

LAW AND ECONOMICS YEARLY REVIEW

ISSUES ON FINANCIAL
MARKET
REGULATION,
BUSINESS
DEVELOPMENT AND
GOVERNMENT'S
POLICIES ON
GLOBALIZATION

Editors

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LAW AND ECONOMICS YEARLY REVIEW

www.laweconomicsyearlyreview.org.uk

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The “Law and Economics Yearly Review” is an academic journal to promote a legal and economic debate. It is published twice annually (Part I and Part II), by the Fondazione Gerardo Capriglione Onlus (an organization aimed to promote and develop the research activity on financial regulation) in association with Queen Mary University of London. The journal faces questions about development issues and other several matters related to the international context, originated by globalization. Delays in political actions, limits of certain Government’s policies, business development constraints and the “sovereign debt crisis” are some aims of our studies. The global financial and economic crisis is analysed in its controversial perspectives; the same approach qualifies the research of possible remedies to override this period of progressive capitalism’s turbulences and to promote a sustainable retrieval.

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ISSN 2050-9014

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CONTENTS

The EU seeking a new balance between regulatory harmonization, economic convergence and sovereignty	149
--	------------

Francesco Capriglione

Eurozone creation and possible exits: political, institutional, monetary and economic issues. An analysis of the key stress points of the single currency and their interactions	190
---	------------

Rainer Masera

Testing the EU framework for the recovery and resolution of banks: the Italian experience.....	242
---	------------

Stefano Micossi

“We know what we are, but know not what we may be”: considerations on the (need for) harmonization of regulations for financial leasing in the EU.....	255
---	------------

Antonio Blandini – Gianfranco Alfano

Smart contracts and (non-)law. The case of the financial markets	291
---	------------

Francesco Di Ciommo

Microcredit in the Italian and Brazilian legal systems: a bird’s eye view	326
--	------------

Roberto Miccù – Jose Luis Bolzan de Moraes – Diego Rossano

FOCUS ON GLOBAL PERSPECTIVES

Revisiting the issue of unitary enterprises’ “inefficiency” (on the example of the stavropol territory)..	351
--	------------

Aleksey P. Anisimov – Vyacheslav S. Eliseev – Ekaterina V. Stepanova

Strategic and organizational effects of environmental regulation on operational processes of sustainable MSEs.....	365
---	------------

Nunzio Casalino – Henrietta Nagy – Barbara Borin

SMART CONTRACTS AND (NON-)LAW. THE CASE OF THE FINANCIAL MARKETS *

Francesco Di Ciommo **

ABSTRACT: Over the last few years, the term 'smart contract', largely coined by technology experts, has also entered the vocabulary of jurists. But what does this expression mean, and why should a jurist reflect on this new conceptual category? In attempting to answer these two fundamental questions, this essay reaches the following conclusions: 1) smart contracts are not contracts; 2) the terms 'smart contract' and 'blockchain' are not interchangeable; 3) the legal problems raised by the smart contract phenomenon require an analytical approach strongly conditioned by the technological ecosystem of reference and must be assessed on a case-by-case basis; 4) for this reason too, the category in question has substantially no legal significance; 5) in any case, precisely because of this technological conditioning, any attempt by jurists to understand and regulate the phenomenon risks becoming obsolete at the very moment in which it is carried out; 6) furthermore, reasons, issues relating to the validity and effectiveness of so-called smart contracts, and those relating to any liability arising from them are normally handled independently by the computer systems concerned with no reference to the institutions and rules of the legal system, which concentrate solely on trying to avoid market distortions.

The hypotheses outlined above, which certainly arouse general concern, are confirmed by observing what happens on the financial markets, where algorithmic trading (AT) and high-frequency trading (HFT) have become an established reality over the last few years and are continuing to grow.

*A first and different version of this work was published under the title of *Gli Smart Contract e lo smarrimento del giurista nel mondo che cambia. Il caso dell'High Frequency Trading (HFT) finanziario*, in Fimmanò - Falcone (ed.), *Fintech*, Naples, submitted for publication.

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SUMMARY: 1. Algorithmic trading and the Internet of Things: a phenomenology of the changing world. – 2. Smart Contracts: a fashionable (non-legal) category. – 3. The Blockchain at the service of Smart Contracts. – 4. The financial markets from Algorithmic Trading (AT) to High-Frequency Trading (HFT). – 4.1. Speed and intensity of trading as competitive factors. – 4.2. HFT and market abuse risks. – 4.3. First attempts at regulating HFT. – 4.4. AT and HFT in the light of MIFID Directives I and II. – 5. Conclusion: law and non-law.

1. It often happens, especially in the so-called social sciences, that the emergence in the practice of unprecedented issues sparks new debate among scholars. The first reaction is to identify a conceptual category to define, and therefore somehow contextualize, the new phenomenon with the more or less explicit aim of fitting it into the system and facilitating its study, and thus, in the case of law, also perhaps identifying its characteristics from the perspective of regulation¹.

Historically, this has greatly favoured the evolution of knowledge in legal scholarship and in the world of law in general, where there is no shortage of examples. Suffice it to mention, in the sphere of civil law, the significant event constituted by the formulation of personality rights, conceptualized for the first time by Otto von Gierke in the late 19th Century, or the all-important development of the theory of the legal transaction, reinforced by the introduction of the BGB in 1896². In both cases, after the emergence of social demand for the protection of new individual interests or the regulation of hitherto neglected matters,

¹A completely different approach to the subject was adopted by Kant, whose *Critique of Pure Reason* demonstrated that categories are not determinations of reality but only of knowledge, as they represent how the human intellect works applied to the material (of empirical origin) given in sensible intuition. More recently, Gilbert Ryle's approach in the neo-empirical field is worthy of note – in *The concept of mind* (1949), he defined “categories of a concept” as the group of rules that govern its use.

²The literature on the two topics mentioned is boundless. See, in particular, MESSINETTI, *Personalità (diritti della)*, in *Enc. dir.*, XXXIII, Milan, 1983, 354; by various authors, *Categorie giuridiche e rapporti sociali. Il problema del negozio giuridico*, Milan, 1978; GALGANO, *Il negozio giuridico*, in *Tratt. Cicu-Messineo*, Milan, 1988; STOLFI, *Teoria del negozio giuridico*, Padua, 1961; and SACCO, *Negozio giuridico. Circolazione del modello*, in *Dig. Disc. Priv.*, Sez. civ. section, XII, Turin, 1995 respectively.

jurists reacted by creating categories causing heated debate that would have a marked influence on the attitudes of future legislators and judges.

Something similar has been happening over the last few years regarding the complex, and increasingly significant, topic of economic operations independently and directly concluded and/or performed, in whole or in part, by IT software (using algorithms), i.e. a network of computers (or even robots or automata) with no human involvement and mostly operating in cyberspace.

These operations are now known in various sectors (technological, legal, and sociological) across the globe as “algorithmic trading” and identified by the (non-technical) expression “smart contract” (i.e., intelligent contracts), classed under a relatively new category, which, on closer inspection, not only includes contracts but mostly concerns only one or more execution phases of a contract, often a framework contract or adherence agreement.

More specifically, the term smart contract generally refers to situations that envisage the translation and transposition into computer code – making them intelligible to the software (operating through one or more algorithms³) – not only of the rules that form what may roughly be called (para)contractual regulation, but also the real-world circumstances on the basis of which a service is to be performed automatically (or partly so), a service to be performed according to those rules; failing that, some effect related to the operation on the basis of the initial formulation must in any case be produced⁴.

In other words, as the term is used today, a smart contract may be any economic operation, or part of one, involving two or more parties that can operate, and therefore produce effects independently of human intervention following established rules and the external information acquired in the course of the automated device’s activities, forming the basis for the transaction. At the same ti-

³For a brief and clear reflection on what algorithms are and how important they are in the ‘digital society’, see ITALIANO, *Dixit algorithmi. Breve Storia del nostro futuro*, available online at “<http://open.luiss.it/2019/01/23/dixit-algorithmi/>”.

⁴See ASHARAF - ADARSH (ed), *Decentralized Computing Using Blockchain Technologies and Smart Contracts, Emerging research and opportunities*, IGI Global, Hershey, PA (USA), 2017.

me, the software assesses whether certain specific conditions have been fulfilled before proceeding to carry out the operation.

This means that, in a healthy ('neutral') technological environment, shielded from deceptive external influences, the risk of deviation from the predetermined path within which the operation must take place – such as possible non-fulfilment – is extremely limited because automata comply (or should comply⁵) with the orders received. Thus, if the pre-established conditions are fulfilled, the automata will perform the action, or will at least produce the effects their algorithms were set in place to generate.

Moreover, the algorithm is generally programmed to handle all contingencies (hence the term “smart” contracts), reducing to a minimum, or, at least (hopefully) stopping disagreements between the parties in the event of some new occurrence, and preventing changes to the balance of the relationship arising from some unforeseen circumstance.

Lastly, it goes without saying that using an algorithm to carry out a transaction significantly reduces the times and costs of each operation.

For all these reasons, smart contracts are becoming extremely successful on the market as companies are always more willing to use them in both business-to-consumer trade and in business-to-business relations.

Of course, such a broad description of the phenomenon means that the ‘smart contract category’ can include real contracts, stipulated and executed (more or less) entirely by automated systems, and the individual phases of a contractual transaction, or even just an economic transaction by itself. The latter situation arises, for example, when the automated system only has to ascertain the existence of the conditions necessary to execute all or some of the services dependent on them, which may happen when only the conclusion of the contract is to be left to

⁵In reality, it is quite likely that an algorithm will not faithfully reflect the will of the parties. Either the computer “translation” of the contract to be executed may be inaccurate, or the algorithm may take initiatives that were not foreseen by its designer, as (and this will be discussed more fully in the text) many algorithms feed on gained experience. On this, and many other points, see Ed Finn, *What Algorithms Want. Imagination in the Age of Computing*, Mit Ed., Boston (Mass., USA), 2017.

the automatic verification of the conditions under which the parties want the contract to be finalized.

In this regard, it should be observed that when the contract is concluded exclusively by means of one or more software(s), the automated verification of the factual prerequisites for finalization must be carried out in accordance with rules previously set by the parties in a framework contract or at least in contractual terms (normally for a certain period of time). These terms express the will of both parties to enter into a contract by means of automated systems if some specific conditions are met, and perhaps under certain circumstances rather than others, depending on the presence or absence of pre-established variables.

It may happen – and in practice it happens very often – that the terms of the contract (a ‘framework’) have, in reality, been established by only one party, and can be accepted by any number of counterparties. In today’s market dynamics, this generally happens by performing some concrete action – as quick to carry out as it is immediate in its effects – which, rather than fully expressing the intentions of the parties, concretizes the factors upon which the effectiveness of the contractual agreement depends.

These brief notes, which will be developed more fully later, are not so much an attempt to define what is commonly understood today as a smart contract but the product of a necessary effort to contextualize the topic right from the start, albeit in very general and approximate terms. From this first outline, it may in fact be observed how the development of telematics and, more broadly, the continuous innovation that daily marks the latest technologies also (and perhaps especially) brings to the market(s) possibilities that were unimaginable until very recently.

For some time then there has been intense global discussion on the *Internet of Things*, describing how the Internet will increasingly become a vehicle (or

environment) for things rather than people to communicate with each other⁶. The concrete applications of this technology range from handling consumer goods (during production, storage, distribution, sales, and after-sales service) to the tracking of lost or stolen objects and the automated management of technological devices at a distance, and much more.

According to the most reputable studies, the number of objects connected to the Internet exceeded the number of people on the planet in 2008, while in 2020, there will be approximately fifty billion objects connected to the Internet, compared with a world population of approximately 9 billion people. With the growth of the Internet, and with its countless other interconnection networks, new algorithms are being consolidated, computing capacity is constantly on the increase, and the world we live in is changing radically at a hitherto unthinkable pace.

2. It is now widely believed that, working together with robotics, augmented reality, and virtual reality, the Internet of Things will continue to foster the interconnection of people, things, and environments so that in the next few years our lives will be fully digitized and networked⁷. For the more optimistic, this means

⁶The term "Internet of Things" is thought to have been coined by Kevin Ashton in 1999. (See Id., *That "Internet of Things" thing*, in *RFID Journal*, 2012). Among the many publications on the subject, see GERSHENFELD – KRIKORIAN – COHEN, *The Internet of Things*, in *Scientific American*, Vol. 291, No. 4 (October 2004), pp. 76-81; KORTUEM – KAWSAR – SUNDRAMOORTHY – FITTON, *Smart objects as building blocks for the Internet of things*, in *IEEE Internet Computing*, Vol. 14, Issue: 1, Jan.-Feb. 2010; and ZANELLA – BUI – CASTELLANI – VANGELISTA – ZORZI, *Internet of Things for Smart Cities*, id., Vol. 1, Issue: 1, Feb. 2014.

⁷The subject has, in fact, been the object of study for several decades. For one of the first reflections on the question, see CAIRNCROSS, *The Death of Distance: How the Communications Revolutions Will Change Our Lives*, Boston, 1997. For a diachronic view of the impact that telematics has had so far on our lives from the legal perspective, see, especially for essential bibliographic and jurisprudential references DI CIOMMO, *Diritti della personalità tra media tradizionali e avvento di Internet*, in Comandé (ed), *Persona e tutele giuridiche*, Torino, 2003, 3; ID., *Evoluzione tecnologica e regole di responsabilità civile*, Naples, 2003; ID., *Internet e crisi del diritto privato: globalizzazione, dematerializzazione e anonimato virtuale*, in *Riv. crit. dir. priv.*, 2003, 11; ID., *Civiltà tecnologica, mercato ed insicurezza*, in *Riv. crit. dir. priv.*, 2010, 565; and ID., *L'accesso ad Internet tra diritto e responsabilità*, in *Comunicazione digitale*, 2014, 29, ID., *Il diritto di accesso alle informazioni in Internet*, in Perlingieri - Ruggeri, *Internet e Diritto civile*, 2015, 77.

objects will continue to do what they have been doing for humans up to now but in a more efficient and ultimately more useful way.

However, the development of these technologies is so rapid, comprehensive, complex, and pervasive that legal observers – and even more so legislators of all latitudes – are inevitably expressing serious doubts about how to address the problems arising from this state of affairs.

One of the results of this uncertainty seems to be the fashion of using the smart contract category – to use a term coined by technology experts⁸ – as though it could have some at least descriptive value in the legal sphere too. On the other hand, as is already evident from the few considerations set out here so far, beyond what has been observed here in general terms, the elements included in the category in question are too diverse, like the situations, contractual or otherwise, that can currently be referred to as (or come under the umbrella term) ‘smart contract’, for it to be of any use in law.

So, despite arising from the best intentions, current attempts to carry out some sort of systematic reasoning or ordering in relation to the category in question – discussing the formulation, nature, interpretation, invalidity, and execution of smart contracts – would appear to be doomed to failure, because each different case in the pseudo-category requires specific considerations, that fit in badly, if at all, with other possible intelligent contracts⁹. Not to mention the fact that

⁸It is commonly believed that the expression was coined by N. Szabo in his *Smart Contracts: Building Blocks for digital market*, 1996, available online at “http://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/smart_contracts_2.html”. For a critical reflection on the possibility of reaching a full definition of the phenomenon, see MIK, *Smart Contracts: Terminology, Technical Limitations and Real World Complexity*, 9 *Law, Innovation & Technology*, 269 (2017).

⁹For the legal scholarship on the subject, in addition to the studies mentioned in the other notes, see especially. FOX – GLOSTEN – RAUTERBERG, *The New Stock Market: Sense and Nonsense*, in 65 *Duke Law Journal* 191 (2015); REIJERS – O’BROLCHÁIN – HAYNES, *Governance in Blockchain Technologies & Social Contract Theories*, in 1 *Ledeger* 134 (2016); KÓLVART – POOLA – RULL, *Smart Contracts*, in Kerikmäe – Rull (eds), *The Future of Law and eTechnologies*, Springer, 2016, 133; K.E.C. Levy, *Bopok Smart, Not Street-Smart: Blockchain-Based Smart Contracts and The Social Workings of Law*, in 2 *Engaging Science, Technology, and Society*, 1 (2017); SCHOLZ, *Algorithmic Contracts*, in 20 *Stan. Tech. L. Rev.* 128 (2017); WERBACH – CORNELL, *Contracts Ex Machina*, in 67 *Duke Law Journal*, 313 (2017); RASKIN, *The Law and Legality of Smart Contracts*, in 1 *Geo. L. Tech. Rev.* 305 (2017); TUR FAÜNDEZ, *Smart contracts. Análisis jurídico*, Editorial Reus, Madrid, 2018; and

these attempts inevitably foster the misunderstanding (aided and abetted by the use of the inaccurate but popular English expression) that when we speak of 'smart contracts' we necessarily refer to contracts, whereas, as we have seen, this is not always the case.

One confirmation of all this uncertainty is, among other things, the fact that when giving an example of a smart contract, reference is often made to what happens in the motor insurance market, where, on the basis of data collected by instruments placed in the vehicles, the software used by the insurance company receives information about the driver's behaviour (such as constantly exceeding speed limits), which can influence the makeup of the relative negotiating relationship, insofar as they may create certain conditions that bring into play or otherwise clauses of advantage or disadvantage (or increase the insurance premium). However, as is evident in the present case, the contribution of technology is limited to sending information to a technological platform that, on the basis of the contractual terms originally reached by the parties, perhaps in a wholly traditional way, gives concrete form to the effects of the contract, depending on the nature of the information¹⁰.

Essentially, this looks like a situation that does not appear to create particular legal problems, as it can be managed by applying common and traditional contractual rules. At the same time, it raises technical issues because it is, of course, necessary to ensure that the data are collected and transmitted correctly and that

KOLBER, *Not-so-Smart Blockchain Contracts and Artificial Responsibility*, in *21 Stan. Tech. L. Rev.* 198 (2018).

Among the most interesting Italian studies, see. PARDOLESI – DAVOLA, "Smart contract" e innovazione a tutti i costi, submitted for publication in Foro it., V.; read by kind permission of the authors; FINOCCHIARO, Il contratto nell'era dell'intelligenza artificiale, in Riv. trim. dir. e proc. civ., 2018, 441; PAROLA – MERATI – GAVOTTI, Blockchain e smart contract: questioni giuridiche aperte, in Contratti, 2018, 681; CAGGIANO, Il contratto del mondo digitale, in Nuova giur. civ., 2018, II, 1152; CUCCURU, Blockchain e automazione contrattuale. Riflessioni sugli smart contracts, id., 2017, II, 107; PASQUINO, Smart Contracts: caratteristiche, vantaggi e problematiche, in Diritto e processo, 2017, 11; and SABATO, Gli smart contracts: robot che gestiscono il rischio contrattuale, in Contr. e impr., 2017, 378, but also in Perlingieri - Fachechi (ed.), Ragionevolezza e proporzionalità nel diritto contemporaneo, Naples, 2017, 387.

¹⁰See BELLINI, *Smart Contracts: che cosa sono, come funzionano quali sono gli ambiti applicativi*, available online at "<https://www.blockchain4innovation.it/mercato/legal/smart-contract/blockchain-smart-contracts-cosa-funzionano-quali-gli-ambiti-applicativi/>".

the resulting automatic variation of the effects of the contract between the parties actually corresponds to what was originally agreed upon.

However, what happens when two or more software companies decide whether to enter into a contract is completely different. They make their own decisions on the basis of the algorithms they are programmed with so they perform, or do not perform, certain actions on the basis of whether certain pre-established conditions are fulfilled. Software products of this kind can 'talk to each other' and, depending on the analysis of the data at their disposal, fully automate a given economic transaction, acquiring, operation after operation, techniques and decisional (behavioral) modalities that can be very different from those originally written into the original algorithm. This comes about because the software is often programmed to memorize the experiences acquired in the field and to adapt its future behaviour to the information acquired. Through these learning and fine-tuning processes, the software products grow by themselves as they acquire information, so it can be very difficult to trace the way they work back to specific human intention or the responsibility of the programmer. This type of so-called algorithmic economic transactions has recently taken off in the financial sector in particular, as we shall see in the coming sections.

In the light of the above, we can safely reiterate what has already been said about the fact that on a strictly legal level, the concept of smart contract seems to refer to such a wide range of situations that it does not lend itself fully to any univocal treatment, except in very general terms of pure recognition.

It comes as no surprise, then, that even in the very earliest European scholarship in addressing the topic, the concept of 'smart contract' was described and defined in very heterogeneous terms¹¹.

The same uncertainty, also in terms of definition, is reflected in US legal scholarship on smart contract(s), which, however, focuses on a number of macro-themes that can be found in most kinds of transaction within the (pseu-

¹¹Among others, see CUCCURU, *op. cit.*; DI SABATO, *op. cit.*; PAROLA – MERATI – GAVOTTI, *op. cit.*

do)category at issue and are therefore worth examining. Thus, we examine the question of the presumed autonomy of smart contracts with respect to legal institutions and courts of law, and especially the fact that the algorithms often seek to manage problems of execution and even disputes between the parties automatically too¹². We shall examine the question of liability in relation to smart contracts, with special reference to operations involving the so-called “black box algorithmic agents”, where the decision-making process of the automaton cannot be fully predicted by the parties or the person who set up the algorithm¹³. In conclusion, among other things, we examine in greater detail the crux of the relationship between human will and how the algorithm operates, and from this angle we can observe that the rigidity of the automatism necessarily relegates this will to nothing more than a statement, leading to problems in applying the traditional legal discipline on contracts¹⁴.

3. There is a further topic to be discussed, albeit briefly, in order to complete our discussion of the smart contract and also to attempt to show how an examination of the mode of operation and regulations of the above-mentioned instruments from the legal standpoint today appears not only particularly difficult, given their diversity, but also risks becoming substantially useless in just a few months or years due to the speed with which, thanks to the obsolescence of the technology used, computer protocols and algorithms are continuously modified or replaced by those who control them.

We must also add a reflection on the relationship between the smart contract and the blockchain, as some predict increasing use of so-called smart con-

¹²See RASKIN, *op. cit.*; but also, among others, KOULU, *Blockchains and Online Dispute Resolution: Smart Contracts as an Alternative to Enforcement*, *ScriptEd*, Vol. 13, iss. 1, 2016; and ORTOLANI, *Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin*, 36 *Oxford J. Legal Studies* 529 (2016).

¹³See KOLBER, *op. cit.*; and Sholz, *op. cit.*; but also, among others, T. Gillespie, *Can an Algorithm Be Wrong?*, *LIMN*, 2, available on-line at “<http://limn.it/can-an-algorithm-be-wrong>, 2012”.

¹⁴See WERBACH – CORNELL, *op. cit.*; but also, among others, DAVIS, *Contracts As Technology*, 88 *N.Y.U. L. Rev.* 83 (2013); and HOFFMAN, *Relational Contracts of Adhesion*, 85 *U. Chi. L. Rev.* 1396 (2018).

tracts in the near future, given the recent development and popularity of the blockchain, which is expected to continue¹⁵.

Blockchain is a technology based on network users sharing a common database so that their transactions can be managed through a chain of operations that take place between the different nodes in the network¹⁶. In other words, through the use of an open ledger (the data base) accessible to its users and updated automatically as the clients (nodes) in the chain use it, certainty, verifiability, and knowledge are assigned to specific circumstances.

The shared open ledger is “made up of blocks, each of which represents a number of transactions whose origin and time of execution are assigned indelibly and immutably, through an asymmetric key cryptography mechanism and a time stamp (‘timestamping’), respectively. Each block is irreversibly connected to the previous one through a specific algorithmic operation (the ‘hash function’) and forms, in this way, a chain of blocks (‘blockchain’) accessible and searchable by all the nodes of the network. Before being added to the chain, each block is checked, validated, and encrypted by the so-called miner nodes through a mathematical operation, and is therefore tamper-proof¹⁷.

It is thus considered that the blockchain confers certainty and immobility to data and documents without the need to resort to authorities, institutions, or some third party and is therefore decentralized with no intermediation.

The first and most important application of blockchain technology came about in 2009, with the so-called bitcoin virtual currency, which had become very

¹⁵See, among many, GIANCASPRO, *Is a ‘smart contract’ really a smart idea? Insights from a legal perspective*, 33 *Computer Law & Security Rev.* 825 (2017); LUU – CHU – OLICKEL et Al., *Making Smart Contracts Smarter*, in *Proceedings of the 2016 ACM SIGSAC Conference on Computer and Communications Security - CCS’16*, New York, USA, ACM Press, 2016, 254; HOLDEN – MALANI, *Can Blockchain Solve the Holdup Problem in Contracts?*, *University of Chicago Coase-Sandor Institute for Law & Economics Research Paper No. 846*, 2017, available online at “<https://ssrn.com/abstract=3093879>”; as well as FILIPPI and WRIGHT, *Blockchain and the Law: The Rule of Code*, Harvard Univ. Press, 2018.

¹⁶The blockchain is the best-known application of distributed ledger technology (DLT), a technology based on the distribution and sharing of commonly used and useful information among the users of a network. The philosophy behind DLT is in contrast with the traditional logic of integrated and centralized management of information and protocols.

¹⁷Also PAROLA – MERATI – GAVOTTI, *op. cit.*

successful in previous years, before its exchange value fell sharply in 2018¹⁸. On the technical level (in both IT and legal terms), however, blockchain clearly provides ideal conditions to foster the use of smart contracts, because, as long as the system works and there are no gaps, it provides certainty about the contents and the date of a given activity and therefore also a given document, and ensures that it cannot be altered¹⁹.

To date, however, there are no legal norms nor is there even a regulatory framework governing blockchain in Europe or in the rest of the world²⁰. There is currently no certainty, nor can there be, on the concrete applications of this technology either now or in the future, nor, of course, on the arrival of some innovation that will soon make blockchain obsolete. This, however, does not appear to be a problem for smart contracts, as they can operate entirely independently of the blockchain, given that each computer system can be equipped with technologies

¹⁸In mid-December 2018, the total capitalization of the cryptocurrencies known on the world markets reached 104 billion dollars, down sharply from the peaks recorded during the year but still in line with the figures from the start of August 2017. Compared with other cryptocurrencies, the bitcoin dominance index stands at over 55%, while its price, on January 27, 2019, stands at €3,107.00, after peaking at €9,183.00 in January 2018, with a historical maximum of €16,721.00 on December 15, 2017. Among the other cryptocurrencies, of particular note is Ethereum, whose value on January 27, 2019 stood at €99.86, after reaching a historical high of €1,136.27 on January 12, 2018. For an updated study on the legal issues relating to the phenomenon of crypto currency, see CAPACCIOLI, *Bitcoin e criptovalute*, in Cassano – Tili – Vaciao, *Tutele e risarcimento nel diritto dei mercati e degli intermediari*, Milan, 2018, 445.

¹⁹For a first attempt at identifying and contextualizing the main legal issues relating to the blockchain in Italian scholarship, see SARZANA DI IPPOLITO - NICOTRA, *Diritto della blockchain, intelligenza artificiale e IoT*, Milan, 2018. The topic is also addressed from the specific perspective of cryptocurrency by PELLEGRINI - DI PERNA, *Cryptocurrency (and Bitcoin): a new challenge for the regulator*, in *Open Review of Management, Banking and Finance*, 2018, 318.

²⁰In reality, things are changing in the United States and in Europe alike. On 1 February 2018, the European Commission, with the support of the European Parliament, set up the EU Blockchain Observatory and Forum. On April 10, 2018, on the initiative of twenty-two European countries not including Italy (which joined immediately afterwards), the European Blockchain Partnership was set up to harmonize the approach taken by the various countries. Moreover, on October 3, 2018, the European Parliament approved a resolution entitled “Distributed ledger technologies and blockchains: building trust with disintermediation”, where, among other things, Parliament stressed the need for an in-depth assessment of the potential and legal implications of smart contracts. In addition, French government ordinance no. 1674 of 8 December 2017 introduced the possibility of using blockchain to register the ownership and transfer of unlisted securities. (available on the government website “Legifrance” at “<https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000036171908>»; see, among others, GARDENAL – MARCHESE, *Il blockchain ammesso nelle operazioni di M&A*, in *Il Sole 24Ore*, available online at “<http://www.diritto24.ilssole24ore.com/art/avvocatoAffari/mercatiImpresa/2018-03-15/francia-blockchain-ammesso-operazioni-ma-123710.php>”.

that can attribute a certain degree of certainty and verifiability to the contents of a specific contract, including the identity of the parties, the date, *et cetera*.

In actual practice, only a somewhat modest fraction of the automated economic operations carried out on the Internet, or at any rate using telematic tools, use the blockchain, while all other smart contracts are entered into through other means, whose form and mode of operation depends on the choices of the operators concerned and the capabilities of the technical systems involved, problems related to the certainty of the date, the reliability and verifiability of the information processed automatically, the impossibility of modifying the contents, and the overall security of the operation in question.

Thus, it would be wrong to consider the smart contract to be the spawn of the blockchain, or in some way necessarily tied to this technology, just as it would seem erroneous to state that “blockchain technology allows the self-enforceability of the contract”²¹. In fact, the automatism of execution of contracts “when the events pre-established by the parties and recorded in the code” does not depend on the use of the blockchain, but – as we have seen above – is a consequence of the parties sharing an automated computer system to which they both leave the execution in accordance with the framework agreement that they negotiated and concluded beforehand, or that one party proposed and the other accepted, – also beforehand²².

This allows us to safely predict that smart contracts will also survive the decline and obsolescence that will inevitable befall the blockchain (like all technology) a few months or many years hence. In this regard, it should be noted that the issues relating to the blockchain that have so far prevented its more widespread use are both numerous and significant. The first of these is that executing transac-

²¹The quoted text is from PAROLA, MERATI, GAROTTI, *op. cit.*, esp. 684.

²²It can thus be argued that blockchain facilitates (but does not actually allow) the self-enforceability of a contract only if we wish to emphasize that the more the parties trust in the reliability of the automatic system, the more likely they will be to entrust one or more phases of the transaction they are interested in to the system.

tions using this technology is by no means expeditious²³, and the verification and validation of data blocks is very costly in terms of organization and energy consumption²⁴. Furthermore, there is currently no certainty as to how long the system based on the chains of blocks, and therefore on the thousands and thousands of servers scattered all over the world that constantly process, validate, and store the data, will last, continuing to operate perfectly all day every day.

Evidence for what has just been said about the non-dependence of smart contracts on the blockchain can be found in the experience gained over recent decades in the field of financial transactions. In fact, automata (and, therefore, algorithms) and telematic networks have been used to collect information and plan strategies since the second half of the nineteen-nineties, making trading decisions and executing operations on the markets. And this took place totally independently of any blockchain, as it does even today.

4. Although the subject has so far been substantially neglected, as mentioned above, the financial transactions sector has long been the locus for natural development and application of smart contracts²⁵. In fact, the use of algorithms

²³At present, a transaction on the bitcoin system is estimated to take ten minutes, as this is how the protocol that manages block validation is organized. See “<https://www.tokens24.com/it/criptopedia/basics/come-funzionano-le-transazioni-bitcoin>” and “<https://support.conio.com/it/articles/115001186449-quanto-tempo-impiega-una-transazione-ad-essere-confermata->”.

²⁴According to reliable estimates, total annual electricity consumption for the production of bitcoin exceeds 32 terawatts, well above the annual consumption for a country the size of Ireland, which consumes 25 terawatts. See MARRO, *Come lavorano e quanto guadagnano i «minatori» del Bitcoin*, in *Il Sole 24Ore*, 20 December 2017, available online at “<https://www.ilsole24ore.com/art/notizie/2017-12-19/come-lavorano-e-quanto-guadagnano-minatori-bitcoin-163810.shtml?uuiid=AEVOppUD>”.

²⁵One of the most recent and constructive examinations of the phenomenon from the purely financial point of view is a work by a group of researchers, *Computerized and High-Frequency Trading*, in *The Financial Review*, vol. 49 (2014), Issue 2, 173-433; and LINTON – MAHMOODZADEH, *Implications of High-Frequency Trading for Security Markets*, USC-INET Research Paper no. 18-02, of 30 January 2018, Univ. Of Southern California, CA (USA), available online at “https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3112978”, but also in *Annual Review of Economics*, vol. 10 (2018), 237. See also, among others, CESPA – VIVES, *High Frequency Trading and fragility*, ECB Working Paper no. 2020, February 2017, available online at “<https://www.ecb.europa.eu/pub/pdf/scpwp/ ecbwp2020.en.pdf?ff0853c8630ef920d9429e31ff85b2682>”; CALCAGNIBILE – BORMETTI – TRECCANI – MARMI – LILLO, *Collective synchronization and high frequency systemic instabilities in financial markets*, 2015, available online at the Cornell University website, “<https://arxiv.org/pdf/1505.00704.pdf>”; also P.

allowing transactions to be carried out automatically, i.e. without human intervention, has become increasingly commonplace in securities markets all over the world since the 1990s.

To illustrate the importance of the phenomenon, it should be observed from the outset that, according to accredited estimates, even in 2009, algorithmic transactions accounted for around 75% of the volume of stock trade carried out in the United States²⁶. Confirmation comes from the incident of May 6th, 2010, when, in the space of just 10 minutes, Dow Jones suffered a flash crash that sent it from 10,650 points to less than 10 thousand, with a return, 10 minutes later, to 10,520 points²⁷. This occurred because of a huge number of mutually conditioning swaps that happening at that time with a frequency that immediately revealed the involvement of automata rather than traditional human trading²⁸. This triggered the SEC (Security and Exchange Commission) to focus on the question of smart contracts for the first time ²⁹.

Hoffmann, *A dynamic limit order market with fast and slow traders*, Working Paper Series no. 1526, March 2013, European Central Bank, available online at "<https://ssrn.com/abstract=1969392>"; CAIVANO *et al.*, *High frequency trading. Caratteristiche, effetti, questioni di policy*, Consob Discussion papers, 5 December 2012, available online at "<http://www.Consob.it/documents/11973/219968/dp5.pdf/04c93f02-d620-456c-b0a1-868233013f6e>"; and, lastly, FRICKE – GERIG, *Too Fast or Too Slow? Determining the Optimal Speed of Financial Markets*, available online at "https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2363114".

²⁶See HENDERSHOTT – JONES – MENKVELD, *Does algorithmic trading improve liquidity*, in *Journal of Finance*, vol. 66 (2011), 1.

²⁷See Consob, *Il trading ad alta frequenza. Caratteristiche, effetti, questioni di policy*, December 2012.

²⁸The investigations carried out by the SEC (the supervisory body for the U.S. markets) and the CFTC (Commodity Futures Trading Commission) later ascertained that the flash crash of May 6, 2010 had been caused by a single 4.5 billion-dollar order of sale of futures on the S&P 500 index: the order was probably a mistake, also considering that there were no indications regarding price or time frame. The liquidity on the market was not able to absorb it, thus triggering a downward spiral, in turn exacerbated by the triggering of automatic orders.

²⁹As has been rightly pointed out, although the SEC (see note no. 25) ascertained that high-frequency trading systems were involved in the peculiar (and somewhat exceptional) intraday trend of the principal Dow Jones index on 6 May 2010, "it is a complex matter to prove whether they have had a positive or negative impact on the operation of the market in this scenario, because the presence of systems able to carry out operations at very high speed certainly exacerbated the fall in prices, but when the negative trend came to an end, the same systems allowed vigorous recovery over the next 10 minutes. It should be noted that following the famous 1987 stock crash, the Dow Jones index took over a year to recover a loss percentage comparable to what was recovered in just 10 minutes in 2010. Observing the contrasting effects that high-frequency systems may have caused in an episode lasting less than an hour is indicative of the

In Europe, and therefore also in Italy, the use of automatic agents to carry out financial transactions is growing but still appears somewhat limited³⁰.

In fact, at *Borsa Italiana*, the number of transactions carried out by automatic agents adopting so-called strategies of 'high-frequency negotiation' in 2016 and 2017 only reached just under 30% of the entire volume traded, up on 2014, when the percentage had reached 25.4%, and 2015, reaching 28.7%³¹. Nevertheless, the figure is actually quite modest, both in absolute values and in terms of growth trends in comparison to with the results recorded in the more advanced and dynamic markets. We should also consider that almost all the high-frequency foreign traders operating in Italy are foreign³².

The terms Algorithmic Trading (AT) and High Frequency Trading (HFT) were coined in the United States, where the phenomenon had already taken root in the late nineties. They refer to transactions managed by an automaton using an algorithm (and here we have the smart contract idea again) and high-frequency transactions, characterized by their speed, respectively.

complexity of the subject". Thus PUORRO, *High Frequency Trading: una panoramica*, in *Questioni di Economia e Finanza (Occasional paper)*, Bank of Italy, no. 198 - September 2013, esp. 5. It should be added that, as will be highlighted later on in this essay, massive use of HFT in recent years has made the financial markets much more volatile, and phenomena of rapid loss and equally rapid recovery of stock market indices less exceptional. See also PAULIN – CALINESCU – WOOLDRIDGE, *Understanding Flash Crash Contagion and Systemic Risk: A Micro-Macro Agent-Based Approach*, in *Journal of Economic Dynamics and Control*, 10.1016/j.jedc.2018.12.008 (2019),

³⁰Some estimates state that robot traders handle 66% of the volumes traded on the global financial markets. See CARLINI, *Borse, come il robot trader "cavalca" il populismo e sfrutta lo spread*, in *Il Sole24 Ore*, 5 October 2018, available online at "<https://www.ilsole24ore.com/art/finanza-e-mercato/2018-10-02/-borse-come-robot-trader-cavalca-il-populismo--212907.shtml?uid=AEIROKFG>".

³¹See the *Relazione Consob per l'anno 2016* (the 2016 Consob Report), of 31 March 2017, 48; *Relazione Consob per l'anno 2017* (the 2017 Consob Report), of 31 March 2018, 52; and the *Relazione Borsa Italiana* (The Italian Stock Exchange Report), of March 2018, 23. See also CHIAMENTI, *Esma mette la museruola all'high frequency trading*, available online at www.bluerating.com/mercato/540483/esma-porta-lhigh-frequency-trading-vero-la-regolamentazione, showing, among other things, that the highest incidence of HFT (64.2% of the 2014 total and 68% in 2015, source *Relazione Consob per l'anno 2015*, of 31 March 2016) in Italy is in the IDEM (Italian Derivatives) market, where mini futures are traded.

³²Out of a total of about 29% of the amounts traded through HFT on the MTA (the Italian screen-based stock exchange), 92% of these are attributable to foreign traders. (see *Relazione Consob per l'anno 2017*, cit., 52).

More precisely, the concept of HFT is normally associated with a wide spectrum of automated operational strategies used in financial markets, which represent a sort of evolutionary step forward compared with simple AT. They mainly exploit the speed of execution of transactions and try to maximize the competitive surplus value that this speed can generate. They can also place many similar or identical orders (sale, purchase, booking, cancellation, withdrawal and so on) at the same time and thus cause immediate reactions in other operators, most of them also consisting in automated systems, that perceive the relevant moment on the market and operate accordingly.

As we mentioned, the more the market choices are made by automata, the greater the possibility of performing a large number of transactions in a short time. This is because the increased data-collection and calculation ability of modern computers, together with the strengthening of the communication channels along which the data pass, and the development of scientific methods for studying them, now allows – if equipped with the right algorithms and in possession of the largest and most complete set of information³³ – automated systems to make the choices best suited to their algorithm in a fraction of a second and infinitely multiply them in a very short time, varying the conditions relating to the operation with the changing situation³⁴. So much so that HFT constitutes a further evolutionary stage of basic AT, often being set up with the deliberate aim, among other things,

³³Automata that operate as financial traders use statistical analysis and historical series covering at least 10 years, but they are constantly fed moment by moment with new information that they receive or seek – also using ‘semantic analysis’ (See LEWIS, *Flash Boys. At Wall Street Revolt*, W.W. Norton & Co., USA, 2014) – on the most disparate platforms. They scan the Internet, and especially social networks, to detect events that can have some impact on the markets and even the mood of investors ahead of the competition.

³⁴According to the most recent scientific findings, it takes about five minutes to read a newspaper article and three seconds to write a tweet of 140 characters. Naturally, algorithmic machines have different operating times, as their speed of transaction depends on the power of the processors used and is subject to the speed of light, so the physical distance between two nodes in the communication network affects the time needed to transfer data from one node to another. Systems using HFT not only require the most powerful software and hardware but they also have to be able to reduce their physical distance from trading centres, which in turn allows further reduction of the latency times and leads to a profitable transaction. (see, among many, ANGEL, *When Finance Meets Physics: The Impact of the Speed of Light on Financial Markets and Their Regulation*, in *The Financial Review*, 2014, p. 273).

of gaining economic/financial advantage from the presence of less evolved and more easily predictable algorithmic systems on the trading books³⁵.

A precursor of HFT, and therefore a first exemplar of AT, is commonly identified in the phenomenon of the so-called SOES bandits, a category of trader that emerged in the mid-1990s. They would carry out several operations a day in order to take advantage of the slightest variations in prices or market makers delays in order to update the prices offered in money or letter³⁶. This was facilitated by the decision of the U.S. Securities and Exchange Commission to allow the use of alternative trading systems running parallel to the regulated markets. These systems, operating through computer platforms that bypassed the services offered by the broker-dealers, came to be known as Electronic Communications Networks (ECN). They basically correspond to the MTFs (Multilateral Trading Facilities) now regulated by MIFID in Europe.

The ECNs ran parallel to the regulated markets because, by express regulatory provision, orders given on the former could not be executed on the latter. Consequently, the best price for a transaction on an ECN could actually be lower than the best regulated market price for the same product at the same time, thus damaging investors who had chosen to operate on a platform running as an alternative to the regulated market.

The need to reduce the risk of inefficiency in automated systems operating on ECNs gave impetus to the development of AT equipped with algorithms and technological infrastructures that could allow them to operate very quickly. The fact that different prices for the same financial instruments might appear on the market actually increased the possibilities of taking advantage of arbitrage to the benefit of the operators who, by operating more quickly than the others and being able to process the information present in the various markets more effectively, were able to turn the differences in price that sometimes occurred to their advan-

³⁵On this see, again, Puorro, *op. cit.*, part. 9.

³⁶See HARRIS and SHULTZ, *The trading profits of SOES bandits*, in *Journal of Financial Economics*, vol. 50 (1997), 39.

tage. Thus, the fastest and most informed trader could buy at the lowest price on the market, often offered by the less informed trader and, at the same time, sell at the highest price. This would bring a gain at zero risk, exploiting both the price differences and the information asymmetry that, as we have seen, depended on the structure of the markets themselves. To counter this phenomenon, in 1997, the SEC imposed the *Limit Order Display* on market makers, obliging them to inform all traders what was the best buy and sell price at any time on the entire market, including ECNs.

A further important factor in the development of the technology behind the HFT is the 2007 US regulatory measure called the Regulation National Market System (Regulation NMS). It included two rules that had a considerable impact on the phenomenon in question³⁷.

Under the first, the Sub Penny Rule (Rule 612), the U.S. SEC requires all markets to use the decimal system to calculate the prices of shares above or equal to the unit. This limited the 'bid-ask' spread, reducing the cost to the investor of buying and selling a single stock, and at the same time prompting traders to develop increasingly sophisticated algorithmic trading systems to take advantage of minimal price fluctuations.

Under the second rule, the Order Protection Rule (Rule 611), the SEC overcame the problems related to the structural inefficiency of ECNs, related to the lack of information exchange, and, at the same time, replaced the concept of 'best execution' with that of 'best price', according to which the broker who receives an order to buy or sell is obliged to transfer it to the market with the best market price, if there is no possibility of offering the best price in the market in which he operates.

4.1. On closer inspection, the promulgation of the rules mentioned above, although quite recent, are already pieces of history, considering the pace of evolu-

³⁷See PANCS, *Designing Order-book transparency*, in *Electronic Communication Network*, J. Eur. Econ. Association, 2014, 24.

tion of the financial markets in recent decades. In this respect, suffice it to say that in the United States alone – where until recently, as we may recall, operation only took place in regulated markets – there are currently more than sixty trading venues for shares, all in competition with each other. This, in addition to being groundbreaking, paves the way for more skilled and faster high frequency traders to obtain excellent results while minimizing the risks, for the reasons mentioned above³⁸.

Thus, the best organized and most aggressive market operators today focus on the possibility of obtaining constantly improved performance from their technological trading tools, which are superior in terms of speed of making and handling a trading decision on the market, as well as in terms of volumes of trading operations carried out in the shortest time possible. It is clear, in fact, that the more operations the single trader can carry out in the shortest possible time to affect the work of his competitors, or even just to anticipate it, the more useful the operations will be to him. And this will be even evident when, in the next section, we examine the most common strategies adopted by those who do HFT.

From this standpoint, notwithstanding the decisive importance of the power of the software and hardware used by individual operators, reduction of latency times due to the physical distance between the traders' servers and the market platforms is also of fundamental importance³⁹.

In other words, since orders are electrical impulses that, despite travelling at very high speeds, encounter the limitation of the physical space to be covered, as already mentioned⁴⁰. Thus, a trader wishing to be at the forefront, even using a

³⁸On this point see FOX – GLOSTEN – RAUTERBERG, *High-Frequency Trading and the New Stock Market: Sense and Nonsense*, cit.

³⁹Latency is the time it takes to carry out the series of operations necessary to move from decision to execution. In today's structured financial markets, in addition to data-processing speed and the time taken to 'decide' to make an investment (or divestment), latency is a key factor in terms of the time that elapses between the operator taking the decision and the moment when the broker receives the order. Latency also impacts on the time needed for the broker to process the order (and thus understand all the elements it contains) and send it to the market where the financial instrument in question is traded, not to mention the time between the moment the order reaches the market and the disclosure of the data to all participants.

⁴⁰See note 34.

system based on an efficient algorithm and a powerful computer processor, may find that it may not be enough to win the competition with other market players. This is because physical distance from the platforms where the stocks are actually traded prevents a decision that has been made quickly and efficiently from reaching the market with equal celerity. Moreover, the same distance can also slow down the acquisition of market information that the software has to carry out moment by moment. This further impairs the decision-making and enforcement process that the automaton has to perform to achieve the desired profit.

To overcome these problems, several private companies have built, or are building, increasingly modern and secure network infrastructures to speed up and make less risky the transfer of data from one point of the network to another so as to promote even more competitive performance with respect to HFT operators. The key is to have a server located not physically far from the preferred trading platform.

Consequently, the phenomenon of 'co-location' has emerged. This is a commercial service offered by the trading platforms themselves, which allows participants in the market, or any interested party, to rent spaces ('racks') near the market platforms in order to locate their servers nearby. An alternative to co-location is 'proximity central hosting', i.e. an IT hospitality service offered by a third party to the interested parties allowing them to carry out their market orders from a physical position close to their chosen platform. On the issues of co-location and proximity central hosting, recent regulatory measures have been put in place in Europe to try to ensure operators have equal conditions of access to different services, as will be briefly illustrated below.

4.2. Increasingly widespread high-frequency financial trading has led to the emergence, or at any rate, the worsening, of certain market situations considered unhealthy, i.e., unsuited to promoting adequate conditions of market development, as well as the opportunities for abuse by the most unscrupulous operators to the detriment of less aware and organized investors.

The first problem, “ghost liquidity”, although not exclusively attributable to HFT, is (also) closely correlated to the use of the more dynamic and aggressive trading technologies. In short, volumes of exchange can increase at any given moment thanks to the use of the most up-to-date high-frequency trading technologies for any number of reasons, especially when there is turbulence on the markets: 1) automata can decide to activate very short-term risk-reduction strategies (buying and selling in the span of a few minutes), and 2) automata inevitably influence each other, so if an automaton decides to buy up a huge amount of a given stock, the others, that collect information on the market and price variations, can also decide to buy that or some other stock, which can bring about a positive moment for the stock exchange and can turn a positive one into one of euphoria.

This gives the impression that new liquid assets have entered the market, but in fact there is nothing, so from then on, thanks to the above-mentioned short-term strategy, the automata will probably begin to sell in order to monetize the gain (and therefore increase the price of the security), quickly setting bearish strategy in motion.

Furthermore, economic theory has identified some strategies, typically adopted by those who operate on high-frequency financial markets, which, if implemented by operators with considerable portfolios or strong liquidity and cutting-edge technologies, can create distorted representations of the trading book and consequent market abuse.

The best known of these are ‘stuffing’, ‘smoking’, ‘spoofing’, ‘layering’, and ‘front running’.

The term ‘stuffing’ refers to the practice of placing a large number of orders on the market using high-frequency trading systems at the same time so as to create a ‘fog’ effect, thus preventing slow traders – operators who do not use advanced technologies – from having an immediate and exact view of what is happening, so they can take advantage of the paralysis of their competitors to carry out profitable operations.

'Smoking', on the other hand is the practice of placing attractive bluff orders for one or more products in order to capture the attention of other operators, especially slow traders, and then immediately changing the trading conditions of the products in question and taking advantage of the slowness of other operators in noticing the change.

The term 'spoofing' refers to operations carried out by traders in order to alter the price trend of a target product (or at any rate its trading conditions). In a nutshell, if a trader intends to sell a product from his portfolio in order to raise the price and sell higher than the best price on the market at that time, he can flood the system with massive orders to buy that product and induce competitors to believe that there really is increased interest in the product and that there is therefore a good chance that the value of stock will increase, thus making it worth buying. Market reactivity to phenomena like this, and the fact that automata observe and talk to each other (as we have already observed), soon hike up the price of the product in question. In the meantime, the trader who started the process takes advantage of the speed of his systems to cancel the orders before they are executed and places the sales orders he was actually interested in from the start, making profitable transactions for him, as sales will probably be finalized at a higher price than the starting price.

The term layering denotes a variation of spoofing, where a trader wishing to spark off a market reaction in the opposite direction to the operation he intends to execute with a given product or products does not place two different orders on the market, namely the one he means to cancel and the true one at slightly different times, as above. He places them simultaneously. However, the first is visible to other operators, while the second is a "hidden order" (and therefore not visible in the trading book). In this way, the market is led to believe there is a certain movement of the market, while the trader operates using hidden orders on the opposite side of the order book, taking advantage of the market's reaction to the visible order, which, in the meantime, is cancelled.

The last, and perhaps most strongly opposed, practice that deserves our attention here is that of 'front running'. It can only be performed by intermediaries operating on the market both on their own account and on behalf of third parties. In this case, the trader, knowing the order that he is about to place on the market for his client, exploits the speed allowed by his computerized trading systems to place an order on his own account (similar or opposite to that of the client) a few moments before placing the client's order on the same market.

These few simple remarks clearly show that the use of high-frequency trading systems paves the way for market manipulation, which can bring the more aggressive and better organized traders huge profits in the short term, but at the same time, not only do they penalize the other operators, but they risk triggering copycat behaviour and further distortion of the markets. This has the overall effect of creating inefficient trading conditions on all markets in the medium term⁴¹. It goes without saying that the competent authorities are unable to prevent the practices in question from being carried out. In any case, as we have already mentioned, some scholars believe that the use of high-frequency trading systems can actually improve the quality of markets in terms of volatility, liquidity, information, and prices.

In order to prevent fraudulent use of the algorithms leading to market abuse, the market regulatory authorities and legislators in the more advanced countries have adopted regulation to address the issue of high-frequency financial trading, as we shall see in the next two sections.

One more important factor needs to be underlined: despite the millions of daily financial operations that can be categorized as algorithmic trading, there is

⁴¹IEX was set up in the United States in 2013 to counter the risks associated with the use of high-frequency trading, and to enhance the stability and security of the markets. It is an information-technology platform currently owned by a number of investment funds, where securities can be bought and sold on the stock exchange in different ways from those allowed on other platforms, especially ways that combat high-frequency trading. For example, to avoid predatory arbitrage, a minimum order latency (350 milliseconds per transaction) is required, co-location is prohibited, and privileged access to market information by some operators but not others is forbidden. See PICARDO, *How IEX Is Combating Predatory Types of High-Frequency Traders*, in *Forbes - Investopedia*, available online at "<https://www.forbes.com/sites/investopedia/2014/04/23/how-iex-is-combating-predatory-types-of-high-frequency-traders/>".

no current record of any significant dispute between private parties to an automated financial transaction: at any rate nothing has hit the front pages, nor has anything come to the attention of scholars.

In practice then, there have been no significant problems regarding the malfunctioning of automata and consequent liabilities concerning, for example, failure to finalize a contract, misunderstanding contractual intent, errors regarding inserting data into the system, or using an electronic impulse, or anything else⁴². This is because, on the one hand, those who use algorithms inevitably accept the risks connected with them (naturally seeking to reduce them to the minimum and taking precautions against the possibility of problems occurring); on the other hand, the speed of the swaps and the importance that trust and reputation have in the financial markets advise against, if not completely prevent, any disputes about the correctness of an automated operation being made known to third parties, as they are handled by the parties themselves and resolved via private systems of dispute resolution alone⁴³.

A major problem, is, of course, the difficulty supervisory bodies encounter in tracing which software, and so which automatic system, has caused a given market reaction, and to evaluate its actions in terms of lawfulness or illegality in order to apportion any civil, administrative, and/or criminal liability. From this point of view, the traditional juridical rules governing the phenomenon are evidently inadequate⁴⁴.

4.3. The first regulatory action relating to HFT date back to the period when, after the 2010 crash mentioned above, two key actors in the U.S. regulatory

⁴²Over the last few years, news stories have reported numerous cases of errors (or alleged errors) committed by automata operating in the financial markets that have led to significant stock market movements and/or heavy damage to the traders involved. On the subject in general, see ALDRIDGE – KRAWCIW, *Real-time Risk. What Investors Should Know about Fin-Tech, High Frequency Trading and Flash Crashes*, Hoboken (New Jersey, USA), 2017.

⁴³See, among various, ANDREOTTI, *Dispute resolution in transnational security transaction*, Oxford and Portland (Oregon, USA), Hart Publishing Plc, 2017.

⁴⁴For some interesting considerations on the causes and extent of this failure, see YADAV, *The Failure of Liability in Modern Markets*, in *Virginia Law Review*, vol. 102 (2016), 1031.

framework, the SEC and the Commodity Futures Trading Commission (CFTC), jointly presented a report in quick response to an episode that had given rise to concerns about how high-frequency trading is carried out.

The first American regulatory response was to set up a mechanism to identify the activity of 'large traders' whose particularly high volume of trading, due in part to their technical, IT and organizational capabilities, is able to condition market prices⁴⁵. This would make it easier for the authorities themselves to control the activity of the large traders by requiring them to provide the said authorities with information.

This obligation was part of the broad-ranging regulatory reform known as the "Dodd-Frank Wall Street Reform and Consumer Protection Act", strongly supported by the Obama administration, in order to promote fuller regulation of the American markets and provide better protection of the consumers⁴⁶.

Among the most significant changes brought by the reform to the world of HFT, the following particular stand out: a) the possibility for the SEC to require hedge funds to draw up reports containing information relating, for example, to the types or amount of assets held, and to make it – and any other information useful for assessing the fund – public; b) setting up a new institution, the Financial Stability Oversight Council (FSOC), to supervise the stability of the market and the financial system as a whole; and c) stricter regulation of the Commodity Market, where it is forbidden to revoke or cancel orders.

In addition, immediately after the reform came into force, the SEC issued two rules, Rule 13h and Rule 13h-1190, requiring, i) large traders to identify themselves as such through written application to obtain a Large Trader Identification Number (LTID), a *conditio sine qua non* for operating as such on the markets, and

⁴⁵See PRASCH, *The Dodd-Frank Act: Financial Reform or Business as Usual*, in *J. Economic Issues*, 2012, 186; M. Richardson, *Regulating Wall Street: the Dodd-Frank Act*, in *Economic Perspectives*, 2012, 45.

⁴⁶The official document containing the reform that American legislator itself called the "Dodd-Frank Wall Street Reform and Consumer Protection Act" (12 USC 5301), and approved on 21st July 2010, may be consulted on line at "<https://www.congress.gov/111/plaws/publ203/PLAW-111publ203.pdf>". See, among many, RICHARDSON, *Regulating Wall Street: the Dodd-Frank Act*, in *Economic Perspectives*, 2012 199.

ii) that such actors present their Large Trader Identification Number to all brokers and/or dealers through whom they have traded on the NMS; iii) that brokers and/or dealers, upon specific request provide the SEC with data relating to transactions carried out by large traders in the NMS by the morning of the day following a transaction; iv) that brokers and/or dealers maintain and constantly update their accounting books and records for any such transactions⁴⁷.

The new regulations in question, however, reveal some serious weaknesses, especially as their speed and precision makes algorithmic systems so increasingly efficient that they can evade supervisory authority controls. For this reason, the present US Administration aims to modify the current HFT regulations, but there is still no certainty about the direction to take, as some observers call for the introduction of obligatory periods of latency or presence on the market for an order (to prevent spoofing, layering, and front running), and also to require traders who use technologies designed for high frequency operations to keep the markets updated with information, thus preventing them from taking advantage of the information asymmetry to the detriment of 'low traders'. Other observers, conversely, favour substantial deregulation of the phenomenon in order to promote competition based on technological competition.

4.4. In Europe, the MIFID I and MIFID II directives have introduced important rules on financial transactions carried out using intelligent information systems⁴⁸.

⁴⁷See KINI, HARREL, LYONS, *Federal Reserve adopts key Dodd-Frank Act definition*, in *Banking Law Journal*, 2013, 47.

⁴⁸This is, of course, European Parliament Directive 2004/39/EC of 21 April 2004 (the *Markets in Financial Instruments Directive*, hence the acronym MIFID), which, as of 3 January 2018 was replaced by MIFID II, with Directive (2014/65/EU) which, together with MiFIR, namely EU regulation 600/2014, *Markets in Financial Instruments Regulation*, now constitutes the European reference legislation on the matter. The literature on this subject is vast. For an overview of MIFID II, see, among others, PEZZUTO – RAZZANTE, *MIFID II: Le novità per il mercato finanziario*, Turin, 2018; TROIANO – MOTRONI, *La MiFID II, Rapporti con la clientela-regole di governance-mercati*, Padua, 2016; and CAPRIGLIONE, *Prime riflessioni sulla MiFID II (tra aspettative degli investitori e realtà normativa)*, in *Riv. trim. dir. ec.*, 2015, 72. On MIFID, see F. Capriglione, *Intermediari finanziari, investitori, mercati: il recepimento della MIFID. Profili sistematici*, Padua, 2008.

In particular, the latter – expressly acknowledging the positive effects that the introduction of new information and communication technologies has had on the markets – has introduced, or in some cases more fully defined, certain obligations for traders using AT systems and additional obligations for traders using HFT systems.

The most significant innovations include: a) the provision that operators using high-frequency trading techniques must be identified as such by the supervisory authorities and other market operators; b) the obligation for investment firms using automatic trading techniques to set up appropriate organization and control systems to ensure the resilience of their trading systems; c) the obligation for all companies using TA techniques to engage in market making on a continuous basis, except in specific cases, in order to bring liquidity to the market in a regular and transparent manner; d) the obligation for those wishing to offer physical space allowing operators' servers to work close to the trading platforms to guarantee all operators equal conditions so that proximity is not the prerogative of only a few and does not become a competitive factor conditioning the market; e) the recommendation that the regulators of the various markets constantly monitor the work of AT and HFT systems and to encourage a more efficient structure for operators' commissions.

Along with the important innovations just mentioned, it should also be noted that among the main innovations already introduced by MIFID – and reiterated by MIFID II – is the recognition of alternatives to the regulated markets, with the consequent corollary effect of the liberalization of negotiation, and the further provision requiring *best execution* in the execution of trading orders. This recognition, for the reasons already mentioned above, has done much to foster AT, and especially HFT.

One can therefore safely say that in Europe it was the MIFID directive, combined with the development of the alternative markets mentioned above and

the gradual fragmentation of the market, that gave the decisive boost to the spread of the HTF⁴⁹.

Returning to the issue of the difference between AT and HFT, it should be noted that algorithmic trading is defined in Article 1 of MIFID II as a set of trading techniques where the choice of trading parameters, such as price, quantity, and the time taken to complete their trading, are left to the “choice” of a highly computerized algorithm. The automatic decision characteristic of AT, among other things, is not limited to the parameters of the individual trade but also extends to “whether to send the order” and how to manage the position once the trade is finalized.

MIFID II therefore identifies zero, or at any rate minimal, human intervention in financial instrument transactions as a fundamental characteristic of AT. Therefore, from a regulatory point of view, this category must include all transactions where an IT algorithm replaces human decision-making activity in trading choices. The article excludes from the category any computer system used only for transmitting orders to one or more trading venues, dealing with orders that do not involve establishing trading parameters, confirming orders, or post-trading handling of the operations carried out⁵⁰.

With regard to high-frequency algorithmic trading, MIFID II reaffirms the notion that HFT is a species within the broader genus of AT and distinguishes a specific and more binding regulation for the case in question. HT is described and classified as a set of very high-speed trading mechanisms generally used by operators who “operate on their own account” and use this form of trading to implement strategies of market making (with the risk of market abuse) and/or arbitrage strategies. Article 1 of MIFID II itself specifies how this case is characterized by: a)

⁴⁹On this, see ESMA, *High-frequency trading activity in EU equity markets, Economic Report*, no. 1, 2014, part. 5.

⁵⁰All the trading systems, even if highly sophisticated and computerized, that are used exclusively to execute and to manage a set of orders that have already been benchmarked are thus excluded, including those where the price, the quantity of the order, and the time when the swap is to take place have already been established by a human being. See BUSCH - FERRARINI, *Regulation of the EU financial markets: MIFID 2 and MiFIR*, Oxford University Press, Oxford, 2017, part. 137.

the use of “infrastructure designed to minimize network and other latencies, including at least one of the structures for algorithmic order placing: co-location, proximity hosting, or direct electronic access at high speed”, b) “establishment by the system of initialization, generation, transmission, or execution of the order for the individual order or transaction without human intervention”, and c) “high daily traffic of messages consisting of orders, quotations, or cancellations”.

As mentioned above, the ontological difference between the two trading techniques leads to different forms of regulation, especially regarding exemption. Indeed, it should be reiterated that due to its characteristics and potential, HFT is considered to be more threatening to the market (see Recital 62 of MIFID II), and thus, “high-frequency algorithmic trading” requires the application of the relevant MIFID II rule also “to persons who deal in financial instruments other than commodity derivatives or emission allowances or related derivatives on their own account and who do not provide other investment services or perform other investment activities in financial instruments other than commodity derivatives, emission allowances or related derivatives”. On the other hand, if these “persons” only use non-high-frequency information technology, the rules on AT will not be applied.

The rules introduced with the approval of MIFID II are also inspired by (and in any case rest on) the intensive work on AT and HFT that ESMA has been doing since 2010 (when it was still operating as CESR). In 2010, in fact, the authority issued a Call for Evidence to probe the structural problems of the financial markets in the light of the impact of new technologies, and in 2011 the same authority published a consultation document called “Guidelines on systems and controls in a highly automated trading environment for trading platforms, investment firms and competent authorities”, followed on 24 February 2012 by the publication of the ESMA Guidelines on the same subject with the same title⁵¹.

⁵¹The Guidelines are available online on the official ESMA website, at the following address: “https://www.esma.europa.eu/sites/default/files/library/2015/11/esma_2012_122_en.pdf”.

It should be pointed out that these guidelines are expressly applicable also to entities other than investment firms that are not subject to MIFID if, and in so far as, they are operators with any sort of access to the trading platforms, directly via 'Direct Market Access' (i.e., through a form of electronic access that provides a variety of actors with entry into the market, be they intermediaries and otherwise, without having to become members, using infrastructures and systems made available by one or more participants), or through Sponsored Access (an agreement whereby a member of the market allows its customers to access the market using his/her own ID, in order to place orders directly on the market, but without using the member's infrastructure).

In extreme summary, we might say that ESMA was seeking to pursue two main objectives: firstly, to ensure fair and orderly trading, with particular emphasis on a substantially level playing field and information circulating among all those operating on the market, and secondly, to prevent users of high-frequency trading systems from engaging in market abuse⁵².

The importance of the Guidelines and the role of the ESMA in the configuration of the European financial markets is confirmed by the range of powers conferred to the authority by MIFID II, establishing that the ESMA (albeit maintaining the possibility of issuing acts of soft law such as "Recommendations" and "Guidelines"), can and must issue real technical regulatory standards governing specific areas of the vast subject of algorithmic trading and, more specifically, high frequency algorithmic trading.

5. Our reflection so far, starting from the observation that the term 'smart contract' – principally coined by technologists – has entered the lexicon of jurists, has sought to answer two fundamental questions: what is meant by this term and what does it mean for a jurist to think about the new conceptual category?

⁵²Pursuant to Legislative Decree No. 58/1998 (TUF) and its implementing provisions contained in Consob Regulation No. 16191/2007, these guidelines were partially implemented in Italy by Consob in its Communication of April 4, 2012.

The outcome of our inquiry is essentially that:

1) smart contracts are not contracts,

2) the terms 'smart contract' and 'blockchain' should not be confused, as they are two totally different and mutually independent phenomena,

3) the legal problems raised by the countless and widely different scenarios that can be classified as smart contracts require an analytical approach strongly conditioned by the technological ecosystem of reference and must, therefore, be addressed on a case-by-case basis,

4) for this reason too, the category in question has substantially no legal significance,

5) in any case, precisely because the nature of smart contracts and how they work depends so much on the technology used, they are significantly affected by technological developments so that any attempt made by jurists to understand and regulate the phenomenon risks becoming obsolete at the very moment it is carried out,

6) It comes as no surprise that, in the field of smart contracts, issues relating to the validity and effectiveness of contracts, or those relating to any liability, are normally handled independently by the computer systems concerned, and therefore with no recourse to the institutions and rules of the legal system.

To corroborate the assumptions summarized above, we have analyzed what happens in the financial markets, within which, for at least twenty years now, the use of computer systems, and therefore algorithms, to analyze data, take decisions and perform trading operations has spread, also (and especially) in order to carry out a very high number of operations in a very short time and enjoy a competitive advantage over less equipped operators.

As we have seen, mainly in sections 4 onwards, systems defined as algorithmic trading and, especially, high frequency trading are used every day to trade millions of securities in the securities markets around the world to a value of billions of euros, but national and supranational legislators have not intervened to regulate the phenomenon through *ad hoc* civil law rules to regulate contracts, the

fulfillment of obligations, and related responsibilities. Rather they have produced public (including potential criminal) law regulations, meant, for the most part, to combat market abuse⁵³.

These norms do not then aim to alter the existing relationship between the two or more parties to the transaction in question, still less to protect the interests of weaker actors. Rather, they have been conceived solely to protect the market from the negative effects that certain attitudes and/or behaviour of private operators may have on the flow and development of the market.

This observation underlines how technology is modifying the relationship between the law and the different arenas of human experience⁵⁴, as legal norms are increasingly being forced to (substantially) abandon the regulation of highly technological phenomena and are, therefore, prone to extremely rapid obsolescence and transnational dynamics⁵⁵. This, however, appears to be well tolerated (if not favoured) by the market operators – or, at least, by the better organized and more influential ones on account of their technological and financial capabilities – as on the one hand they internalize the risk associated with the use of the new technologies through insurance or self-insurance mechanisms, and on the other hand they ensure that the risk of inefficient and damaging disputes is reduced to a minimum. Furthermore, they oblige each other to use private and highly technological systems to resolve any such disputes, also making it possible to limit the risk of repercussions on their reputations, possibly leading, at a given time, to distrust and wariness towards the individual operators concerned or even the market itself.

⁵³For an updated and concise overview of the main criminal law issues relating to market manipulation, see MACRILLÒ – CAMINO, *Il diritto penale degli intermediari finanziari*, in Cassano – Tilli – Vaciago, *op. cit.*, 517.

⁵⁴On this subject, especially the private law crisis regarding current technological developments, kindly refer to DI CIOMMO, *Internet e crisi del diritto privato: globalizzazione, dematerializzazione e anonimato virtuale*, *op. cit.*; and ID., *Civiltà tecnologica, mercato ed insicurezza*, *op. cit.*

⁵⁵On this subject, and for the literature referenced, kindly see DI CIOMMO, *Evoluzione tecnologica e regole di responsabilità civile*, Naples, 2003, esp. chapter 1.

Where technology and business organization cannot reach (namely with regard to the few contentious issues relating to new technology on the market that end up in the traditional courtrooms despite all best efforts), modern legal systems load judges with further responsibilities in addition to their traditional ones, at least in civil law legal systems, as they are asked to make up for the lack of pre-established rules by interpreting and applying (even creative) legal principles to deal with the new questions posed by a world that is changing too quickly and in too complex a way for legislators to keep pace with.

Whether or not this dynamic ensures conditions of formal and substantive justice is another problem that cannot be dealt with here⁵⁶.

Our discussion cannot close, however, without underlining that in such a scenario Jean Carbonnier's reflections on the so-called "Kingdom of Non-Law", expressed in terms of "Law and Non-Law", "Law of the Non-Law" and "The Right to Non-Law" are highly apposite⁵⁷. Without, however, agreeing with the great French sociologist where he observes that the law is, by its very nature "flexible", since the juridical phenomenon (also independently of the concept of legal system), understood as a historical reality, not only continuously changes its very characteristics and operational registers due to the social changes it has to follow but expands or contracts in the exercise of its mission and therefore in the occupation of the normative spaces found in society as a function of the conditioning capacity that other factors and other normative agents express in the same society at the same time⁵⁸.

⁵⁶On this subject, strongly debated in Italy and abroad for several years now, see the contributions in DI CIOMMO – TROIANO (eds), *Giurisprudenza e autorità indipendenti nell'epoca del diritto liquido. Studi in onore di Roberto Pardolesi*, Rome, 2018. Kindly see also DI CIOMMO, *Sulla giustizia ingiusta (dalla giurisprudenza normativa alla giustizia del caso concreto): la vicenda emblematica delle nullità negoziali*, in *Foro. it.*, 2018, V, 249.

⁵⁷See, in particular, CARBONNIER, *Flexible droit* (first edition., Paris, 1969), in Italian translation, *Flessibile diritto*, Milan, 1997; but also ID., *Sociologie juridique* (first edition., Paris, 1978), Paris Puf, 2004. Among many, see also, CUCULO, *Ordinamento giuridico e non-diritto: rileggendo Jean Carbonnier*, in *Sociologia*, 2016, 312.

⁵⁸For many authoritative scholars, the evolution of the relationship between the law and technology will inevitably lead to the decline of law, or at least the affirmation of the predominance of technology, but Carbonnier's approach seems more convincing and ultimately correct. On this, see, among many, the rich dialectic condensed in IRTI - SEVERINO, *Dialogo su*

This analysis allows (and forces) the contemporary jurist to observe how, at this moment in history, the marriage of technology and economics (or better, finance) has (perhaps momentarily) relegated law – at least in the sense in which it is still commonly understood – to a totally different operational, and possibly (and admittedly) even more modest dimension than the constituents of law have occupied for millennia, or at least until a only a few years ago.

diritto e tecnica, Rome-Bari, 2001, wherein the philosopher who advocates the end of law as we know it is counterbalanced by a jurist determined to defend law as the only means able to allow man to choose the “goals” to which technology can be applied.

