the validity of distributed ledger technology without embracing an express definition of the aforementioned terms.

Overall, once it has been confirmed that a certain contractual agreement sustained in a blockchain-based smart contract is covered by the Rome I Regulation, then the conflict-of-law rules set out in this Regulation will determine the national law applicable to both the material and formal validity of the given contract, as I have explained above.

3. Formation of blockchain-based smart contracts

As regards the formation of blockchain-based smart contracts, they may be concluded in either of the following ways. First, the paradigmatic way consists of displaying the smart contract[84] by the user in a permissionless blockchain as a legally binding offer if it meets the legal requirements for this offer to be valid in accordance with the appropriate law. The transaction called by another user to the former smart contract may amount to an

[79] *BOE* n. 116, 12th July 2002. The Information Society Services Act implements the Directive 2000/31/EC of the European Parliament and of the Council of 8 June 2000 on certain legal aspects of information society services, in particular electronic commerce, in the Internal Market ('Directive on electronic commerce') into the Spanish legal system.

[80] For example, see in Arizona, Provision 44-7061 E1 and E2 of the House Bill 2417/2017 available at: https://www.azleg.gov/legtext/53leg/1r/bills/hb2417p.pdf; in Illinois, the House Bill 3575 (23 August 2019), available at: https://www.ilga.gov/legislation/101/HB/10100HB3575.htm.

[81] See Article 8 ter of the "Decreto-legge 14 dicembre 2018, n. 135, coordinato con la legge di conversione 11 febbraio 2019, n. 12, recante: "Dispozioni urgenti in materia di sostegno e simplificazione per le imprese e per la pubblica amministrazione", *Gazzetta Ufficiale della Reppublica Italiana*, 12 febbraio 2019, Serie Generale n. 36, p. 49.

[82] See Part I.2. (i) of the "Bill No. 45, Malta Digital Innovation Authority Bill, 2018", *Government Gazette of Malta No. 19,994* (22 May 2018), available at: http://justiceservices.gov.mt/.

[83] For instance, Luxembourg has implemented distributed ledger technology in the field of securities, see Article 18 bis of the "Loi du 1er mars 2019 portant modification de la loi modifiée du 1er août 2001 concernant la circulation des titres", *Journal Officiel du Gran-Duché de Luxembourg,* Nº 111 du 5 mars 2019.

[84] For the creation of a Smart contract into Ethereum blockchain see: ANTONOPOULOS, A. M. and WOOD, G., *supra, op cit.*, pp. 112-114.

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acceptance of the encoded operation, which will subsequently be validated, executed and stored by the nodes of the blockchain. An example of this would be that of the deployment of a smart contract which, in exchange for a cryptoasset, performs algorithmic investment.[85] In other words, the Initial Coin Offering (ICO) illustrates this sort of formation of smart contracts in which one contracting party seeks to collect funds to fund a project. In exchange for those funds, the investor will receive tokens to be used in the future according to the terms stipulated in the White Paper that founds the ICO. In this situation, the smart contract would be concluded between pseudo-anonymous parties identified only through their ID addresses and thereby making use of their respective public and private key to sign and send the corresponding transactions on the blockchain.

Aside from this, the conclusion of a blockchain-based smart contract may imply the negotiation and conclusion of a smart contract between known contracting parties in the context of either permissioned or permissionless blockchains. This second scenario is likely to adopt an array of different forms[86], from concluding a contract entirely and solely expressed in digital code to different combinations of digital coding contract and natural language contract (wet contract/analog or conventional contract). In this latter category of patterns, smart contracts may be deployed according to any of the following forms: firstly, the terms and conditions of the agreement may be embedded in a conventional contract that is subsequently converted into digital coding language[87] to be deployed in the blockchain. One example could consist of including in the smart contract a human readable contract document in order to make its comprehension easier. In this regard, the smart contract user could proceed as follows: the user should upload the human readable document to the IPFS (a distributed protocol allowing anyone to store any static data) and then, successively, the user should insert a hush (automatically created unique number) line into the smart contract referring to the human readable document previously uploaded. The latter human document should be accepted (acceptance function) by the counterparty for a binding contract to exist.[88] Another example of the translation of the human readable document into digital or software coding is provided by a project developed by the OpenLaw blockchain-based protocol[89]. To illustrate such a project, OpenLaw uses a loan agreement in which no bank or other private or public authority intervenes. In order to conclude such a contract, the lender and the borrower may agree

[85] UK JURISDICTION TASKFORCE, *supra, op. cit.*, pp. 33-34. Besides, on this type of smart contract, see also TJONG TJIN TAI, T., "Implementing Excuses", *supra, loc. cit.*, pp. 82-83.

[86] See, for instance, SMART CONTRACTS ALLIANCE and DELOITTE, "Smart Contracts: 12 Use Cases for Business & Beyond", 2016, p. 9, available at: https://digitalchamber.org/wp-content/uploads/2018/02/Smart-Contracts-12-Use-Cases-for-Business-and-Beyond_Chamber-of-Digital-Commerce.pdf; APARICIO BIJUESCA, M. B., "Chapter 1: The challenges associated with smart contracts: formation, modification and enforcement", in SMART CONTRACTS ALLIANCE, *Smart contracts: Is the Law Ready?*, September 2018, pp. 25-28 (pp. 14-35), available at: https://digitalchamber.org/smart-contracts-whitepaper/; FELIU REY, J., *supra, loc. cit.*, p. 5.

[87] FARREL. S., MACHIN, H., and HINCHLIFFE, R., *supra, loc. cit.*, p. 96; STARK, J., *supra, loc. cit.*; IDELBERGER, F., GOVERNATON, G., RIVERET, R. and SARTOR, G., "Evaluation of logic-based Smart contracts for blockchain systems", *RuleML*, 2016, p. 174 (pp. 167-183).

[88] BRAENDGAAR, P., "Simple Convention for Human Readable Terms for Smart Contracts", *Blog Stake Ventures*, June 29th, 2016, available at: https://blog.stakeventures.com/articles/smart-contract-terms.

[89] The project's explanation (15 July 2018) is available at: media.consensys.net/blockchain-based-lending-1eee5edabe8a.

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upon either creating their loan agreement from whatever template is already available on the blockchain or uploading their own standard loan agreement onto this platform. This platform enables the contracting parties to write, sign and incorporate the contractual terms of the loan agreement drawn up in readable human language into the blockchain by means of facilitating their conversion into the markup language accepted by the Ethereum network. Once it is on the blockchain, this agreement remains immutable. However, the smart contract may be triggered by the calls of the contracting parties whenever they have to withdraw additional funds or return the funds and the interests agreed depending on the type of loan agreement. Within the framework of this project, the function of funding the loan is removed from a centralized financial institution and is conferred upon a decentralized application compatible with Ethereum (Metamask[90]).

The foregoing examples offer slightly different interpretation of the Ricardian Contract known as a "document which is legible to both a court of law and to a software application"[91] insofar as the same document combines both prose and computer-parsable markup.[92]

This fact, which consists of having the contractual terms and conditions in human readable languages ensures the understanding of all of the contractual clauses, not only by the contracting parties but also by third trusted authorities such as judges and arbitrators, in the event that their interventions being needed. However, a subsequent problem arises associated with the risk of discrepancy between the conventional contract and the digital coding contract. Indeed, most of the time coders or developers will be in charge of translating the contractual clauses written in natural language into digital or software coding[93] and this task, although assisted by lawyers, may result in misinterpretations and coding errors. Some initiatives have sought to eliminate such a possibility by integrating the conventional contractual clauses into the new Solidity smart contract in the Ethereum blockchain.[94]

Secondly, another form that smart contracts may adopt consist in dividing the contractual terms and conditions into the two languages (natural and digital coding) depending on which clauses are more appropriate to be converted into coding language.[95] In practice, this option could be useful for differentiating the conditional clauses (If A / Then B) admitted by the software underling the smart contract and blockchain from those that are not suitable because they entail subjective interpretation. For instance, let us take as an example conditional clauses using the conditional language: "If A / Then B" which is the clause whereby an airline company obliges itself to pay the passenger a certain amount

[90] On Metamask see: https://metamask.io/.
[91] GRIGG, I., "The Ricardian Contract", available at: http://webfunds.org/guide/ricardian.html.
[92] GRIGG, I., "Towards a Ricardian Constitution", available at: https://steemit.com/eos/@iang/towards-a-ricardian-constitution.
[93] What is more, Ethereum, for example, requires smart contracts to be executed on the blockchain to convert their high-level language (Solidity, most of the time) into Ethereum Virtual Machine bytecodes, ANTONOPOULOS, A. M. and WOOD, G., *supra, op. cit.,* p. 7 and p. 129.
[94] See BRAENDGAAR, P., *supra, loc. cit.*
[95] CARIA, R. de, *supra, loc. cit.,* pp. 31-32; CATCHLOVE, P., *supra, loc. cit.*; MEKKI, M., *supra, loc. cit.,* p. 12.

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of money if the flight is delayed or the other clause whereby an insurance company agrees to indemnify the insured party in exchange for a given premium, if it rains over a given certain level for a certain number of days. By contrast, other contractual clauses requiring some subjective interpretation, such as, choice of law or choice of jurisdiction clauses or clauses concerning excuses (hardship), even though they can be converted into coding clauses, are ultimately not capable of being self-executed on the blockchain.

4. Determining the law governing blockchain-based smart contracts

A) INTRODUCTORY ASPECTS

Many authors have pointed out the importance of determining the competent jurisdiction and the law applicable to blockchain-based smart contracts[96], while indicating at the same time the complex problems associated to the cybersystem in which they are executed entirely or partially. In this regard, blockchain-based smart contracts amplify, where possible, the problems that electronic commerce causes when ascertaining the law governing the aforementioned contracts.[97] Indeed, as a paradigmatic illustration, let us examine the issue of pseudo-anonymity behind permissionless blockchains that may render disputes almost impossible to be adjudicated. Moreover, the geographically-oriented connecting factors used by most of the conflict-of-law rules make the determination of the applicable law even more difficult in the cybersystem scenario in which *a priori* no boundaries exist. Even the closest connecting factor has been found to be inappropriate for blockchain technology because of this same de-nationalized nature.[98]

Therefore, the purpose of the current section is to analyze the extent to which the general conflict-of-law rules (Articles 3 and 4) laid down in the Rome I Regulation may be appropriate to ascertain the law governing blockchain-based smart contracts. Before doing this, three ideas should be borne in mind. Firstly, as I have already indicated, blockchain-based smart contracts are not a new substantive category of contracts, but rather a form that the contracting parties may adopt to externalize and perform their contractual obligation. As a consequence, the appropriate conflict-of-law rule to be utilized will depend upon the specific controversial blockchain-based smart contract at stake (sale of goods, services, financial services, etc.). Secondly, the analysis of the law applicable to blockchain-based smart contracts only refers to the contractual relationship established between the parties to it and, therefore, does not focus on other relationships that the blockchain technology may generate among founders, developers or coders therein, for instance, for coding errors.[99]

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[96] For instance, see in DiMATTEO, L. A., CANNARSA, M. and PONCIBÒ, C., "Smart Contracts and Contract Law", in DiMATTEO, L. A., CANNARSA, M. and PONCIBÒ, C. (eds.), *The Cambridge Handbook of Smart Contracts, Blockchain Technology and Digital Platforms,* Cambridge University Press, Cambridge, 2020, p. 4 (pp. 3-18); MEKKI, M., *supra, loc. cit.,* p. 13; CARIA, R. de, *supra, loc. cit.,* p. 32.

[97] CARIA, R. de, *supra, loc. cit.,* p. 34.

[98] LEHMANN, M., *supra, loc. cit.,* p. 112; GUILLAUME, F., "Aspects of private international law related to blockchain transactions", *supra, loc. cit.,* p. 79.

[99] As for cryptocurrency networks, A. Dickinson characterizes as "matters relating to contract" the relationships established between the participants to Bitcoin and Ripple, DICKINSON, A.,

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And thirdly, the present analysis also leaves aside other specific conflict-of-law and substantive legal instruments that could primarily govern the given blockchain-based smart contract if it fell under their respective scopes of application, such as the United Nations Convention on contracts for the international sale of goods, 11 April 1980, among others.[100]

B) THE ROME I REGULATION

a) *Situation involving a conflict of laws*

Broadly speaking, the Rome I Regulation applies to contractual obligations in civil and commercial matters that involve a conflict of laws. The concept of contractual obligations was tackled above when dealing with smart contracts' legal implications.[101] To sum up, a contractual obligation exists in situations in which there is an obligation freely consented to by one party towards another or assumed by two or more parties. In addition, for this obligation to be subject to the Rome I Regulation, it must be connected to more than one just legal system.

As I have already outlined, blockchain-based smart contracts are run (executed) by the nodes (computers connected to the network), which form the blockchain network, when all of them validate and mine (include in the block) the transactions that users or other smart contracts deploy in the blockchain. The nodes' operations are what make the status of the ledger (the blockchain) and that of the smart contract itself change. Nodes are situated all over the world, in particular, when it comes to permissionless blockchains. This fact has led some authors to affirm that sustaining smart contracts on this transnational technology renders these contracts automatically international[102], at least in relation to permissionless blockchains, insofar as the location of the nodes is disseminated over different jurisdictions (those places where the nodes are located). This criterion makes the counterparties' habitual residence criterion irrelevant when it comes to evaluating whether or not a smart contract has cross-border connotations.

The criterion based on the location of the nodes (understood as both servers and clients in the Peer-to-Peer systems) is taken here as an element to characterize the relevant smart contract as international rather than being used as a connecting factor, which has been widely discarded in terms of determining the applicable law in the electronic commerce,

"Cryptocurrencies and the Conflict of Laws", in FOX, D. and GREEN, S. (eds.), *Cryptocurrencies in Public and Private Law*, Oxford University Press, 2019, pp. 105-106 (pp. 93-137).

[100] For instance, the Hague Convention on the law applicable to international sales of goods, of 15 June 1955; the Convention on the contract for the international carriage of goods by road, of 19 May 1956 and the Convention concerning international carriage by rail, of 9 May 1980 (Protocol of Modification 3 June 1999).

[101] *Supra*, paragraph III.2.

[102] GUILLAUME, F., "Blockchain: le pont du droit international privé entre l'espace numérique et l'espace physique", *supra, loc. cit.*, pp. 174-175; GUILLAUME, F., "Aspects of private international law related to blockchain transactions", *supra, loc. cit.*, p. 59; RÜHL, G., "Smart (legal) contracts, or: Which (contract) law for Smart contracts?", *supra, loc. cit.*, p. 6.

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unless the contractual terms establish otherwise.[103] Indeed, the criteria based on the location of the server or the Internet provider have been mostly rejected because of their arbitrariness and the fact that the location of those elements remain unknown to some of the contracting parties.[104]

When it comes to blockchain-based smart contracts, these criteria should also be rejected in order to determine the applicable law for the same reason, but, by contrast, these criteria could be taken into consideration with a view to establishing the internationality of the relevant smart contract. Pursuant to the international location of the nodes' criterion, business-to-business blockchain-based smart contracts could be considered to be international unless the terms and conditions of the blockchain network specify otherwise concerning the internationality of its network.

However, the use of the criterion based on the nodes' location in the context of permissioned blockchains by users whose identities are disclosed becomes more doubtful when the smart contract is concluded between parties established in the same country, unless other international criteria resulted from the case. By contrast, in other situations, the criterion of the nodes' location could again gain relevance if, for instance, the nodes were holding accountable for any damages to the users. On the other hand, the use of permissioned blockchains by users (and nodes) connected to one single country does not necessarily mean that the smart contract cannot become international if the counterparties insert into their contractual agreement a choice of law clause in favor of a foreign law (Article 3 of the Rome I Regulation). In such circumstances, however, the chosen law will not displace the application of the mandatory rules in force in the country in which all the relevant elements of the situation were located at the time of the choice (Article 3.3 of the Rome I Regulation).

As for the determination of the applicable law, the Rome I Regulation gives precedence to party autonomy (Article 3). Nevertheless, if the contracting parties do not agree on the applicable law or the parties' consent to this agreement is induced by vitiating factors, the objective connecting factors of Article 4 do therefore apply.

b) *General connecting factors*

b.1) Party autonomy (Article 3 of the Rome I Regulation)

[103] See, among others, DE MIGUEL ASENSIO, P. A., *Derecho privado de internet*, 5th ed., Civitas, Thomson Reuters, Madrid, 2015, p. 1061; VAN der HOF, S., "Party Autonomy and International Online Business-to-Business Contracts in Europe and the United States", in SCHULTS, A. (ed.), *Legal Aspects of an E-Commerce Transaction, International Conference in The Hague, 26 and 27 October 2004*, Sellier, European Law Publishers, München, 2006, p. 128 (pp. 123-134); CALVO CARAVACA, A. L. and CARRASCOSA GONZÁLEZ, J., *Derecho internacional privado*, Vol. II, 17th ed., Comares, Granada, 2017, p. 1169; FERNÁNDEZ ROZAS, J. C. and SÁNCHEZ LORENZO, S., *Derecho internacional privado*, 11h ed., Civitas, Thomson Reuters, 2020, p. 667; RÜHL, G., "Smart (legal) contracts, or: Which (contract) law for Smart contracts?", *supra, loc. cit.*, p. 6 and p. 16. By contrast, other authors have turned to this criterion as a connecting factor to determine the law applicable to the relationships established in the framework of cryptocurrency networks. See on this aspect, DICKINSON, A., *supra, loc. cit.*, pp. 112-114.
[104] VAN der HOF, S., *supra, loc. cit.*, p. 128.

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The Rome I Regulation gives priority to party autonomy. Thus, contracting parties are free to choose the law governing their contractual relationship. In terms of blockchain technology, the choice of the law applicable to the smart contract is in line with the self-help nature attributable by some authors to these contracts, as sustained in the blockchain, in the sense that this choice of law clause may contribute to ensuring the execution of the contract[105] insofar as the parties decide to locate the contract in a particular legal system that will govern every aspect of it (Article 12 of the Rome I Regulation). Moreover, the choice of the applicable law also ensures the choice of a legal system that recognizes blockchain-based smart contracts as a way of expressing binding legal agreements (as the law that governs contracts in substance in accordance with the conflict-of-law rules for formal validity under Article 11 of the Rome I Regulation).

In spite of this choice of law agreement not being in line with the "If A / Then B" writing style, that is to say, the one run by the code and executable by the blockchain network, its non-executable nature does not demand that this clause may not be stored in the blockchain as part of the contractual agreement according to any of the forms to which I referred some paragraphs above.[106]

Article 3.1 of the Rome I Regulation also permits a tacit choice of the applicable law, as this provision states that "The choice shall be made expressly or clearly demonstrated by the terms of the contract or the circumstances of the case". The tacit choice seeks to establish the real will of the contracting parties for the application of a certain law. Therefore, the parties must manifest a clear intention to make a choice of law.[107] And this intention may stem either from the terms of the contract or from the circumstances of the case. In relation to the first option, this is to say, from the terms of the contract, a cursory reading of the tacit interpretation embraced by Article 3 of the Rome I Regulation does not align itself well with the computer coding writing style that seeks to be clear in order to eliminate ambiguity in its interpretation[108], particularly, within the existing premature situation of having a blockchain-based smart contract which is only sustained in a computer code version. However, let us imagine a blockchain-based smart contract that used an oracle to get external information (such as, for instance, interest rates; price fluctuation or compensation limits for loss, etc.) to the blockchain for ensuring its self-execution function. In the event of such information being associated to a given country,

[105] CARIA, R. de, *supra, loc. cit.,* p. 31; RASKIN, M., *supra, loc. cit.,* pp. 313-314; PONCIBÒ, C. and DiMATTEO, L. A., *supra, loc. cit.,* p. 118.

[106] See, *supra*, paragraph III.3. In particular, as for the use of the Ricardian Contract to accommodate choice of law clauses, see RÜHL, G., "Smart (legal) contracts, or: Which (contract) law for Smart contracts?", *supra, loc. cit.,* p. 12

[107] Interpreting the analogous provision contained in Article 3 of the Rome Convention on the law applicable to contractual obligations, 10 June 1980, see GIULIANO, M. And LAGARDE, P., "Rapport on the Convention on the law applicable to contractual obligations", *Official Journal of the European Communities,* C 282, 31 October 1980, p. 17.

[108] In relation to the characteristics of computer language, see, among others, CANNARSA, M., "Contract Interpretation", in DiMATTEO, L. A, CANNARSA, M. and PONCIBÒ, C. (eds.), *The Cambridge Handbook of Smart Contracts, Blockchain Technology and Digital Platforms,* Cambridge University Press, Cambridge, 2020, pp. 106-107 (pp. 102-117).

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the law of that country could be considered to govern the contract as an expression of a contracting parties' tacit choice of the applicable law.

On the other hand, as for the tacit choice of the applicable law derived from the circumstances of the case, here, the same off-line criteria that govern international contracts in general could also be used[109] to ascertain the law governing blockchain-based smart contracts.

b.2) The applicable law as a default rule (Article 4 of the Rome I Regulation)

If the contracting parties do not choose the law governing their contractual relationship or if the chosen law is declared unenforceable because of the concurrence of vitiating factors, then Article 4 of the Rome I Regulation sets out a fallback rule. This rule envisages different scenarios. In the first place, Article 4.1 determines directly the law governing eight different categories of contractual obligations establishing a specific connecting factor for each of them. However, if the controversial contractual obligation does not fit within any of the categories of such contractual obligations or the elements of the contract fit into more than one of those categories, then the second connecting factor appoints the law of the country where the person required to make the characteristic performance of the contract has his or her habitual residence (Article 4.2). Nonetheless, courts may apply the law of another country if they find their case to be manifestly more closely connected with that of another country (Article 4.3). This same last connecting factor will be applied to those contracts that are not covered by the first two paragraphs of Article 4 (Article 4.4).

The foregoing explanation of Article 4, as a default rule, embraces territorial connecting factors such as, for instance, the habitual residence of the seller or the person required to make the characteristic performance of the contract, the location of the property or the country with whom the contract presents its closest connections, which are not entirely appropriate to be applicable to permissionless blockchains, in particular. This assertion is particularly relevant in relation to the habitual residence-based connecting factor, fundamentally used by the first two paragraphs of Article 4, when the identity of the contracting parties to the blockchain-based smart contract is anonymous or pseudo-anonymous, as is mostly the case in the context of permissionless blockchains. In this case, the contracting parties only disclose their respective digital addresses which are generated, in turn, by their respective private and public keys, thereby making it practically impossible to discover their real identity[110] and, as a result, their habitual residences. This makes it virtually impossible to adjudicate the dispute. Indeed, this event gives rise to an initial problem of obtaining remedies and determining jurisdiction as has

[109] For the criteria used to infer a tacit choice of law from the parties' will in the field of Internet contracts see DE MIGUEL ASENSIO, P. A., *supra, op. cit.,* p. 1061.
[110] On this point see, *supra*, footnote 47.

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been pointed out[111] since obtaining such remedies is dependent upon being able to identify the parties[112] involved in the controversy.

In terms of conflict-of-law rules, as mentioned above, anonymity also makes it complicated to ascertain the location of the territorial connecting factors used by Article 4 of the Rome I regulation. In this regard, however, the Rome I Regulation has already tackled contractual obligations in which at least one of the two contracting parties is unknown, at least, at the moment of formalizing the contract as Article 4.1 g) reflects when dealing with contracts for the sale of goods by auction. In relation to these kinds of contracts, the Rome I Regulation opts for submitting the contracts to "the law of the country where the auction takes place, if such a place can be determined", rather than the law of the seller's habitual residence as established in Article 4.1. a) for contracts of the sale of goods, in general. The reason for this lies in the fact that personal details may be unknown by the contracting parties, thereby justifying the application of a known connecting factor, that is to say, that of the place of auction, insofar as this place is known. However, this place cannot be identified if the auction takes place on the Internet. Under such circumstances, the law applicable should be determined in accordance with the closest and most real connection contained in Article 4.4. Hence, the use of the closest connecting factor may be especially appropriate to govern contracts to be performed in cyberspace with connections with the real (off-line) world.

Nonetheless, the inconvenience of using geographical connecting factors in the context of permissionless blockchains as represented by the closest connecting factor, as established by paragraphs 3 and 4 of the same Article 4, has been underlined. This connecting factor has been argued to be meaningless in permissionless blockchain scenarios which are completely de-nationalized[113] because it is extremely difficult to individualize the country most closely connected with the controversial situation, when the elements operating the blockchain-based smart contract are disseminated all over the world without being tied to any particular country[114], especially when those elements are primary associated to the nodes. Indeed, the assertion of refuting the viability of the closest connecting factor is tied to the widespread location of the nodes all over the world. However, if this criterion has been rejected to be used as an objective connecting factor to determine the applicable law within the framework of electronic commerce, then the same rejection could also be maintained in the field of blockchain-based smart contracts. The main reason for this lies in the difficulty of identifying the location of the nodes involved in a given smart contract, not to mention when this intervention is random, insofar as not all of the nodes of the network take part in the same transactions.

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[111] For instance, among others, see PONCIBÒ, C. and DiMATTEO, L. A., *supra, loc. cit.*, p. 123; MÖSLEIN, F., *supra, loc. cit.*, p. 16; TJONG TJIN TAI, T., "Formalizing contract law for smart contracts", *Tilburg Private Law Working Papers Series,* No. 06/2017, p. 3.

[112] CLÉMENT, M., "Smart Contracts and the Courts", in DiMATTEO, L. A, CANNARSA, M. and PONCIBÒ, C. (eds.), *The Cambridge Handbook of Smart Contracts, Blockchain Technology and Digital Platforms,* Cambridge University Press, Cambridge, 2020, p. 286 (pp. 271-287).

[113] LEHMANN, M., *supra, loc. cit.*, p. 112.

[114] LEHMANN, M., *supra, loc. cit.*, p. 112; GUILLAUME, F., "Aspects of private international law related to blockchain transactions", *supra, loc. cit.*, p. 61 and p. 79.

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IV. FINAL REMARKS

The ongoing implementation of blockchain-based smart contracts is fundamentally based on the trust placed on the digital code run by either a pseudo-anonymous or identified community that ensures the correct performance of cross-border trade operations in the network ignoring the intervention of third parties. Insofar as this system works as planned, private law is not required. Nevertheless, coding is still a human activity exposed to errors and misconduct. In addition, the development of smart contracts at the present time is still in its infancy as has been shown, firstly, due to the impossibility of smart contracts of being able to execute every single clause of a contractual agreement as a result of some clauses being unable to be expressed in the conditional code language "If A/ Then B", as was explained above. And secondly, the additional fact that smart contracts cannot yet execute off-line obligations, such as the delivery of physical things in the context of contracts of carriage or for the sale of goods, unless some type of interconnection exists between the off-line obligation and the software running the smart contract, which the Internet of Things (IoT) tends to create between the two of them.

In terms of conflict-of-law rules, the Rome I Regulation has proven itself to be resilient enough to accommodate business-to-business blockchain-based smart contracts due to the fact that they still have relevant and significant connections with the real (off-line) world.

What remains to be seen is how the development of artificial intelligence and robotization will affect the implementation and performance of smart contracts and what the legal implications will be.

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