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This volume, titled **"Regulatory and Compliance Insights"**, focuses on the significant progress and ongoing challenges in the field of financial regulation and compliance. The articles are organized to cover key themes such as, capital markets, independence of financial supervision, digital transformation, and capacity building, reflecting the comprehensive approach needed to address the dynamic nature of financial markets.

1.4
Academic Article

Artificial Intelligence and Market Abuse Regulation

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Summary

Artificial Intelligence and Market Abuse Regulation

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Foreword

The purpose of this contribution is to analyse how developments in the field of artificial intelligence ('AI'), and the debate on its implications, including in the legal sphere, affect the regime established by the EU Market Abuse Regulation ('MAR') ([1]). The topic shall be explored by considering the two main areas of the MAR: on the one hand, inside information and the related disclosure regime; on the other hand, conducts qualifying as market manipulation.

1 Regulation (EU) No 596/2014 of the European Parliament and of the Council of 16 April 2014 on market abuse (Market Abuse Regulation) and repealing Directive 2003/6/EC of the European Parliament and of the Council and Commission Directives 2003/124/EC, 2003/125/EC and 2004/72/EC, in OJ 173, 12.6.2014.

01

AI and the management of inside information

The analysis regarding the first aspect of the interrelation between AI and MAR is centred on the transparency regime thereunder, essentially consisting of the obligation for issuers to disclose to the public, as soon as possible, any inside information directly concerning them (Article 17 MAR) ([2]).

It consists of a regime that, as noted in a previous contribution, has significant repercussions on the internal structure and organisation of the issuer ([3]). The importance of analysing AI systems, and the functions they can perform in this context, becomes clear when one considers that the obligation to disclose inside information entails the proper management of data and information for entities subject to MAR. Since, in fact, issuers must disclose inside information 'as soon as possible', and given that disclosure cannot be delayed unless the specific (and rather restrictive) requirements for delay apply, the issuer must be able to identify inside information in due time, and thus to disclose it in an equally timely manner.

The identification and proper handling of information are, indeed, at the heart of the disclosure regime. Complying with the MAR disclosure obligations is not, however, trivial and can be quite challenging, particularly where the size and structure of the issuer and/or of the group to which it pertains is more significant.

In addition, when considering the complexity of the notion of inside information, one must also take into account the fact that most of the events generating such information are neither instantaneous nor static, but are, on the contrary, the result of prolonged and multi-stage processes: inside information, in this sense, often has a dynamic dimension. Although a possible simplification of the MAR regime is being discussed as to whether the current obligation to disclose information should be maintained in the intermediate stages of prolonged processes ([4]), even if such changes were to be adopted, this would not, in any case, affect the issuer's duty to identify potential inside information directly concerning it beforehand, and to carry out the subsequent steps ultimately leading to disclosure. The problem would therefore continue to exist, and it is essential that the issuer has adequate systems and procedures in place, both at individual and group level, to ensure the prompt identification and ongoing monitoring of potential inside information.

This assertion remains valid even if the MAR does not explicitly foresee an actual obligation for the issuer in this respect. In fact, while MAR establishes, in Article 17, an obligation to disclose information to the public 'as soon as possible', it does not contain a provision expressly requiring the issuer to have in place adequate internal organisational arrangements for such purposes.

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2 Article 17 provides, *inter alia*, that "1. An issuer shall inform the public as soon as possible of inside information which directly concerns that issuer [...]".

3 F. Annunziata, '*Madamina, Il Catalogo È Questo...': the Duty to Disclose Inside Information and the Proper Organization of the Company: The Market Abuse Regulation ('MAR') and Italian Company Law*. Bocconi Legal Studies Research Paper Series, available at: https://ssrn.com/abstract=3621359, 2020.

4 Proposal for a Regulation of the European Parliament and of the Council amending Regulations (EU) 2017/1129, (EU) No 596/2014 and (EU) No 600/2014 to make public capital markets in the Union more attractive to companies and to facilitate access to capital for small and medium-sized enterprises, Brussels, 7.12.2022 COM (2022) 762 final 2022/0411 (COD).

In this sense, since Article 17 requires information to be disclosed 'as soon as possible', the way the issuer is structured and organised to achieve this result is left to the reasonable assessment of its management bodies, whose efforts are only measured by the results actually obtained: that is, that the disclosure of inside information is duly carried out pursuant to the terms of the Regulation.

The approach followed by MAR, in this sense, could ultimately be regarded as the result of a good balance between the costs and benefits of regulation. In theory, one could also accept the idea that as long as the disclosure is carried out in a proper and timely manner, the precise means by which the issuer achieves this result is essentially irrelevant: the disclosure obligation is, in fact, formulated in general terms, constituting the only standard under which it is reasonable to assess the diligence of the issuer and its management bodies. Whether or not the issuer is adequately structured thus remains an internal matter, which the law should not directly address as long as the result required by the standard (i.e., disclosure 'as soon as possible') is achieved.

This position is, however, exposed to a number of potential objections. In fact, even if the MAR regime is silent on the point, the obligation to implement adequate internal arrangements seems to be, in any case, implicit in the system: the silence of the Regulation is, therefore, somewhat deafening.

Such an assertion can be supported by considering the significant number of *soft law* measures that, even if not formally binding, have been adopted by the supervisory authorities of many Member States with regard to the qualification and treatment of inside information. Among the most relevant documents to be considered in this respect are those issued by the competent authorities of Italy, Germany, France, the Netherlands and (still usefully) the United Kingdom. In most of them, although not in all, and not always with the same degree of detail, the obligation of the issuer to be adequately organised in order to comply with disclosure rules is clearly stated, or inferable from the content of the guidelines.

In particular, in November 2017, Consob published a comprehensive guide on the identification, management and disclosure of inside information ([5]). In the document, while making it clear that the guide, as a *soft law* measure, is not suitable to supplement, nor to complete, the rules in force, it serves as an interpretative guidance and as a reference for the approach adopted by Consob in relation to its own supervisory activities. Among other aspects, the guide focuses precisely on the adequacy of the issuer's organisation for the purpose of identifying, managing, and disclosing inside information. It emphasises the need for the issuer to adopt 'adequate' systems, and devotes an entire, lengthy section to describing what should be considered an example or standard of an adequate internal arrangement. The guide also identifies the various phases into which an adequate management of inside information should be divided: the process begins with the implementation of adequate organisational structures, so that the issuer is adequately prepared with the tools to monitor the entire process; as an initial procedure, the issuer shall identify the so-called 'material information' ([6]) , which is information that may, at least potentially, be classified as 'inside information' in a later moment; the guide, in this respect, establishes the criteria for identifying the moment when certain material information becomes inside information; and, finally, the guide addresses the need to publish the information 'as soon as possible' or, alternatively, to apply the delay regime, in

5 The official text of the mentioned guidelines is available at: https://www.consob.it/documents/1912911/1987745/LG_Gest_Inf_Priv_20171013.pdf/d435449f-845c-f26f-a6e3-7a8f20e99c0f.

6 The notion of 'material information' has no equivalent in the MAR, and is used by the guide to refer to any information that could possibly evolve into actual inside information, meeting all the requirements defined in Article 7 of the MAR.

which case observing the appropriate measures foreseen by the Regulation. Of particular relevance are the long paragraphs of the guide devoted to the process of identifying and monitoring inside information: a process that, according to the document, should start at a very early stage, when the information is still preliminary, not formally meeting the objective requirements of true inside information.

Other important measures, for the purpose of analysing the impact that the soft law instruments under discussion have on the organisational structures of issuers, concern the special forms of corporate liability found in certain national laws. In Italy, for example, Legislative Decree No. 231/2001 (hereinafter, 'the Decree')([7]) provides for a special form of liability of natural persons, in the event of offences committed by persons acting on behalf of the company, such as representatives, managers, directors, subordinates and persons who perform - even *de facto* - management or control functions ([8]). Moreover, according to the Decree, the liability of the legal entity is excluded if it can be proved that the management body adopted and implemented, before the offence was committed, a so-called 'organisation and management model' aimed at preventing the practice of the offences set out in the Decree ([9]). Since violations of the rules on market abuse fall within the scope of the Decree, this is a highly relevant matter to be taken into consideration in the analysis herein.

The uncertainty in the EU Market Abuse Regulation as to whether there is a clear obligation, on the part of the issuer, to adopt adequate organisational structures to handle inside information also emerges from the work of the European Securities and Markets Authority ('ESMA'). In the consultation conducted at the end of 2019 on a potential reform of the market abuse regime, ESMA suggested, among other topics, amending the regulation in order to include a specific provision requiring the issuer to be properly organised and to have adequate systems in place in order to identify inside information and to comply with the disclosure obligation ([10]).

During the consultation phase, most respondents observed that it is not necessary to include in the MAR an explicit requirement to establish adequate systems and controls for the identification, handling, and disclosure of inside information. They argued that such systems and controls are in any case already implicitly required, as they are necessary to enable issuers to classify information and identify when it becomes inside information: in other words, the obligation exists, even if it is not clearly spelled out ([11]) . Accepting such arguments, ESMA ultimately concluded that there is no need to supplement Article 17 MAR to specify the existence of a duty of adequate organisation ([12]) .

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7 Legislative Decree No. 231 of 8 June 2001 on administrative liability dependent on criminal offences.

8 ([8]) The sanctions specifically provided for by the Decree include: pecuniary sanctions; disqualification from exercising the activity (temporary or permanent, in the case of particularly significant or repeated violations); temporary revocation or suspension of licences, permits or authorisations related to the violation; prohibition from contracting with the Public Administration; prohibition from advertising goods and services; prohibition from financial facilitations, subsidies and contributions; mandatory confiscation of the price or profit deriving from the illegal conduct; publication of the judgment.

9 The compliance programmes provided for in the Decree are also relevant for the purposes of liability arising from violations of the disclosure regime established by Article 17 MAR.

10 See ESMA, Consultation Paper: MAR Review Report (ESMA70-156-1459), 3 October 2019, para. 118.

11 In the final paper (pars. 234-235 s.), ESMA also noted that: "*As indicated in the CP [Consultation Paper], based on its size, sector of activity and specific features, each issuer should tailor the relevant controls to its business and structure. Especially when considering delaying the disclosure, it is fundamental to have robust processes to handle and manage the inside information and to thoroughly assess the presence of the conditions enabling such delay. In other words, ESMA believes that issuers that do not have in place effective arrangements, systems, procedures, or other types of controls for the identification, handling and disclosure of inside information are highly likely to breach their obligation to disclose inside information as soon as possible. In this respect, the low number of notifications of delayed disclosure cases may be an indication that there is a need for issuers to invest in appropriate procedures, systems, and controls in order to comply with Article 17(1) and 17(4) of MAR.*

12 ESMA, MAR Review Report (ESMA70-156-23), 23 September 2020, para. 209 s.

These observations lend themselves to two considerations. Firstly, even if it were not deemed necessary to include an explicit reference in the text of the Regulation to the need for the issuer to equip itself with adequate structures, such a duty exists, as it constitutes a prerequisite for the proper fulfilment of the *disclosure* obligation. With reference to Italy, moreover, this duty may be traced back to the rules laid down in Article 2086 of the Civil Code, even though similar provisions, especially ones with such a level of granularity, cannot always be found in other Member States. The fact that the MAR is silent on this specific matter, therefore, sounds somewhat as hypocrisy, in addition to reflecting a broader, and well-known, problem represented by the insufficient coordination between the MAR and company law ([13]) .

Moreover, the silence of the MAR ultimately makes it impossible to enforce any failure to comply with the alleged duty of proper organisation, which does not clearly result in violations of the *disclosure* regime, such as, for example, delays in disclosure, omissions, incorrect disclosure, etc. In other words, defects in the adoption of controls and procedures are not relevant if they do not *also* constitute a breach of the issuer's disclosure obligations. However, the lack of adequate arrangements should in *itself* be considered a breach of MAR, similarly to what is found in the context of EU financial legislation as a whole with respect to all types of intermediaries and service providers (ranging from credit institutions, investment firms, asset managers, payment service providers and – more recently – crypto-asset service providers), where, instead, legislation consistently identifies and establishes a specific duty for the supervised entity to be adequately structured and organised.

The rationale behind this long-standing approach in EU financial legislation is, of course, the prevention and appropriate management of the risks related to the activities of a supervised entity. There is no reason why the same rationale should not apply to issuers that use capital markets for financing purposes and which, as such, are subject to the provisions of MAR. The argument that issuers are not financial intermediaries, and therefore do not pose a problem of client-consumer protection, to be linked to precise organisational obligations in the provision of services, misses the point: when an entity turns to the capital market, even as an entity that raises resources on a widespread basis, or accesses trading venues, it is obliged to safeguard against the risks arising from its very presence on markets. The lack of adequate arrangements for the management of inside information raises a possible risk of lack of transparency for the market, which should be appropriately mitigated. Therefore, the inclusion of an explicit provision in the Regulation to such extent would also provide legal certainty, improve the level of harmonisation between Member States and enhance the effectiveness of the MAR in this specific matter.

A final observation that can be made with regard to the ESMA Report is the clear recognition of the complexities underlying the process of identifying and managing inside information. It is precisely in this area that AI systems could prove useful. ESMA, together with national supervisory authorities, could therefore consider explicitly supporting and endorsing the use of AI for such purposes, including through experimentation, *sandboxes* and similar tools aimed at developing new styles of regulation and supervision ([14]).

13 K.J. Hopt, *Insiderrecht - Grundlagen Internationale Entwicklung, öknomischer Hintergrund, offene Fragen*, in L. Klöhn - S. Mock (eds.), *Festschrift 25 Jahre WpHG: Entwicklung und Perspektiven des deutschen und europäischen Wertpapierhandelsrechts*, Berlin, 2019, emphasising the need to improve coordination between MAR and other areas of law, including (especially) company law.

14 See, from a broad perspective, D.W. Arner - R.P. Buckley - D.A. Zetzsche, *FinTech and the Four Horsemen of the Apocalypse: Building Financial Ecosystems for Resilience, Innovation and Sustainable Development,* 39 Bank. & Fin. L. Rev. 5, 2022.

02

Functions and limits in the use of algorithms

The foregoing considerations seem to support the view that AI can be a useful tool to: (i) support the process of early identification, from its inception, of facts, events, or circumstances that may produce inside information, and (ii) meet the disclosure requirements of Article 17 MAR ([15]) .

As to the first aspect, in the dynamic dimension of corporate life, AI can certainly support the management body in the process that starts with the identification of potential, or actual, inside information, as well as in the disclosure phase. It can also bring significant improvements to the information management process due to its inherent self-learning capability. AI is also able to support the (always complex) analysis of the possible price impact of a given piece of information: the AI tool could be able to perform a comparative analysis, of a historical type, on similar cases, also including information external to the issuer, comparisons with market peers, etc. In this way, the application would be able to draw indications on the possible expected impact of the disclosure of certain information. In addition, AI can support the process of proper *ex-post* tracking of the flow of a given piece of information, which could prove useful in case of internal investigations or for other purposes.

The use of AI can also serve to solve problems that arise in the context of decisions left to the discretion of corporate executives. As discussed in the literature considering the current limitations of transparency and disclosure regimes, both in the US and Europe, the activity of collecting and managing information places significant burdens on companies ([16]). The use of AI can help support this process, thus leading to greater efficiency.

In this sense, in the increasingly complex environments in which issuers operate, the use of AI systems should be encouraged so as to support an efficient and timely process for the identification and management of inside information under the MAR.

Notwithstanding the above, the question now arises as to whether AI may also intervene in the phase leading not only to the identification, but also to the *disclosure* of inside information to the public, in particular the phase relating to the decision to disclose or to delay the disclosure. In its current wording, the MAR contains no specific provisions on *how* this decision is to be made or *who* is responsible for it. Moreover, the different corporate structures and approaches adopted under national law ultimately lead to different solutions across Member States, starting with the role and involvement of the management body - organised differently according to variegated corporate forms - or of a delegated body within the board of directors, or outside it, etc.

However, in our view, there is a clear dividing line between the use of AI to identify and manage inside information and the use of AI to *directly* carry out the disclosure obligation. While on the first point it could be argued that the use of AI tools brings considerable potential advantages, it should also be considered that AI cannot entirely replace human intervention. It is, in fact, almost intuitive to observe that, as AI systems evolve and develop, they

15 For the benefits that AI can offer in relation to general business information, see M. Siebecker, *Making Corporations More Humane through Artificial Intelligence*, 45 J. Corp. L. 95, 2019.

16 In critical terms, J.S. Nelson, "*'Don't Ask, Don't Tell' Corporate Crime*", available at https://ssrn.com/abstract=2979728, 2017.

could soon also be tasked with *directly discharging* the obligation to publish inside information, in a fully automated process: starting, for instance, with the identification by algorithms of potential inside information within the issuer's sphere of activity, tracking its evolution, assessing its *price-sensitivity*, and up to the moment of disclosure. Based on the current state of technological evolution, it is not difficult to imagine, in the not-too-distant future, an AI application covering the entire process, and going so far as to directly prepare releases for disclosure, and then sending them to the dissemination system, as required by MAR ([17]) . From such a perspective, the use of Chat GPT could already be a viable option.

It should also be noted that, over time, the technical provisions governing the disclosure of inside information under the MAR regime have increasingly relied on electronic means of disclosure: this legislative development is, of course, perfectly in line with the possible use of AI systems to manage, on an automated basis, not only the identification, but also the actual disclosure of inside information.

However, the automation of the entire process leading to disclosure is, at present, a questionable development to say the least. Even if technology were to effectively support this development in the future (a scenario that is easy to imagine even today), its consequences are, at present, unpredictable and potentially capable of undermining the effectiveness and enforcement of MAR.

The problem lies in the principles governing liability(ies) resulting from omissions, failures, or inadequate performance of the duty to disclose information in a correct and timely manner.

Although MAR, and the related Market Abuse Directive (so called 'MAD 2') ([18]), require Member States to introduce and adopt administrative and criminal sanctions in the event of violations of their provisions, the texts are silent on aspects concerning the civil liability of the issuer or its management body *vis-à-vis* shareholders, investors, or the market in general.

If the issuer's management body were to adopt AI systems for the identification and possible disclosure of inside information, in the event of malfunctioning, whether intentional or unintentional, of the system, resulting in non-compliance with the disclosure regime, the consequences in terms of liability, damages, and compensation would have to be dealt with solely on the basis of national law.

Considering liability matters, as a rule, in most legal systems, the liability of the issuer for non-compliance with disclosure regimes usually derives from the common principles of corporate law, tort law, or may be explicitly established by law itself ([19]). Considering liability in the primary market, directors and managers are mostly subject to prospectus liability, including under the provisions of the EU Regulation. However, in some jurisdictions, liability is limited only to those who are actually involved in the drafting of the prospectus: this is the case, for example,

17 See Commission Implementing Regulation (EU) 2016/1055 of 29 June 2016 laying down implementing technical standards as regards technical means for adequate public disclosure of inside information and for delaying public disclosure of inside information in accordance with Regulation (EU) No 596/2014 of the European Parliament and of the Council.

18 Directive 2014/57/EU of the European Parliament and of the Council of 16 April 2014 on criminal sanctions for market abuse (OJ L 173, 12.6.2014, p. 179–189).

19 For a comprehensive overview, see D. Busch - G. Ferrarini - J. Franx (eds.), *Prospectus Regulation and Prospectus Liability*, Oxford, 2020, and the chapters on national systems therein; D. Busch, *The influence of the EU prospectus rules on private law*, 16 Cap. Mkt. L. J. 3, 2021.

in Germany, the Netherlands ([20]) and Italy (where liability applies to persons responsible for even parts of the prospectus); however, German law extends liability to controlling shareholders. In some jurisdictions, moreover, the liability of corporate bodies is not clearly provided for - this seems to be the case, for example, in Finland ([21]).

As regards disclosure obligations not related to primary market transactions, some legal systems provide for concurrent liability of the issuer and its officers, including members of the management body. An analysis of the different techniques used to achieve this can be found in recent contributions: while some jurisdictions make explicit reference to directors or managers ([22]), other systems merely apply general civil law ([23]).

A key issue, when considering the disclosure regime under market abuse rules, is to clarify which rules apply to the acquisition of inside information by an employee or corporate officer in relation to the issuer itself, especially concerning the liability of the legal entity, possibly in addition to that of the natural person: this is a point where legal systems diverge and reach different solutions, which depend mainly on how the liability of the entity in relation to the acts, torts, and omissions of its agents is treated.

The issue can be observed from different perspectives. The first suggests approaching it from the perspective of liability associated with the classic '*black box*' dilemma, typical of AI systems, which has also been addressed by recent legislative initiatives on AI in the European context ([24]). In this regard, liability issues should be examined by considering, firstly, the process leading to the selection and choice of a given AI system and the diligence employed in this context. Secondly, the analysis should focus on how the management body controls and supervises the

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20 M. Gelter, *Issuer Liability: Ownership Structure and the Circularity Debate,* in M. Petrin – C. Witting (eds.), *Research Handbook on Corporate Liability,* Cheltenham-Northampton, 2022.

21 I.H.V. Pönkå, *Finland: Protecting Minority Investors and Compensating their Losses,* in P.-H. Conac - M. Gelter, (eds.), *Global Securities Litigation and Enforcement*, Cambridge (UK), 2019.

22 M. Gelter, *Issuer Liability: Ownership Structure and the Circularity Debate, cit.*, who cites Prado, *Brazil: The Protection of Minority Investors and Compensation for Their Losses*; for Brazil, S. Rousseau, *Canada: The Protection of Minority Investors and the Compensation of Their Losses*, for Canada; P.H. Conac, *France: The Compensation of Investors' Losses for Misrepresentation on Financial Markets,* for France; G. Ferrarini – P. Giudici, *Italy: The Protection of Minority Investors and the Compensation of Their Losses,* for Italy; K.-H. Chun, *South Korea: Protection of Minority Investors in Capital Markets*, for South Korea; L. Lennarts – J. Roest, *Netherlands: Protection of Investors and the Compensation of their Losses,* for the Netherlands; Y. Guseva, *Russia: Russian Capital Markets and Shareholder Litigation: Quo Vadis?,* for Russia; M. Naharro, *Spain: Minority Investors' Protection in Spain: Civil Liability Remedies under Securities Law,* for Spain; F.I. Kayali, *Turkey: The Protection of Minority Investors and the Compensation of Their Losses in Turkish Capital Markets*, for Turkey, all in P.-H. Conac - M. Gelter, cit. See also the contributions, cited by the same author, by P.T. Domingues, *Portugal: The Legal Framework of the Portuguese Capital Market,* in P.-H. Conac - M. Gelter, cit., for Portugal; A. Nariman – M. Suleiman, *Malaysia: Protection of Minority Investors in the Capital Market - Public Enforcement and Shareholders' Litigation*, in P.-H. Conac - M. Gelter, cit., for Malaysia; U. Varottil, *India: The Efficacy of India's Legal System as a Tool for Investor Protection,* in P.-H. Conac - M. Gelter, cit., for India; M. Vasiljević – J. Lepetic – J. Vaslijević, *Serbia: The Protection of Minority Investors and the Compensation of their Losses*, in P.-H. Conac - M. Gelter, cit., for Serbia; R.H. Huang, *China: Private Securities Litigation: Law and Practice*, in P.-H. Conac - M. Gelter, cit., for China.

23 M. Gelter, *Issuer Liability: Ownership Structure and the Circularity Debate, cit.,* citing M. Gelter – M. Pucher, *Austria: Securities Litigation and Enforcement,* in P.-H. Conac - M. Gelter, cit., for Austria, I.H.V. Pönkå, *Finland: Protecting Minority Investors and Compensating their Losses, cit.,* for Finland; D.A. Verse, *Germany: Liability for Incorrect Capital Market Information*, in P.-H. Conac - M. Gelter, cit., for Germany, R. Bahar – X.E. Karametexas – J. Tawil, *Disclosure Duties: How does Swiss Law protect minority shareholders?,* in L. Heckendorn Urscheler (ed.), *Rapports suisses présentés au XIXe Congrès international de droit inclusi: Vienne, du 20 juillet au 26 juillet*, Geneva 2014., for Switzerland; W.-R. Tseng, *Taiwan: Investor Protection in Taiwan's Capital Market,* in P.-H. Conac - M. Gelter, cit., for Taiwan; E. Mastromanolis, *Greece: Public Enforcement and Civil Litigation in the Greek Paradigm of Minority Investor Protection,* in P.-H. Conac - M. Gelter, cit., for Greece.

24 See Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence and amending Regulations (EC) No 300/2008, (EU) No 167/2013, (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1139 and (EU) 2019/2144 and Directives 2014/90/EU, (EU) 2016/797 and (EU) 2020/1828 (Artificial Intelligence Act) OJ L, 2024/1689, 12.7.2024.

operation of AI applications, thereby adopting appropriate standards of care. Liability could thus be implied in an unsatisfactory selection process of a particular system or in the lack of control and supervision over its operation.

While this approach is undoubtedly useful, it must nevertheless be observed that, once inside information exists, its disclosure is mandatory: there is, therefore, a specific and clearly identifiable result that must be achieved and that the issuer's internal rules must ensure. This means that non-compliance with the disclosure regime - whether resulting, as the case may be, in a situation of non-disclosure, a late disclosure, or, even, in an incorrect or incomplete disclosure - would constitute a breach of Article 17 MAR, i.e., of a mandatory legislative provision, deriving directly from EU law and directly applicable in national legal systems. As such, the violation could also be a source of liability for the issuer, not only from an administrative point of view, but also for damages towards third parties.

However, the solution to this problem requires addressing the sensitive issue of deciding which rules govern the liability of the issuer *as a legal entity*.

As in many other areas of EU financial legislation ([25]), the MAR is silent on civil liability issues, while addressing administrative and criminal ones. It is precisely in this context that national laws may diverge even considerably. Indeed, it is not necessarily the case that the rules on the imputation of liability lead to the issuer being directly liable for failures to disclose inside information, in respect of information which, although present within the company (or group) organisation, was not *actually* known to the directors personally. In Germany, for example, the issue is controversial to say the least, being debated in the context of the theory of the so-called 'attribution of knowledge' doctrine (*Wissenzurechnung)*, on which there is a large, and controversial, literature ([26]). In general, where an algorithm, operating in an increasingly autonomous way, generates *outputs* that result in violations of the transparency discipline, issues typical of the civil liability system, such as the foreseeability of the damage, the causal link, and fault, take on problematic aspects, many of which are similar to those discussed in the debate on the so-called *Corptech* ([27]).

The examination of these issues, also and above all from a comparative perspective, would require a space that is completely incompatible with the limits of the present contribution. The current analysis will therefore be limited to identifying the problem, this being sufficient to rule out - and subject to a necessary in-depth examination of the subject - that algorithms can be entrusted not only with the phase of identification and management of inside information, but also with its *disclosure* to the public, automatically and without any human intervention.

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25 T. Tridimas, *Financial regulation and civil liability: an EU law perspective*, in O.O. Cherednychenko - M. Andenas (eds.), *Financial Regulation and Civil Liability in European Law*, Cheltenham-Northampton, 2020.

26 *Ex multis*, G. Wagner, *Wissenszurechnung: Rechtsvergleichende und rechtsökonomische Grundlagen*, 181 Zeitschrift Für Das Gesamte Handels - Und Wirtschaftsrecht (ZHR) 203, 2017.

27 G. Sandrelli, *Algoritmi a support delle decisioni degli amministratori e responsabilità*, in V. Donativi (ed.), *Trattato delle società,* Milan, 2022. For further details, F. Annunziata, *Artificial Intelligence and Market Abuse Legislation. A European Perspective,* Cheltenham-Northampton, 2023.

03

The use of augmented intelligence systems

The above issues can also be linked to the current debate on so-called augmented intelligence.

Augmented intelligence is regarded as a particular application of AI technologies or as an alternative to them ([28]). The two concepts are related but not coincidental. A substantial difference between augmented intelligence and AI lies in the fact that, whereas the latter generally serves to assist humans by automating processes with the aim of imitating and replacing them to the greatest possible extent, the former is based on more or less complex paradigms of collaboration between man and machine ([29]). More precisely, augmented intelligence, like AI, is functional for processing large amounts of data to extract patterns and identify new meaningful information, but, in this case, human intervention is encouraged and required rather than replaced ([30]).

Augmented intelligence is often referred to in the literature as a useful tool for implementing automated decision-making processes in business organisations ([31]). Instead of replacing human action, the best option would be to promote a long-term, mutually reinforcing human-AI symbiosis. However, the implementation of AI requires companies to develop sufficient expertise in AI systems and technology architecture ([32]). At the same time, when the human-interacting algorithm is proactively involved in the decision-making process, the use of augmented intelligence can have direct repercussions on the allocation of decision-making authority within the enterprise in relation to a given task.

The foregoing analysis, although based on a very new and still evolving phenomenon - and on a literature that is also developing -, seems to support the conclusion reached herein in relation to the limits within which algorithms could be effectively used to support issuers' compliance with the disclosure regime under Article 17 MAR. Such use of algorithms should, on the one hand, be openly stimulated and supported, but, on the other hand, it should be based on different scales/models of intelligence that are not (only) 'artificial', but rather 'augmented', in order to ensure compatibility between technological developments and the rules that, in practically all legal systems of the EU Member States, apply in relation to the liability of the issuer and its management body for the breach of duties to disclose inside information to the market. This applies, in particular, to the final stage of the identification and management of inside information by the issuer, leading to the decision to disclose it or, possibly, to delay its disclosure.

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28 At the same time, forms of *Inverse Reinforcement Learning*, in which algorithms 'learn' from humans, are also developing. For an application in the field of trading venues, see S.Y. Yang – M.E. Paddrik – R.L. Hayes – A. Todd – A.A. Kirilenko – P. Beling – W. Scherer, *Behavior Based Learning in Identifying High Frequency Trading Strategies,* 2012 IEEE Conf. Computational Intel. Fin. Eng'g & Econ. 1, 2012.

29 *The future of augmented intelligence (*22 March 2022), available at: https://www.sbs.ox.ac.uk/oxford-answers/future-augmented-intelligence; *What is augmented intelligence? (*22 March 2018), available at: https://www.mediaupdate.co.za/media/143606/what-is-augmented-intelligence; *What is augmented intelligence?,* available at: https://www.domo.com/glossary/what-is-augmented-intelligence.

30 M.N.O. Sadiku – S.M. Musa (eds.), *A Primer on Multiple Intelligences*, Berlin, 2021, according to whom the goal of augmented intelligence is not to replace human activities, but rather to elevate existing human capabilities. AI is often designed to mimic human intelligence, whereas augmented intelligence enhances human intelligence and makes it work faster and more efficiently.

31 M.H. Jarrahi, *Artificial intelligence and the future of work: Human-AI symbiosis in organisational decision making,* 61 Bus. Horiz. 577, 2018; M.N.O. Sadiku – S.M. Musa (eds.), *A Primer on Multiple Intelligences*, cit.

32 M.H. Jarrahi, *Artificial intelligence and the future of work: Human-AI symbiosis in organisational decision making,* cit.

04

Some reflections on the notion of inside information in the light of the development of AI systems

Developments in AI stimulate various reflections on its ability to influence, in the new, increasingly technological market environment, the way in which the *disclosure* regime under the MAR and, ultimately, the notion of inside information itself should be viewed. The structure underpinning the rules on the *disclosure* of inside information is based, for example, on the duty of the issuer to proceed with disclosure in relation to information directly concerning it. It is the issuer who, in this conception, is, so to speak, at the centre of the system, and is charged with making available to the public any information that may be significant for maintaining the information efficiency of the markets. The assumption is that the disclosure of such information by the issuer itself promotes the transparency and efficiency of the markets, leading to market prices reflecting the issuer's fundamental values or, at least, tending towards that goal.

However, technological developments are leading to a progressive and growing influence on investor behaviour of information that is disseminated on the market independently of the issuer and processed as such in investment decisions. In this respect, developments in digital platforms, social networks, blogs, etc. (hereinafter referred to as 'media') offer a very different landscape from the one that existed at the origin of the current EU disclosure and transparency regime more than 40 years ago ([33]).

From a traditional perspective, *traders* who base their decisions primarily on the information available in the Media must be considered 'noise *traders*', if not 'irrational' investors. This approach, however, is increasingly being challenged in the face of the expansion of the Media and, in particular, the way *algo-traders* interact with them ([34]) . Most of the information that is disseminated, and actually used, by 'algorithmic' investors is no longer, in fact, the product of disclosure by the issuer ([35]). For instance, the use of media information typically lends itself to so-called 'Trading on News' (*Momentum Trading*): algorithms and high-frequency trading ("HFT") systems exploit the effect that news and macroeconomic data can have on the price trend of financial instruments. Such algorithms thus exploit their ability to quickly draw operational indications from the continuous flow of information from media of all kinds, and turn them into trading orders, which are then quickly sent to trading venues ([36]).

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33 G. Balp - G. Strampelli, *Preserving Capital Markets Efficiency in the High-Frequency Trading Era*, U. ILL. J. L. Tech. & Pol'y 349, 2018.

34 T. Foucault – J. Hombert – I. Rosu, *News Trading and Speed. HEC Research Paper Series 975* (29 May 2013), available at https://www.eief.it/files/2013/06/thierry-foucault.pdf. , who argue that when an investor has quick access to news, his or her trades become much more sensitive to such news, representing a larger fraction of the trading volume, and in turn affecting short-term price forecasts.

35 I. Rosu, *Fast and Slow Informed Trading,* 43 J. FIN. MKT. 1, 2019. According to P. Bilinski, *The Content of Tweets and the Usefulness of YouTube and Instagram in Corporate Communication*, 31 Eur. Acct. Rev. 1, 2022. Investors react more meaningfully to a company's communications on Twitter when (i) they include financial information, (ii) they mention the CEO or CFO, (iii) they include a visual element, and (iv) the posts are written in a moderate tone. Earnings announcement tweets are particularly effective when the retail ownership portion is substantial.

36 For examples of information processed by HFT see, in particular, J.A. Brogaard, *High Frequency Trading, Information and Profits,* UK Government Office for Science, Foresight, Driver Review (*DR 102011)* (15 March 2011), available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/289021/11-1241-dr10-high-frequency-trading-information-and-profits.pdf. and A. Puorro, *High Frequency Trading: An Overview,* Bank of Italy Occasional Paper No. 198 (27 September 2013), available at https://www.bancaditalia.it/pubblicazioni/qef/2013-0198/index.html.

Quite intuitively, the way such information is 'used' by algorithmic traders (see *below*) has important repercussions on market dynamics. It cannot be ruled out that algorithms, in the context of HFT, operate and process data with a fundamental analysis approach: if this were the case, algorithms would fit perfectly into the traditional framework of how markets work, including, of course, efficient capital markets hypothesis ('ECMH') theories. However, as noted in a recent study, this would not be an ideal situation, as the algorithms would first have to process the available data on the fundamental value of an instrument and wait for the price to follow the direction of the value([37]).

On the contrary, algorithmic traders, and in particular high-frequency traders, mostly operate by taking advantage of market movements, even irrational ones, as long as they have an impact on elements that can be exploited for profit, such as price, quantity, volatility, etc. Market consensus, investor behaviour and expectations thus become extremely important factors, along with spontaneous coordination between the market players themselves. Algorithmic traders are also able to act much faster than traditional investors, thus achieving what has been called a 'structural insider advantage': at the time of trading, such a 'structural insider' possesses information that is not yet fully public, not because it has not been disclosed, but because it takes time for it to be incorporated into prices([38]).

In such circumstances, communication spreads across the market in ways that do not correspond to the centralised issuer-based model, but rather in horizontal and complex patterns that wind through different types of communities and media, ultimately reverberating on investors' decisions ([39]). This phenomenon also fosters new, albeit questionable, forms of *herd-like behaviour* or predatory trading, widely observed in the well-known, and probably somewhat overstated, Gamestop and Reddit cases ([40]), which, however, are only the tip of the iceberg.

In today's environment, the relevance of information disseminated through the web, social networks, and platforms has become increasingly significant ([41]), and algorithms have acquired the ability to capture and process this information in a very short period of time. This is, in fact, the primary source of their 'data'.

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37 M. Arrigoni, *Informazioni privilegiate e funzionamento dei mercati finanziari,* Milan, 2022. According to K.S. Haeberle - M. Todd Henderson, *Making a market for corporate disclosure*, 35 Yale J. Reg. 383, 2018. On the other hand, a market for corporate information should be developed, where anyone can buy access to information from companies before it is published, provided they are willing and able to pay the market price for it - an intriguing, if erratic, proposal.

38 M. Arrigoni, *Informazioni privilegiate e funzionamento dei mercati finanziari,* cit.

39 J. Mitts, *A Legal Perspective on Technology and the Capital Markets: Social Media, Short Activism and the Algorithmic Revolution,* Columbia Law and Economics Working Paper No. 615 (Oct. 28, 2019), available at https://ssrn.com/abstract=3447235.

40 *Ex multis*, S.S. Guan, *Meme Investors and Retail Risk,* 63 B.C. L. Rev. 2051, 2022; C. Jones – A. Reed – W. Waller, *When Brokerages Restrict Retail Investors, Does the Game Stop?,* Columbia Business School Research Paper (18 November 2021), available at https://ssrn.com/abstract=3804446; T. Hasso – D. Müller – M. Pelster – S. Warkulat, *Who Participated in the GameStop Frenzy? Evidence from Brokerage Accounts,* 45 Fin. Res. Letters 102140 (2022); S.A. Gramitto Ricci – C.M. Sautter, *Corporate Governance Gaming: The Collective Power of Retail Investors,* 22 Nev. L. J. 51, 2021; F. Allen – M. Haas – E. Nowak – M. Pirovano – A. Tengulov, *Squeezing Shorts Through Social Media Platforms,* Swiss Finance Institute Research Paper No. 21-31 (10 April 2021), available at: https://feeds.usi.ch/documents/attachment/2671/squeezing-shorts-through-social-news-platforms.pdf.; P. Lucantoni, L'*"high frequency trading" nel prisma della vigilanza algoritmica del mercato*, in *Analisi giur. econ.,* 2019, 297 ff.; E.C. Massoc – M. Lubda, *Social Media, Polarisation and Democracy: A Multi-Methods Analysis of Polarised Users' Interactions on Reddit's r/WallStreetBets,* SAFE Working Paper No. *337,* (January 2022), available at https://www.econstor.eu/bitstream/10419/249309/1/178654959X.pdf.

41 R.J. Schiller, *Narrative Economics: How Stories Go Viral and Drive Major Economic Events*, Princeton, 2020, demonstrating how managers use social media feedback instead of other sources of information to guide their investment decisions; A. Sajnovits, *The Market Abuse Regulation and the Residual Role of National Law,* EBI (European Banking Institute) Working Paper Series No. 137/2023 (18 March 2023), available at https://ssrn.com/abstract=4392675.

This phenomenon can also be understood as a case of competition between different types or levels of information capable of influencing the decisions of investors, including, above all, algorithmic traders: on the one hand, those disclosed by the issuer under the traditional *disclosure* regime and, on the other, those disseminated irrespective of or independently of the issuer, through the complex, fast-paced and highly interconnected world of the Media ([42]). While the former should be considered of higher quality and endowed with a greater capacity to support market efficiency, the latter nevertheless retains a significant impact and weight, which tends to overshadow the former.

The ability of the former type of information to 'trump' the latter is, to say the least, a challenging outcome to achieve. This is also the reason why, according to some, there is a need to develop possible regulatory strategies to limit the negative effects of HFT on market allocative efficiency (see *below*): this should be done by reducing the speed advantage of HFTs or by incentivising informed traders to enter markets where they face high costs to compete with HFTs ([43]). However, this approach would lead to measures that hinder technological evolution and create undue competitive advantages related to different technologies in the market.

An alternative would be to increase the amount of information that issuers would have to disseminate to the market. The prices formed in an information-efficient market are considered by traditional economic theory to be accurate. This assumption, which forms the backbone of the ECMH, is generally regarded as valid, even taking into account the so-called 'efficiency paradox': if prices do not correspond exactly to the fundamental value of a financial instrument, they still represent the best available estimate considering the concrete efficiency conditions of the markets ([44]). This, however, does not take into account the significance of *noise traders* and their irrational behaviour. In the current context, and considering the enormous impact of the Media, their relevance cannot be overlooked and, in any case, the possibility of remedying them by increasing the frequency and quantity of information disclosed by the issuer remains remote.

Most probably, the statement that "*in a world with continuous disclosure of material information the expected impact of noise traders on the market price is lower than in a world without such disclosure*" ([45]) is no longer (always) true.

The answers that the MAR provides to counter information inefficiencies focus on the role of the issuer, seen as the only reliable and fundamental source of information of the market: the only one, in other words, that matters, and this regardless of the concrete rules that would apply, i.e., a continuous disclosure system, such as the one contained in MAR, or rules linking *disclosure* to specific events, such as those found in the US system.

42 A. Gross-Klussmann - N. Hautsch, *When Machines Read the News: Using Automated Text Analytics to Quantify High Frequency News-Implied Market Reaction,* 18 J. Empirical Fin. 321, 2011.

43 V. Van Kervel, *Competition for Order Flow with Fast and Slow Traders,* 28 Rev. Fin. St. 2094, 2015; G. Balp - G. Strampelli, *Preserving Capital Markets Efficiency in the High-Frequency Trading Era*, cit.

44 For a discussion on the subject, M. Arrigoni, *Informazioni privilegiate e funzionamento dei mercati finanziari,* cit.

45 L. Klöhn, *Inside information without an incentive to trade? What's at stake in 'Lafonta v AMF'*, 10 Common Mkt. L. J. 162, 2015.

While one of the reasons why the *disclosure* regime was introduced in MAR is the need to reduce the impact of *noise trading*, given the growing impact of technology and media, there is little justification for increasing the volume of information that issuers are required to disclose to the market. Rather, a simplification of the current regime seems preferable, aimed at preserving the quality of the information disclosed by the issuer, reducing its quantity but enhancing its ability to contribute to information efficiency ([46]).

The trend towards such simplification now seems to be on the agenda of the EU legislator. In its late 2022 proposal for regulatory action on various aspects of EU capital markets law, the Commission anticipated a possible change to the current disclosure regime set out in Article 17 MAR, eliminating the need to disclose inside information in the intermediate stages of protracted trials ([47]). The Commission questions the positive impact of the current scope of *ad hoc* disclosure on market efficiency: while not denying the obvious assertion that disclosure is critical to making well-informed investment decisions, the proposal argues that disclosure at a very early stage could mislead investors and trigger investment decisions that could be sub-optimal (e.g., divesting shares too early or not divesting them early enough), resulting in higher opportunity costs for investors. These problems would be particularly evident in protracted processes ([48]). The proposal is also justified by the need to reduce compliance costs, considering the potential benefits of the current regime. The amendment of Article 17 MAR would, however, not affect the notion of inside information, which would remain unchanged for the purposes, in particular, of the insider trading ban ([49]).

For the purposes of this analysis, a number of conclusions can be drawn from this debate. In particular, the growing divergence between the information made available to the market by the issuer, on the one hand, and by the media, on the other, together with the development of increasingly fast and sophisticated algo-trading techniques, showing how significant the role of technology is in this field. AI has a far-reaching impact on markets, and not only in terms of the microstructure and functioning of trading platforms (see *below*), such as to challenge some well-known and deep-rooted traditional beliefs, thus showing how profound the relationship between regulation and technological evolution is.

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46 M. Arrigoni, *Informazioni privilegiate e funzionamento dei mercati finanziari,* cit.

47 See Regulation (EU) 2024/2809 of the European Parliament and of the Council of 23 October 2024 amending Regulations (EU) 2017/1129, (EU) No 596/2014 and (EU) No 600/2014 to make public capital markets in the Union more attractive for companies and to facilitate access to capital for small and medium-sized enterprises (OJ L, 2024/2809, 14.11.2024), Article 2(6)(a): "(6) Article 17 is amended as follows: (a) in paragraph 1, the first subparagraph is replaced by the following: '1. An issuer shall inform the public as soon as possible of inside information which directly concerns that issuer. That requirement shall not apply to inside information related to intermediate steps in a protracted process as referred to in Article 7(2) and (3) where those steps are connected with bringing about or resulting in particular circumstances or a particular event. In a protracted process, only the final circumstances or final event shall be required to be disclosed, as soon as possible after they have occurred.'".

48 R. Veil – M. Wiesner – M. Reichert, *Ad Hoc Disclosure under the EU Listing Act*, 68 Aktiengesellschaft (AG) 57, 2023, argue that the Commission did not provide any further justification for this claim, neither in the Proposal nor in the Impact Assessment. However, in our opinion, reality already makes the Commission's claim quite clear.

49 M. Arrigoni, *Informazioni privilegiate e funzionamento dei mercati finanziari, cit.* In critical terms, see R. Veil – M. Wiesner – M. Reichert, *Ad Hoc Disclosure under the EU Listing Act*, cit., especially in the first paragraphs, although reaching a more moderate conclusion.

05

AI and market manipulation

The relevance of algorithms in relation to market manipulation issues is the second aspect to consider when assessing the interaction between AI and MAR. In this regard, the analysis fundamentally revolves around the use of algorithms in the context of trading activities, thus placing itself at the crossroads between the provisions on market manipulation contained in the MAR and those on algorithmic and high-frequency trading formulated in the context of the Markets in Financial Instruments Directive ('MiFID II') ([50]).

The starting point of the analysis is the regime applicable to algorithmic and high-frequency trading currently in force under MiFID II.

In Europe, the discussion on algorithmic trading and HFT far anticipated most of the trends and debate that are now developing at a more horizontal level, including those that led to the approval of the EU Artificial Intelligence Regulation: algorithmic issues in fact affected trading platforms much earlier than other sectors, and the responses provided by legislators in this context proved to be precursors to the developments now being observed in other areas ([51]).

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50 Directive 2014/65/EU of the European Parliament and of the Council of 15 May 2014 on markets in financial instruments and amending Directive 2002/92/EC and Directive 2011/61/EU (OJ L 173, 12.6.2014, p. 349–496).

51 Among the vast literature on high-frequency trading at least A. Sussman – L. Tabb – R. Iati, *US Equity High-Frequency Trading: Strategies, Sizing and Market Structure,* TAAB Group Report (2 September 2009), available at: https://research.tabbgroup.com/report/v07-023-us-equity-high-frequency-trading-strategies-sizing-and-market-structure; F.J. Fabozzi – S.M. Focardi - C. Jonas, *High Frequency Trading: Methodologies and Market Impact,* 19 Rev. Future Mkt. 7, 2010; R.D. Smith, *Is High Frequency Trading Inducing Changes in Market Microstructure and Dynamics* (June 2010), available at: https://ssrn.com/abstract=1632077; P. Gomber – B. Arndt – M. Lutat – T. Uhle, *High Frequency Trading,* Deutsche Börse Group (March 2011), available at: https: https://www.deutsche-boerse.com/resource/blob/69642/6bbb6205e6651101288c2a0bfc668c45/data/high-frequency-trading_en.pdf.; V. Caivano, *The Impact of High-Frequency Trading on Volatility. Evidence from the Italian Market,* CONSOB Quaderni di finanza no. 80 (March 2015), available at: https://www.consob.it/o/PubblicazioniPortlet/DownloadFile?filename=/documenti/quaderni/qdf80.pdf.; R.S. Karmel, *IOSCO's Response to the Financial Crisis*, 37 J. Corp. L. 849, 2012; C. Lattemann – P. Loos – J. Gomolka – H.-P. Burghof – A. Breuer – P. Gomber – M. Krogmann – J. Nagel – R. Riess – R. Riordan – R. Zajonz, *High Frequency Trading - Costs and Benefits in Securities Trading and its Necessity of Regulations*, 4 Bus. & Info. Sys. Eng. 93, 2012; M. Baron – J.A. Brogaard – B. Hagströmer – A. Kirilenko, *Risk and Return in High Frequency Trading*, 54 J. Fin. & Quant. Analysis 993, 2019; O. Linton – M. O'hara – J.-P. Zigrand, *Economic impact assessments on MiFID II policy measures related to computer trading in financial markets*, Foresight, Government Office for Science, Working Paper (31 August 2012), available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/289075/12-1088-economic-impact-mifid-2-measures-computer-trading.pdf.; S. Patterson, *Dark Pools, The Rise of A.I. Trading Machines and the Looming Threat to Wall Street*, New York, 2012; M. Prewitt, *High-Frequency Trading: Should Regulators Do More?*, 19 Mich. Telecomm. & Tech. L. Rev. 131, 2012; J. Tse – X. Lin – D. Vincent, *High Frequency Trading - Measurement, Detection and Response. Credit Suisse AES Analysis* (2012), available at: https://docplayer.net/77225061-High-frequency-trading-measurement-detection-and-response-market-commentary-6-december-2012.html; A. Cartea – J. Penalva, *Where is The Value in High Frequency Trading?,* 2 Q'ly J. Fin. 1250014, 2012; A. Doyle – B. Thomas, *A cure for all ills?, The Commission's Proposals Must Strike a Difficult Balance between Regulatory Control and Efficient Market Functioning*, 30 Int'l Fin. L. Rev. 60, 2012; D. Easley – M.M. Lopez De Prado – M. O'hara, *Flow Toxicity and Liquidity in a High Frequency World,* 25 Rev. Fin. Stud. 1457, 2012; D. Easley – M.M. Lopez De Prado – M. O'hara, *The volume clock: Insights into the high frequency paradigm,* 39 J. Portfolio Mgmt. 19, 2012; D. Easley – M.M. Lopez De Prado – M. O'hara (eds.), *High-Frequency Trading: New Realities for Traders, Markets and Regulators*, London, 2013; B. Hagströmer – L. Nordén, *The Diversity of High Frequency Traders,* 16 J. Fin. Mkt. 741, 2013; T. Hendershott – R. Riordan, *Algorithmic Trading and the Market for Liquidity*, 48 J. Fin. & Quantitative Analysis 1001, 2013; E. Jaskulla, *Das deutsche Hochfrequenzhandelsgesetz-eine Herausforderung für Handelsteilnehmer, Börsen und Multilateral Handelssysteme (MTF)*, 13 Zeitschrift Für Bank- Und Kapitalmarktrecht (BKR) 221, 2013; A.A. Kirilenko – A.W. Lo, *Moore's Law vs. Murphy's Law: Algorithmic trading and its discontents,* 27 J. Econ. Perspectives 51, 2013; J. Kobbach, *Regulierung des algorithmischen Handels durch das neue Hochfrequenzhandelsgesetz: Praktische Auswirkungen und offene rechtliche Fragen*, 13 Zeitschrift Für Bank- Und Kapitalmarktrecht (BKR) 233 (2013); K. Malinova – A. Park – R. Riordan, *Do Retail Traders Suffer from High Frequency Traders?* (Jan. 11, 2018), available at: https://ssrn.com/abstract=2183806; A.J. Menkveld, *High Frequency Trading and the New Market Makers,* 16 J. Fin. Mkt. 712, 2013; H.A. Bell, H. Searles, *An Analysis of Global HFT Regulation-Motivations, Market Failures, and Alternative Outcomes. Mercatus Center*, George Mason University, Working Paper No. 14-11 (24 April 2014), available at: https://ssrn.com/abstract=2689321; A.P. Chaboud – B. Chiquoine – E. Hjalmarsson – C. Vega, *Rise of the Machines: Algorithmic Trading*

The rise of AI-driven trading and HFT is clearly visible ([52]), and statistics show that the volume/size of HFT orders on EU and US markets is indeed significant. In its 2021 Report ([53]), ESMA collected a huge amount of data from EU regulated markets and MTFs. In total, 52 trading venues from 24 EU Member States provided quarterly aggregated data for derivatives in 2018 and 2019. Although more up-to-date data are not available at the moment, it is expected that the figures, which were already staggering at the time, may increase further.

Not all markets, however, share the same features, and in fact bond markets show different trends. Until mid-2019, bond trading was not significantly influenced by algorithmic trading, but this changed at a later stage, with rapid growth in the third quarter of 2019, when algorithmic trading accounted for around 80 per cent of trading volume. In contrast, HFT for bonds remains marginal.

in the Foreign Exchange Market, 69 J. Fin. 2045, 2014; P. Kasiske, *Marktmissbräuchliche Strategien im Hochfrequenzhandel*, 68 Wertpapier Mitteilungen (WM) 1933, 2014; S. Dolgopolov, *High-Frequency Trading, Order Types, and the Evolution of the Securities Market Structure: One Whistleblower's Consequences for Securities Regulation*, 1 U. ILL. J. L. Tech. & Pol'y 145, 2014; J. Kindermann – B. Coridass, *Der rechtliche Rahmen des algorithmischen Handels inklusive des Hochfrequenzhandels*, 26 Zeitschrift Für Bankrecht Und Bankwirtschaft (ZBB) 178, 2014; C.R. Korsmo, *High-Frequency Trading: A Regulatory Strategy*, 48 U. Rich. L. Rev. 523, 2014; M.M. Lewis, *Flash Boys: A Wall Street Revolt*, New York, 2014; D. Mattig, *Kurze Leitungswege für den Handel in Milli- und Mikrosekunden-Zu den latenzminimierenden Infrastrukturen an Börsen und multilateralen Handelssystemen*, 41 Wertpapier Mitteilungen (WM) 1940, 2014; G. O'malley, *Diving into Dark Pools: An Analysis of Hidden Liquidity with regard to the Proposed Markets in Financial Instruments Directive*, 17 Trinity Coll. L. Rev. 94, 2014; P. Gomber – F. Nassauer, *Neuordnung der Finanzmärkte in Europa durch MiFID II/MiFIR,* 26 Zeitschrift Für Bankrecht Und Bankwirtschaft (ZBB) 250, 2014; P. Gomber – M. Haferkorn, *High-Frequency Trading*, Encycl. Info. Sci. & Tech. 1, 2015; N. Crudele, *Dark Pool Regulation: Fostering Innovation and Competition While Protecting Investors*, 9 Brook. J. Corp. Fin. & Com. L. 569, 2015; A.M. Fleckner, *Regulating Trading Practices*, in N. Moloney – E. Ferran – J. Payne (eds,), *The Oxford Handbook of Financial Regulation,* Oxford, 2015; P. Kasiske, *Compliance-Risiken beim Wertpapierhandel in Dark Pools*, 15 Zeitschrift Für Bank- Und Kapitalmarktrecht (BKR) 454, 2015; D. Kornpeintner, *Die Regulierungsansätze des Hochfrequenzhandels- mit Fokus auf Reg SCI und MIFID II,* Saarbrücken, 2015; F.A. Pasquale, *Law's Acceleration of Finance: Redefining the Problem of High-Frequency Trading*, 36 Cardozo L. Rev. 2085, 2015; J. Vaananen, *Dark Pools and High Frequency Trading for Dummies*, New York, 2015; S. Alvaro - M. Ventoruzzo, *'High-Frequency Trading': notes for a discussion*, in *Banca Impresa Società*, 2016, 417 ff.; R.T. Leuchtkafer, *High Frequency Trading, a bibliography of evidence-based research* (March 2015), available at https://blog.themistrading.com/wp-content/uploads/2015/03/HFT-Bibliography-2015.pdf.; R.S. Miller – G.W. Shorter, *High-frequency Trading: Overview of Recent Developments.* CRS (Congressional Research Service) Report 7-5700 (Apr. 4, 2016), available at: https://sgp.fas.org/crs/misc/R44443.pdf.; N.E. Sokol, *High Frequency Litigation: SEC Responses to High Frequency Trading as a Case Study in Misplaced Regulatory Priorities*, 17 Sci. & Tech. L. Rev. 402, 2016; M. Zook – M.H. Grote, *The microgeographies of global finance: High-frequency trading and the construction of information inequality, Environment and Planning,* 49 Env't & Plan. A 121, 2017; G.J. Jiang – I. Lo – G. Valente, *High-Frequency Trading in the U.S. Treasury Market Around Macroeconomic News Announcements,* HKIMR (Hong Kong Institute for Monetary and Financial Research) Working Paper No. 19 (August 2018), available at: https://ssrn.com/abstract=3233332; W. Li, *High Frequency Trading with Speed Hierarchies* (11 October 2018), available at: https://ssrn.com/abstract=2365121, 2018; E.S. Pagnotta – T. Philippon, *Competing on Speed,* 86 ECONOMETRICS 1067, 2018; D. Ladley, *The Design and Regulation of High Frequency Traders*, University of Leicester, Discussion Papers in Economics No. 19/02 (March 29, 2019), available at https://www.le.ac.uk/economics/research/RePEc/lec/leecon/dp19-02.pdf.; P. Lucantoni, L'*"high frequency trading" nel prisma della vigilanza algoritmica del mercato*, cit.; K. O'connell, *Has Regulation Affected the High Frequency Trading Market?*, 27 Cath. U. J. L. & Tech. 145, 2019; P. Saliba, *The Information Content of High Frequency Traders Aggressive Orders: Recent Evidences,* 20 Quantitative Fin. 1779, 2019; T. Söbbing, *Der algorithmisch gesteuerte Wertpapierhandel und die gesetzlichen Schranken für künstliche Intelligenz im digitalen Banking*, 40 Zeitschrift Für Wirtschaftsrecht (ZIP) 1603, 2019; I. Zlatanov – S. Weiss, *Regulatorische Aspekte des algorithmischen Handels*, 9 Recht Der Finanzinstrumente (RDF) 290, 2019; H. Degryse – R. De Winne – C. Greese – R. Payne, *Cross-Venue Liquidity Provision: High Frequency Trading and Ghost Liquidity*. ESMA Working Paper No. 4 (November 2020), available at https://www.esma.europa.eu/sites/default/files/library/esma_wp_4_2020_hft_and_ghost_liquidity.pdf.; J. Gider – S. Schmickler – C. Westheide, *High-Frequency Trading and Price Informativeness*. Ideas Working Paper Series from RePEc (2021), available at https://ideas.repec.org/p/bon/boncrc/crctr224_2021_257.html.; J. Breckenfelder, *Competition Among High-Frequency Traders and Market Quality. ECB Working Paper No. 2290 (*June 11, 2019), available at: https://ssrn.com/abstract=3402867; E. Boehmer – K. Fong – J. Wu, *Algorithmic Trading and Market Quality: International Evidence,* 8 J. FIN. & Quantitative Analysis 56, 2020; V. Manahov, *High-frequency trading order cancellations and market quality: Is stricter regulation the answer?,* 26 Int'l J. Fin. & Econ. 5385, 2021; E. Schwark – D. Zimmer (eds.), *Kapitalmarktrechts-Kommentar*, Munich, 2020; J. Werner, *Hochfrequenzhandel de lege lata und möglicher Anpassungbedarf de lege ferenda*, 14 Bucerius L. J. 25, 2020; M. Aquilina – E. Budish – P. O'Neill, *Quantifying the high-frequency trading 'arms race'*, 137 Q'Y J. ECON. 493, 2022); C. Martins Pereira, *Unregulated Algorithmic Trading: Testing the Boundaries of the European Algorithmic Trading Regime*, 6 J. Fin. Reg. 270, 2020; M.P. Lerch, *Algorithmic Trading and High-Frequency Trading*, in R. Veil (ed.), *European Capital Markets Law*, London, 2022.

52 FSB (Financial Stability Board), *Artificial intelligence and machine learning in financial services - Market developments and financial stability implications* (1 November 2017), available at: https://www.fsb.org/wp-content/uploads/P011117.pdf.

53 ESMA, *MiFID II/MiFIR review report on Algorithmic Trading. ESMA70-156-4572* (28 September 2021), available at: https://www.esma.europa.eu/sites/default/files/library/esma70-156-4572_mifid_ii_final_report_on_algorithmic_trading.pdf.

For derivatives, the ratio of algorithmic to non-algorithmic trading remained stable until the second quarter of 2019; after this period, algorithmic trading other than HFT started to increase. By contrast, the impact of HFT on derivatives markets is marginal.

These developments are supported by multiple innovations that make high-level computing power increasingly accessible, thus lowering the barriers to entry for operators ([54]). The availability of an increasing amount of data, including alternative data ([55]), also acts as a multiplier for the development and adoption of these technologies.

On trading markets, algorithms are used for several purposes. A first case refers to the ***pre-trade* and *trade generation*** phases, where algorithms can be used, for example, to analyse market conditions and identify investment opportunities, to be supplemented with additional human intervention or to be directly transformed into algorithmic trading decisions, including HFT.

A second significant area where AI is used in trading relates to the **execution** phase. When executing an order, a broker tries to minimise the costs of its impact on the market. Some brokers and large *buy-side* investors, such as pension funds and *hedge funds*, have developed AI models to optimally split and execute large orders across different venues and trading hours, so as to minimise their impact on the market and, consequently, transaction costs. In its 2023 Report, ESMA points out that one of the main challenges these models face is the scarcity of data on meta-orders (i.e., large orders that are split into smaller units for optimal execution), which only the executing entity possesses ([56]). This leads brokers to develop models that are trained on a restricted set of information and whose usability is therefore rather limited.

The application of AI is also experimented with in the ***post-trade* phase**, both by central securities depositories and brokers, to predict the probability that a trade will not be settled given the resources allocated to it, to optimally distribute these resources (i.e., liquidity) ([57]).

Despite the experience gained with the so-called *Flash Crash* ([58]), the empirical evidence on the potential risks and benefits of algorithmic trading is still controversial ([59]). Academic and even more practical studies come to different, even contradictory conclusions, particularly when it comes to assessing the risks and benefits of

54 D. Cliff – D. Brown – P. Treleaven, *Technology Trends in the Financial Market: A 2020 Vision. UK Government Office for Science* (September 2011), available at: https://research-information.bris.ac.uk/en/publications/technology-trends-in-the-financial-markets-a-2020-vision.

55 These are new unconventional data that provide complementary and correlated information to the so-called traditional or common data, for a better analysis and a different point of view. For further references see A. Denev – S. Amen, *The Book of Alternative Data: A Guide for Investors, Traders, and Risk Managers,* Hoboken, 2020.

56 ESMA, *TRV Risk Analysis Artificial intelligence in EU securities markets. ESMA50-164-6247* (1 February 2023), available at: https://www.esma.europa.eu/sites/default/files/library/ESMA50-164-6247-AI_in_securities_markets.pdf.

57 Id.

58 D. Easley – M. Lopez de Prado – M. O'Hara, *The Microstructure of the 'Flash Crash': Flow Toxicity, Liquidity Crashes, and the Probability of Informed Trading,* cit.; F. Partnoy, *The Abraham L. Pomerantz Lecture: Don't Blink: Snap Decisions and Securities Regulation*, 77 Brook. L. Rev. 15, 2011; R.S. Karmel, *IOSCO's Response to the Financial Crisis*, 37 J. Corp. L. 849, 2012; O. Cosme Jr., *Regulating High-Frequency Trading: The Case for Individual Criminal Liability*, 109 J. Crim. L. & Criminology 365, 2019. Flash crashes have also lent themselves to grand narratives, such as the well-known and popular one by M.M. Lewis, *Flash Boys: A Wall Street Revolt*, cit.

59 Some contributions explore the technical characteristics of the types of *memory networks* used in HFT: P. Ganesh – P. Rakheja, *VLSTM: Very Long Short-Term Memory Networks for High-Frequency Trading* (22 October 2020), available at: https://arxiv.org/abs/1809.01506.

HFT ([60]). This divergence of opinion is also due to the fact that most studies do not usually distinguish between different HFT strategies ([61]) and that different risk factors (such as the impact HFT can have on market liquidity and volatility) depend on and are conditioned by specific market conditions (e.g., whether markets are in normal trading conditions or under stress) or a sometimes very narrow scope of analysis ([62]).

Although it is the responsibility of regulators to identify risks ([63]) and threats of new phenomena in order to define appropriate regulatory measures, it is not surprising that HFT remains a contentious area in financial market regulation and that companies that primarily engage in HFT have been described as 'protean in nature' ([64]): an elusive target for regulators, supervisors, and traders themselves, with ambiguous effects on markets ([65]).

Regardless of the position taken in the debate on the virtues and flaws of algorithmic and high-frequency trading, there is no doubt that the use of algorithms in the context of trading activities raises complex issues in terms of risks to market participants and the stability of global markets. The problem, therefore, ultimately lies in how to properly identify and manage these risks ([66]), taking into account the constant and rapid technological evolution of markets and the need, in any case, not to place obstacles in the way of innovation.

At the heart of the complex and articulated provisions contained in MiFID II and aimed at the macro-issue of algorithmic trading is the need to ensure strong safeguards - starting with the market participants themselves - on the proper functioning and operation of algorithmic trading, to better govern the associated risks. This is not surprising: in a regulatory context (that of investment services and activities, as contemplated by MiFID I and MiFID II) in which procedures, systems, internal controls, and risk management profiles are already extensively regulated, algorithmic trading brings with it additional and specific safeguards, justified by the particular form of risks it raises. In this regard, the *flash crashes* that occurred in the run-up to the drafting of MiFID II clearly showed EU regulators how the use of algorithmic techniques requires particular caution.

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60 V. Caivano, *The Impact of High-Frequency Trading on Volatility. Evidence from the Italian Market. CONSOB Quaderni di finanza no. 80* (March 2015), available at: https://www.consob.it/o/PubblicazioniPortlet/DownloadFile?filename=/documenti/quaderni/qdf80.pdf., who highlights the differences in the approaches used by researchers in this field.

61 B. Hagströmer – L. Nordén, *The Diversity of High Frequency Traders,* 16 J. Fin. Mkt. 741, 2013; M.P. Lerch, *Algorithmic Trading and High-Frequency Trading*, in R. Veil (ed.), *European Capital Markets Law*, cit.

62 AFM (2023).

63 The most recent overview is contained in AFM (2023), which is particularly interesting because it is the result of specific analyses conducted directly in the field.

64 M. Chlistalla, *High Frequency Trading, Better than its reputation? Deutsche Bank Research* (7 February 2011), available at: https://www.palmislandtraders.com/econ136/hft_dbank.pdf.; M.P. Lerch, *Algorithmic Trading and High-Frequency Trading*, in R. Veil (ed.), *European Capital Markets Law*, cit.

65 T. Foucault - A. Roell - P. Sandas, *Market Making with Costly Monitoring: An Analysis of the SOES Controversy,* 16 Rev. Fin. St. 345, 2003; A. Gerig, *High-Frequency Trading Synchronises Prices in Financial Markets,* available at: https://ssrn.com/abstract=2173247, 2015; M. Hilbert - D. Darmon, *How Complexity and Uncertainty Grew with Algorithmic Trading*, 22 Entropy 499, 2020, who discuss how algorithmic trading increases complexity and uncertainty. Discussing HFT-related profitability, M.J. Kearns – A. Kulesza – Y. Nevmyvaka, *Empirical Limitations on High Frequency Trading Profitability*, 5 J. Trading 50, 2010.

66 ([66]) Including ethical ones. See G. Spindler, *Control of Algorithms in Financial Markets: The Example of High-Frequency Trading* in M. Ebers – S. Navas (eds.), *Algorithms and the Law,* Cambridge (UK), 2020.

MiFID II comprehensively and specifically addresses the issue of algorithmic trading, introducing a kind of special regime in the broader regulatory framework applicable to the provision of investment services and trading venues. The approach adopted by MiFID II towards the regulation of algorithmic trading and HFT is thus a significant example of how *specifically* technological developments can induce certain legislative choices. The EU rules in this area thus openly defy the principle of technology neutrality: they are specifically tailored to address the impact of the technologies considered here, both on investment firms and trading venues.

MiFID II looks at algorithmic trading issues from two different but converging perspectives: that of the trader using algorithms and that of trading venues accepting or allowing algorithmic trading. More broadly, it aims to design a comprehensive and exhaustive system of rules, combining the two perspectives in a coherent approach.

In a nutshell, with regard to the rules applicable to investment firms ([67]) engaging in algorithmic trading, the relevant provisions focus on:

(i) organisational requirements;

(ii) transparency requirements;

(iii) additional special requirements that investment firms must meet in order to engage in algorithmic trading.

Again, in a nutshell, the MiFID II rules on algorithmic trading and HFT are also aimed at trading venues that allow the use of algorithmic trading systems, in particular high-frequency trading systems, on their platforms. Trading venues (whether in the form of regulated markets (RMs), multilateral trading facilities (MTFs) or organised trading facilities (OTFs) must be adequately structured and equipped with suitable controls to deal with the risks associated with the use of algorithms. They must also have systems and mechanisms capable of supporting very high trading volumes, which are the basis of HFT systems.

06

Specific considerations on algorithmic and high-frequency trading

Obviously, algorithmic, and high-frequency trading stand out among the different mechanisms by which market manipulation may occur. Although this statement seems quite intuitive, it is nevertheless important to note that the MAR itself (unlike the previous directive) clearly mentions algorithmic trading when considering the various possible means by which manipulation can occur ([68]).

67 D. Busch, *MiFID II: Regulating High Frequency Trading, Other Forms of Algorithmic Trading and Direct Electronic Market Access*, 10 L. & Fin. Mkt. Rev. 72, 2016; J. Lee, *Access to Finance for Artificial Intelligence Regulation in the Financial Services Industry*, 21 Eur. Bus. Org. L. Rev. 731, 2020.

68 D. Leis, *High Frequency Trading; Market Manipulation and Systemic Risks From an EU Perspective* (29 February 2012), available at: https://ssrn.com/abstract=2108344.

This focus on algorithmic trading is already visible in Recital 38 of the MAR, which expressly refers to the need to counteract abusive strategies that can be implemented through algorithmic and high-frequency trading. With reference to the body of the Regulation, on the other hand, Article 12(2), in identifying the conduct that could constitute market manipulation, also contemplates the placing of orders on a trading venue, including any cancellation or modification thereof, by any available means of trading, *including through electronic means, such as algorithmic and high-frequency trading strategies*, which manifest the anomaly indices identified by the same provision.

Although, of course, algorithmic trading or HFT do not, *per se*, amount to market manipulation, recent literature observes how certain algorithmic trading strategies are particularly suited to realising forms of 'AI-style market manipulation' ([69]), especially when traced back to so-called '*aggressive*' HFT strategies ([70]). Abuse techniques such as *spoofing*, *order layering*, *pump and dump*, *marking the close,* etc., are also easily realised through the use of algorithms that operate at high speed, capable of impacting the market very quickly ([71]).

Two recent, and highly relevant, texts offer what is, at present, a very comprehensive treatment of the issues surrounding the liability arising from the use of algorithmic trading techniques such as to integrate the extremes of market manipulation([72]).

Basically, *three* case studies can be derived from these contributions, which differ in how human intervention influences or impacts the functioning of the algorithms.

Each case has its specificities: the first two seem to be sufficiently covered - in terms of enforcement and/or liability - by the current provisions contained in MAR and MiFID II. The third, on the other hand, which is more related to future developments of automated and self-learning algorithms, seems to be very complex, and such as to raise new and difficult questions.

The first case is the failure of an algorithm, which was not intentionally distorted or poorly constructed, but was negligently designed ([73]). This situation is far from being purely theoretical, as it mirrors what has happened in most flash crashes, including the one that triggered the wave of legislation on algorithmic trading and HFT in the context of MiFID II: reference is made to the 2012 crash, triggered, in the US markets, by Knight Capital. As has been abundantly reconstructed, Knight Capital's automated trading system, due to flaws in its configuration, went out of control, causing an uncontrolled flow of orders that hit the markets hard, generating dramatic effects on the prices of several securities and, as a result, considerable damage ([74]).

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69 T.J. Putnins, An Overview of Market Manipulation, in C. Alexander - D. Cumming (eds.), *Corruption and Fraud in Financial Markets: Malpractice, Misconduct and Manipulation,* New York, 2020; A. Azzutti, *AI-trading and the Limits of EU Law Enforcement in Deterring Market Manipulation*, 45 Comput. L. & Sec. Rev. 105690, 2022.

70 M.M. López De Prado, *Advances in Financial Machine Learning*, New Jersey, 2018.

71 For a detailed description, F. Annunziata, *Artificial Intelligence and Market Abuse Legislation. A European Perspective,* Cheltenham-Northampton, 2023.

72 A. Azzutti- W.-G. Ringe – H.S. Stiehl *Machine Learning, Market Manipulation and Collusion on Capital Markets: Why the "Black Box" Matters,* 43 U. PENN. J. INT'L L. 79, 2022; A. Azzutti- W.-G. Ringe – H.S. Stiehl, *The Regulation of AI Trading from an AI Life Cycle Perspective,* European Banking Institute Working Paper Series 2022 - no. 130 (27 October 2022), available at https://ssrn.com/abstract=4260423.

73 F. Consulich, *Il nastro di möbius, intelligenza artificiale e imputazione penale nelle nuove forme di abuso del mercato,* in *Banca borsa,* 2018, I, 196 ff.

74 Damages have been estimated around 440 million USD. See N. Popper, Knight Capital Says Trading Glitch Cost It $440 Million, NY Times, August 2012, available at: https://archive.nytimes.com/dealbook.nytimes.com/2012/08/02/knight-capital-says-trading-

Considering the approach of MiFID II, the issues raised in the context of these types of incidents are exactly those that the legislation aims to address: prevention of operational failures, *ex-ante* and *ex-post* controls and verification, resilience of systems, and issues related to the adoption of more robust and long-term approaches to the governance of data and algorithms ([75]). Since MiFID II can be read as a direct response to these cases, and since the approach adopted by MiFID II has proven to be robust over time, the conclusion that can be reached is that the current legislation is generally well equipped to react to such situations, by distributing responsibilities, imposing sanctions, and ensuring appropriate prevention measures([76]).

A second case study can be traced to situations in which an entity *intentionally* develops and/or uses AI systems to engage in practices that cause market manipulation ([77]). A variant of this scenario is where an algorithm, originally designed correctly, is subsequently used, or altered, to manipulate the market: the consequences, however, are no different. Such cases, as well, are already covered by the rules on market manipulation conducts and can lead to liability regimes that are also cumulative, at administrative, criminal, and civil level. They are also conducts that are fully covered by the MAR and its prohibitions and sanctions.

The last case is the most challenging. This is the hypothesis where autonomous trading agents operate independently of human intervention or intent and develop their own strategy, resulting in manipulation of the market ([78]) and disrupting its normal operating conditions ([79]).

The current rules regulating market abuse and related liabilities appear mostly insufficient to address this situation ([80]). The main reason for this is related to the so-called black box dilemma, which, moreover, presents itself along general lines not dissimilar to those already observed with regard to the regime of *disclosure of* inside information by issuers. In the case under discussion, as algorithms become more and more sophisticated, it becomes increasingly difficult to identify and understand the causes of a malfunction, and even to understand how the algorithm arrived at a particular decision[81].

The discussion on these points is influenced by the fact that legal systems may generally require proof, based on documented evidence, of the manipulator's intent to cause harm, in order to impose criminal, administrative or

mishap-cost-it-440-million/.

75 L. Dupont – O. Fliche – S. Yang, *Governance of Artificial Intelligence in Finance. ACPR - Banque de France Discussion document* (June 2020), available at: https://acpr.banque-france.fr/sites/default/files/medias/documents/20200612_ai_governance_finance.pdf.

76 Y. Yadav, *How Algorithmic Trading Undermines Efficiency in Capital Markets,* 68 Vand. L. Rev. 1607, 2015; Y. Yadav, *Oversight Failure in Securities Markets*, 104 Cornell L. Rev. 1799, 2020.

77 V. Mavroudis, *Market Manipulation as a Security Problem: Attacks and Defenses. EuroSec '19: Proceedings of the 12th European Workshop on Systems Security* (2019), available at: https://doi.org/10.1145/3301417.3312493, 2019.

78 E. Martínez-Miranda – P. McBurney – M.J.W. Howard, *Learning Unfair Trading: A Market Manipulation Analysis from the Reinforcement Learning Perspective,* in B.S.J. Costa - I. Skrjanc - E. Lughofer, (eds.), *2016 IEEE Conference on Evolving and Adaptive Intelligent Systems (EAIS)*, Natal, 2016; T. Mizuta, *Can an AI perform market manipulation at its own discretion? - A genetic algorithm learns in an artificial market simulation*, 2020 IEEE Symposium Series on Computational Intelligence (SCCI), available at: https://ieeexplore.ieee.org/document/9308349, 2020; M. Shearer – G.V. Rauterberg – M.P. Wellman, *Learning to Manipulate a Financial Benchmark,* University of Michigan Law & Econ. Research Paper No. 22-038 (14 September 2022), available at: https://ssrn.com/abstract=4219227.

79 A. Azzutti- W.-G. Ringe – H.S. Stiehl, *The Regulation of AI Trading from an AI Life Cycle Perspective,* cit.; E. Leung – H. Lohre – D. Mischlich – Y. Shea – M. Stroh, *The Promises and Pitfalls of Machine Learning for Predicting Stock Returns*, 3 J. Fin. Data Sci. 21, 2021.

80 On criminal liability, with reference to the Italian system, see F. Consulich, *Il nastro di möbius, intelligenza artificiale e imputazione penale nelle nuove forme di abuso del mercato*, cit.

81 Y. Bathaee, *The Artificial Intelligence Black Box and the Failure of Intent and Causation*, 31 Harv. J. L. & Tech. 889, 2018.

even civil liability. In addition, liability is attributed to natural or legal persons (e.g., investment firms) for acts or omissions committed by a natural person (e.g., employees) and is not applicable *per se* to a computer code.

In addition, the discussion on the relevance of the subjective element in the case of market abuse is highly articulated in the different countries of the Union, in particular regarding market manipulation, also because it is necessary to distinguish conducts that can result in a criminal offence from conducts that are only relevant for administrative purposes.

In the context of the repealed MAD of 2003, no provision specifically addressed the subjective element of transactional manipulation. Currently, however, the MAR-MAD II provides an autonomous definition of market manipulation for criminal purposes: Article 5 of MAD II states that criminal liability for market manipulation is to be established by each Member State at least in serious cases and when the manipulation is committed *with intent*. Therefore, with regard to criminal sanctions, as it stands, EU law expressly requires the subjective element of intent.

However, Article 12 MAR - which defines market manipulation for the purposes of applying administrative sanctions - does not contain any explicit reference to subjective elements or to the intention to carry out the conduct. As far as administrative sanctions are concerned, therefore, the debate remains open as to whether the intent requirement is necessary, on which authors have taken divergent positions[82]. In any case, these remain matters for national law, and the practice observable in the various EU countries does not always follow the same standard ([83]). An important decision issued by the EFTA Court in 2020 seems to confirm that, for transaction-based market manipulation, the need to prove intent would not be necessary ([84]). The decision, however, is not very clear and, more importantly, it is uncertain whether it will be followed up significantly.

Similar problems arise in relation to civil liability. Most, if not all, of the authors discussing the various scenarios concerning the potential impact of AI on manipulative conduct highlight the difficulties encountered when trying to address liability issues in this context ([85]). These difficulties are far from being exclusively referable to the case of algorithmic trading and HFT, but rather concern almost all sectors that witness the development of AI systems and deal with liability issues associated with their use and, it bears repeating, are conceptually not very different from those already evoked in the context of the insider *disclosure* discipline.

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82 See N. Moloney, *EU Securities and Financial Markets Regulation*, Oxford, 2014 and S. Mock, *The concept of market manipulation*, in M. Ventoruzzo - S. Mock (eds.), *Market Abuse Regulation: Commentary and Annotated Guide*, Oxford, 2022. (2022). In favour of the subjective element requirement, among others, G. Ferrarini, *The European Market Abuse Directive*, 41 Common Mkt. L. Rev. 711, 2004; E. Avgouleas, *The Mechanics and Regulation of Market Abuse: A Legal and Economic Analysis*, Oxford, 2005; V.D. Tountopoulos, *Manipulation in Illiquid Markets - A Tale of Inefficiency?*, 14 Eur. Co. Fin. L. Rev. 468, 2017; C. Picciau, *Recenti spunti giurisprudenziali sulla frammentariazione di manipolazione del mercato*, in *Nuove Leggi Civ. Comm.*, 2020, 1286 ff. For the US system see, dated but still useful: D.R. Fischel – D.J. Ross, *Should the law prohibit 'manipulation' in financial markets?,* 105 Harv. L. Rev. 503, 1991, according to whom it would not be possible to provide an objective definition of market manipulation.

83 See, for example, Consob, in relation to the declaration of compliance with CESR guidelines: Communication No. DME/10039224 of 30-4-2010.

84 EFTA Court, February 2020, Case E-5/19, Criminal proceedings against F and GP. For comments on the case, see C. Picciau, *Recenti spunti giurisprudenziali sulla frammentariazione di manipolazione del mercato,* cit.

85 Y. Yadav, *Oversight Failure in Securities Markets*, cit.; A. Azzutti- W.-G. Ringe – H.S. Stiehl, *The Regulation of AI Trading from an AI Life Cycle Perspective,* cit.

07

Discussion on possible solutions.

The current academic and practical debate has witnessed a succession of different proposals on how to address the issues highlighted above, most of which, by the way, are far from being specifically related to the regulation of market abuse or even of financial markets, but more generally concern the use of AI per se. The debate is lively among scholars from different backgrounds and, more recently, also among regulators and supervisors. Amid the measures that are being suggested are:

a) Increased explainability (transparency) of algorithms. This is a real *evergreen*. Based on the assumption that algorithms make it difficult to address questions of accountability, a recurring, almost obsessive suggestion is that algorithms, and the decision-making process they embody and follow, should be made more intelligible and 'explainable' ([86]). However, as in most areas of research that could be called 'mainstream', what should be actually 'explainable' becomes often confusing, and at the same time, uncertain ([87]). More generally, "*explainability can relate to the notion of a given AI model being interpretable by and understandable to humans*" ([88]). Of course, explainability decreases as the complexity of the AI tool increases and, for this reason, *deep learning* systems, including *neural networks,* are generally considered to be poorly explainable.

However, explainability can be understood in other ways. In its 2023 report on AI, ESMA notes that a support vector machine (SVM) classifier could be considered interpretable and explainable. However, if one is primarily concerned with determining the importance of the different variables in the model, rather than the structure of the model itself, then the SVM is hardly interpretable and explainable ([89]). The conclusion is that explainability must be contextualised: different levels of explanation must be considered, and the appropriate level depends on the specific AI model and also on its purpose and function (whether, for instance, the analysis is necessary for the protection of third-party users or for compliance reasons, etc.) ([90]).

Finally, it is not certain that explainability - assuming it is actually feasible - can actually be a remedy for the problems considered in this paper, in connection with algorithmic trading. For instance, there is a widespread belief that meeting 'strong' explainability requirements creates a *trade-off* between the maximum level of accuracy of machine learning models and the possibility of explanation: in financial trading, this could lead to 'weaker' algorithms, increasing the risk of non-compliance with financial regulation.

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86 See, most recently, ESMA, *TRV Risk Analysis Artificial intelligence in EU securities markets. ESMA50-164-6247* (1 February 2023), available at: https://www.esma.europa.eu/sites/default/files/library/ESMA50-164-6247-AI_in_securities_markets.pdf., with particular reference to the asset management sector; R. Zuroff – N. Chapados, *Explaining Explainable AI*, in N. Remolina – A. Gurrea-Martinez, *Artificial Intelligence in Finance: Challenges, Opportunities and Regulatory Developments*, Cheltenham-Northampton, 2023. On the difference between explainability and intelligibility (or interpretability), L. Dupont – O. Fliche – S. Yang, *Governance of Artificial Intelligence in Finance. ACPR - Banque de France Discussion document,* cit.; C. Starkweather – I. Nelken, *Behind the Curtain: The Role of Explainable AI in Securities Markets*, Securities Regulation Daily (July 31, 2020), available at https://www.supercc.com/pdf/Behind-the-Curtain_07-31-2020.pdf.

87 ESMA, *TRV Risk Analysis Artificial intelligence in EU securities markets*, cit.

88 Id.

89 An SVM is a supervised learning model with associated learning algorithms that analyse data for classification and regression analysis.

90 L. Dupont – O. Fliche – S. Yang, *Governance of Artificial Intelligence in Finance. ACPR - Banque de France Discussion document,* cit.

b) The AI as a legally liable entity. Some provocative proposals envisage the introduction of rules assigning liability to the AI itself, reinforced/accompanied by *ad hoc* insurance coverage ([91]). These suggestions, however, are to be discarded, as most, if not all, legal systems currently do not grant legal status to algorithms, nor do they seem ready to do so in the near future ([92]). Some of the most reliable studies on AI also emphasise that an algorithm will never - at least in the current state of our knowledge - have the same kind of consciousness attributable to human beings or, alternatively, conclude that this evolution is not currently necessary ([93]).

c) Banning algorithmic trading. More extreme approaches suggest imposing a strict ban on algorithmic trading activities: however, these suggestions were clearly discarded several years ago, as the approach taken by various jurisdictions around the world, including of course the EU, clearly demonstrates. In fact, and apart from other reasons, a ban on algorithmic trading would hinder economic freedom, technological development, and conflict with the principles of neutrality and free competition in financial markets ([94]). Rediscovering the appeal of the ban on algorithmic trading and HFT therefore seems an attempt to bring a mummified corpse back to life.

d) New forms and criteria for liability. Considering the apparent similarity between AI for algo-trading and dangerous products, some advocate introducing forms of strict liability under civil law for damages caused by AI ([95]). However, even these proposals should be regarded with a high degree of scepticism, for reasons not very different from those discussed in connection with a possible ban on algorithmic trading: danger of hindering competition, restriction of economic freedom and conflict with the principle of technological neutrality of regulation. Also in this context, one imagines extensive revisions of the concept of liability itself, to be considered in terms of the effects of the unlawful conduct on the community ('socialisation of the damage') ([96]).

f) New governance arrangements for algorithmic trading. Some believe that the current regime introduced by MiFID II in relation to algorithmic trading and HFT is outdated: the main criticism (which does not seem to hold true, at least in its entirety) is its alleged failure to adequately track, understand and manage the governance of AI and autonomous algorithmic trading ([97]). Considering, more specifically, the approach adopted by MiFID II, the elements of dissatisfaction concern both the regime applicable to investment firms and trading venues. As far as investment firms are concerned, the alleged shortcomings are identified in the circumstance that MiFID II relies excessively on self-assessment mechanisms, left in the hands of algorithmic traders ([98]). As to trading venues,

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91 R. Michalski, How to Sue a Robot, 2018 *Utah L. Rev.* 1021 (2018); R. Abbott – A. Sarch, *Punishing Artificial Intelligence: Legal Fiction or Science Fiction*, 53 UC Davis L. Rev. 323, 2019; D. Powell, *Autonomous Systems as Legal Agents: Directly by the Recognition of Personhood or Indirectly by the Alchemy of Algorithmic Entities*, 18 Duke L. & Tech. Rev. 306, 2020. For further references, see CONSOB, *Quaderni giuridici. AI e abusi di mercato: le leggi della robotica si applicano alle operazioni finanziarie?,* (29 May 2023), available at: https://www.consob.it/documents/11973/201676/qg29.pdf/768199a2-e17c-ca8e-00a5-186da9a19f79?t=1685344502568.

92 J. Lightbourne, *Algorithms & Fiduciaries: Existing and Proposed Regulatory Approaches to Artificially Intelligent Financial Planners*, 67 Duke L. J. 651, 2017.

93 See S. Chesterman, *Artificial intelligence and the limits of legal personality*, 69 Int'l. & Compar. L. Q. 819, 2020.

94 European Commission, *White Paper on Artificial Intelligence European Approach to Excellence and Trust* (19 February 2020), available at: https://ec.europa.eu/info/sites/info/files/commission-white-paper-artificial-intelligence-feb2020_en.pdf; CONSOB, *Quaderni giuridici. AI e abusi di mercato: le leggi della robotica si applicano alle operazioni finanziarie?,* cit.

95 K.A. Chagal-Feferkorn, *Am I an Algorithm or a Product? When Products Liability Should Apply to Algorithmic Decision-Makers*, 30 Stan. L. & Pol'y Rev. 61, 2019. V. Chandola – A. Banerjee – V. Kumar, *Anomaly Detection: A Survey,* 41 ACM Co. Surveys 1, 2019.

96 CONSOB, *Quaderni giuridici. AI e abusi di mercato: le leggi della robotica si applicano alle operazioni finanziarie?,* cit.

97 P.G. Picht -G.T. Loderer, *Framing Algorithms: Competition Law and (Other) Regulatory Tools*, 42 World Competition 391, 2019.

98 A. Azzutti- W.-G. Ringe – H.S. Stiehl, *The Regulation of AI Trading from an AI Life Cycle Perspective,* cit.; R.P.Buckley – D.A. Zetzsche – D.W. Arner – B. Tang, *Artificial Intelligence in Finance: Putting the Human in the Loop*, 43 Sydney L. Rev. 43 2021. See also

MiFID II requires them to cooperate with investment firms to ensure that algorithmic trading complies with market conduct rules, for instance by providing simulation environments to test algorithmic strategies ([99]). Again, over-reliance on self-assessment is considered the weak point ([100]).

In light of the above, many suggest the introduction of new forms of interaction between public and private actors in the field of AI, including hybrid models ([101]).

Although these proposals go in the right direction, the fact remains that regulators should develop a thorough knowledge and sound conceptual framework to distinguish legitimate from illegal algorithmic trading ([102]). In addition, the limitations implicit in testing algorithms in a simulated environment when transferring their results to actual markets should be addressed ([103]).

To counterbalance these critical aspects, AI systems or components should be subject to different levels of pre-approval requirements (such as testing and certification) and other regulatory obligations (human control, revalidation, etc.). Reflecting the approach of the EU AI Regulation, extremely 'risky' AI applications (or components) could ultimately even be banned. For 'risk-free' or 'low-risk' AI trading instruments, on the other hand, the alternative might be to introduce an exemption regime. In general, stricter regulatory requirements should be applied proportionately to the increase of the risk levels posed by AI trading instruments ([104]).

g) Market surveillance embedded in the algorithm. Notwithstanding the critical issues and questions raised in the preceding paragraphs, there also seems to be another remedy that could be adopted to reduce the risk of AI-based trading disrupting markets, and that concerns the internal structure of the algorithm itself. The current regime on algorithmic trading and HFT is based on a series of *ex-ante* evaluations and continuous monitoring activities, aimed at verifying that algorithms operate properly and do not hinder or negatively impact the orderly functioning of markets. This approach, however, has its flaws: most *ex-ante* tests are conducted in a protected environment, which may be very different from real market conditions, and may therefore provide unreliable results. Continuous monitoring, on the other hand, examines market conditions as they develop, so to speak, in real time, or even *ex-post*. This can help minimise negative market conditions, but not necessarily prevent them.

P. Raschner, *Algorithms put to test: Control of algorithms in securities trading through mandatory market simulations? European Banking Institute Working Paper Series*, No. 87 (26 February 2021), available at: https://ssrn.com/abstract=3807935.

99 See Commission Delegated Regulation (EU) 2017/584 of 14 July 2016 supplementing Directive 2014/65/EU of the European Parliament and of the Council with regard to regulatory technical standards specifying organisational requirements for trading venues.

100 A. Azzutti, *The Algorithmic Future of EU Market Conduct Supervision: A Preliminary Check,* in L. Böffel – J. Schürger (eds.), *Digitalisation, Sustainability, and the Banking and Capital Markets Union: Thoughts on Current Issues of EU Financial Regulation,* Cham, 2023, who notes that the EU regulation of algorithmic trading follows a behaviourist approach, which is not suited to properly address the impact of new technologies.

101 Microsoft - Deutsche Bank – Linklaters - Standard Chartered - Visa, *From Principles to Practice: Use Cases for Implementing Responsible AI in Financial Services*, available at: https://aka.ms/fromprinciplestopractice, 2019; FINRA, *Artificial Intelligence (AI) in the Security Industry* (10 June 2020), available at: https://www.finra.org/sites/default/files/2020-06/ai-report-061020.pdf.; M. Kellerman, *Market structure and disempowering regulatory intermediaries: Insights from U.S. trade surveillance*, 15 Reg. & Governance 1350, 2021.

102 D.C. Donald, *Regulating Market Manipulation Through an Understanding of Price Creation*, 6 Nat'l Taiwan U. L. Rev. 55, 2011.

103 C. Brummer - Y. Yadav, *FinTech and the Innovation Trilemma*, 107 Geo. L. J. 235, 2019, presenting proposals for greater international cooperation and coordination.

104 A. Azzutti- W.-G. Ringe – H.S. Stiehl, *The Regulation of AI Trading from an AI Life Cycle Perspective,* cit.

An alternative solution that could be suggested consists in incorporating market manipulation prevention measures *within* the algorithm structure. The suggestion is thus to explicitly require firms that use algorithms and/or HFT to certify the inclusion of mechanisms aimed to prevent, on an *ex-ante* basis and embedded directly in the algorithm, the operation of said algorithm in the event that a risk of market manipulation can reasonably be assumed. This would be a preventive measure, perfectly in line with MiFID II's risk-based approach to algorithmic trading, which would operate at an early stage, different from those usually considered when examining the systems and applications that firms have in place in relation to ongoing and *ex-post* monitoring. As autonomous algorithms are expected to have an increasing ability in the future, based on ML and deep reinforcement learning (DRL), to learn and make decisions in anticipation of future scenarios, they should soon be able to predict whether a certain decision could have a negative impact on the market, thus preventing the algorithm from operating in that context: in short, an *ex-ante* blocking mechanism, which would be part of the 'intelligence' of the algorithm itself. This characteristic of the algorithm should be self-assessed by the algorithmic trader or, better, verified and certified by an expert or external body.

In this regard, one possible avenue could be to support this approach with *soft law* instruments aimed at both national supervisory authorities and market participants. Consequently, even the complex issue of 'algorithmic' liability would be better handled: observation of market movements and conditions would provide very strong evidence to support the conclusion that market manipulation has occurred, precisely because the algorithm has, in spite of everything, continued to operate.

The proposed approach has already been outlined, albeit briefly, in a recent contribution, which correctly points out its possible shortcomings ([105]). The first is that there may be technical barriers (to be identified) to its implementation: a point that, of course, needs further investigation. Assuming that there are no technical or legal barriers to the implementation of such a solution through programming codes, the second objection concerns the fact that it would be difficult to make autonomous, *self-learning* AI adapt dynamically to changing regulations and market dynamics in order to produce credible deterrence over time. Although this objection should not be entirely dismissed, regulatory evolution has always been, and will always be, a problem for regulators, and is far from being specific to the topic of market manipulation: on the contrary, market abuse provisions have not undergone any major or revolutionary changes in recent decades, and in particular, the rules against market manipulation have remained more or less the same. In the area of market manipulation, therefore, the regulatory development and the identification of new conducts, is not so pronounced.

105 M. Azzutti, *Informazioni privilegiate e funzionamento dei mercati finanziari,* Milan, 2022.

A third objection concerns the fact that regulatory prohibitions of market manipulation should also be based on objective and quantifiable definitions in order to be comprehensible to AI systems, and that unfortunately the current EU legal framework seems far from this, being rather characterised by a high degree of vagueness. The latter observation, however, does not take full account of the fact that, on the contrary, the rules against market abuse are firmly based on precise theories of the functioning of financial markets and, in particular, on the foundations of the ECMH, and that some of the most important cases of market abuse have been extensively identified, studied, and analysed over the past decades ([106]). Since these models are well known and fully represented in the economic and statistical literature ([107]), there is room for incorporating them into the functioning of algorithms: indeed, if this were not the case, it would be impossible to detect market manipulation phenomena and enforce the MAR even under a more traditional market surveillance approach.

08

Conclusions

The main findings of this study can be summarised as follows. Considering, firstly, the rules which, in the context of MAR, are applicable to inside information, and in particular the disclosure regime in Article 17 MAR, it was observed that:

(i) AI systems can play a key role in supporting the processes that, within issuers subject to the MAR provisions, lead to the identification and prompt disclosure of inside information: an issue that, until now, has not been particularly addressed. Thanks to their ability to handle large amounts of data and information and their self-learning potential, AI systems may represent a useful tool to support the issuer and its management body in the process leading, in the first place, to identify information that may potentially be or become inside information. AI systems could be useful, in particular, but not exclusively, for structurally large and complex issuers subject to *the* MAR *disclosure* rules, as well as in corporate groups, articulated in different levels and structures of subsidiaries, where inside information may be more difficult to identify and track, especially in the case of multi-stage processes, in a timely manner. In this sense, the use of AI systems can support and facilitate compliance with existing *disclosure* rules. The analysis concludes that the current regime should clearly support the introduction and development of AI systems in this particular area: in this regard, *soft law* can be a useful and not overly intrusive tool to support and promote these junctures. Another outcome of our research in this area is that, from a broader perspective, technological developments are also challenging the traditional approach to the identification of what is, or amounts to, 'inside information' as defined in Article 7 MAR: the paper has analysed the role of the media and tried to challenge the idea that the broadcaster is still to be considered (always) the fulcrum of the dissemination of information to the market.

106 S. Tiwari – H. Ramampiaro – H. Langseth, *Machine Learning in Financial Market Surveillance: A Survey*. 9 IEEE Access 159734, 2021.

107 Broadly, C. Alexander – D. Cumming (eds.), *Corruption and Fraud in Financial Markets: Malpractice, Misconduct and Manipulation,* New York, 2020.

(ii) The use of AI systems has a significant impact on the potential liability of the issuer and/or directors in relation to possible violations of the *disclosure regime*. A malfunctioning of the algorithm, resulting in delays, omissions or inappropriate disclosures of inside information could indeed constitute a breach of the MAR disclosure regime and raise liability issues for the issuer and, ultimately, its management body. This is a non-harmonised area of European law. The limits and implications of a possible full automation of the process leading not only to the identification but also to the disclosure of inside information to the market were discussed. It was concluded that, considering the current structure of MAR and its application under national law, AI systems, although useful to support the action of directors in identifying, monitoring, and disclosing inside information, cannot completely replace human action and intervention, particularly in the last stages of the process that actually leads to the disclosure of information. While EU legislators and supervisors should encourage the use of AI in order to ensure compliance with the disclosure regime, the MAR should prevent, or at least strongly discourage, the use of fully automated systems to manage the disclosure phase (or the delay, as the case may be), as this could raise unsolvable problems in the context of the different liability regimes currently established by the national laws of the Member States. Rather, market abuse legislation should clearly stipulate that: (a) issuers have an obligation to take appropriate organisational measures to identify and manage inside information and (b) issuers have an obligation to clearly identify the persons who are under an obligation to make disclosure of inside information, and their responsibilities.

(iii) Regarding the second strand of research, i.e., the relationship between AI and market manipulation, the main issue is related to algorithmic trading and HFT liability. Despite some criticism of the current MiFID II approach in relation to algorithmic trading, it was concluded that significant changes to the current regulatory framework are not necessary; however, there is room to suggest the introduction of a specific obligation on investment firms using algo-trading and HFT tools to include appropriate measures in their systems to ensure that the algorithms themselves are adequately structured to monitor, predict, and thus *anticipate* situations that may lead to market manipulation, by having specific operating blocks in place for this purpose, again from an *ex-ante* perspective.

In any case, such measures should take into account the complexity and structure of algorithms, which ultimately translates into their ability to manage and monitor different levels of risk and complexity. As suggested in recent contributions, the approach of the EU Artificial Intelligence Regulation - based on the differentiation of risk levels and risk factors in relation to AI - could also be considered as a reference for the relationship between AI and market manipulation risks.