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Artificial Intelligence and EU Insider Regulation

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Abstract

The growing use of artificial intelligence (AI) and big data in capital markets poses new challenges for the Market Abuse Regulation (MAR), which was initially designed for human decision-making and automated trading systems. As the rise of AI makes it possible to trade autonomously through self-learning algorithms, legal uncertainty arises regarding the attribution of inside information, responsibility for AI-driven transactions, and the scope of the insider trading prohibition under Art. 8 MAR. This article examines whether and to what extent such autonomous insider trading is covered by existing law and explores the role of Art. 9 para. 1 MAR, focusing on the possibility of a teleological extension and analogy to establish a "compliance by design" defence for both legal and natural persons using AI. The paper further addresses the use of AI in fulfilling issuers' public disclosure obligation under Art. 17 MAR, particularly in identifying inside information and responding to deepfakes. Finally, it considers how enforcement tools and organisational duties under MiFID II and MAR may need to be adapted to ensure informational fairness in the context of autonomous trading systems.

Keywords: insider trading, public disclosure obligation, autonomous trading systems, artificial intelligence, compliance by design

JEL Classifications: K22, K24, G14

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by

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The growing use of artificial intelligence (AI) and big data in capital markets poses new challenges for the Market Abuse Regulation (MAR), which was initially designed for human decision-making and automated trading systems. As the rise of AI makes it possible to trade autonomously through self-learning algorithms, legal uncertainty arises regarding the attribution of inside information, responsibility for AI-driven transactions, and the scope of the insider trading prohibition under Art. 8 MAR.

This article examines whether and to what extent such autonomous insider trading is covered by existing law and explores the role of Art. 9 para. 1 MAR, focusing on the possibility of a teleological extension and analogy to establish a "compliance by design" defence for both legal and natural persons using AI. The paper further addresses the use of AI in fulfilling issuers' public disclosure obligation under Art. 17 MAR, particularly in identifying inside information and responding to deepfakes. Finally, it considers how enforcement tools and organisational duties under MiFID II and MAR may need to be adapted to ensure informational fairness in the context of autonomous trading systems.

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A. Introduction

In consideration of the definition of artificial intelligence as set out in the EU Artificial Intelligence Act (hereafter AI Act),[1] it is fair to say that AI has already been used in capital markets for more than 50 years. Recent reports indicate that the vast majority of investment decisions are now made by algorithms.[2] Following the remarkable flash crash in the US in 2010, which served as the inspiration for the novel 'Flash Boys' by Michael Lewis[3], algorithms have been more or less rightly suspected of being responsible for slumps in prices caused by market

[1] 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.

[2] In 2018 and 2019, algorithms were responsible for around 80 percent of trading in equities and bonds (*ESMA*, MiFID II Review Report – MiFID II/MiFIR review report on Algorithmic Trading, 28 September 2021, ESMA70-156-4572, p. 20, available at https://www.esma.europa.eu/press-news/esma-news/esma-publishes-mifid-ii-review-report-algorithmic-trading).

[3] *Lewis*, Flashboys, 2012.

manipulation. This prompted the European legislator to introduce specific regulations for algorithmic trading and high-frequency trading over ten years ago, with the aim of combating market abuse caused by such manipulation strategies. Subsequently, opportunities to commit market abuse have proliferated due to the enhanced capabilities of AI.[4] Today, for example, deceptively real-looking video, image and audio recordings (deep fakes) could not only cause unrests in democratic discourse but also enable anyone to manipulate capital markets in new and subtle ways. The dangers connected to such developments are best exemplified by the following: In May 2023, an image showing an explosion in front of the Pentagon was shared on X, causing panic on the stock market and resulting in dramatic drops in share prices.[5]

However, in addition to market manipulation, the ongoing development of new technologies harbors further and yet little-noticed risks to the functioning of capital markets.[6] For instance, there have been warnings of 'structural insider trading' with regard to algorithmic trading.[7] This is because self-learning algorithms possess the capacity to process substantial volumes of data (big data) faster, more comprehensively and more flexibly, giving them a clear advantage over human actors and thus potentially even an insider advantage.[8] For instance, the Chinese AI model *Deepseek*, which recently shook up the tech industry,[9] is backed by an AI-based investment fund called *High Flyer*, which is capable of searching for, finding and analyzing signals hidden in market noise and has thus generated considerable profits.[10] The fact that the risks of insider trading by AI systems are real and not just theoretical was demonstrated in a high-profile laboratory experiment in 2023: The researchers then instructed an AI based on the LLM model

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[4] Further: *Annunziata*, Artificial Intelligence and Market Abuse Legislation, 2023, pp. 71 et seqq.; *Azzutti*, Artificial Intelligence and Market Manipulation: Challenges for Market Abuse Regulations and Governance of Algorithmic Trading, 2024, passim; *Consulich/Maugeri/Milia/Poli/Trovatore*, AI and market abuse: do the laws of robotics apply to financial trading?, 2023, pp. 38 et seqq., available at https://www.consob.it/web/consob-and-its-activities/abs-rp/-/asset_publisher/ee9fPZnpClpQ/content/qg29en/718268; *Azzutti/Ringe/Stiehl*, Machine learning, market manipulation and collusion on capital markets: why the 'black box' matters, 43 U. Pa. J. Int'l L. 79 et seqq. (2021); *Fletcher*, Deterring Algorithmic Manipulation, 74 Vand. L. Rev. 259 (2021); *Lin*, The New Market Manipulation, 66 Emory L. J. 1253 (2017); *Shearer/Rauterberg/Wellman*, Learning to Manipulate a Financial Benchmark, U. Mich. Law & Econ Research Paper No. 22-038; *Yadav*, The Failure of Liability in Modern Markets, 102 Va. L. Rev. 1031, 1073-74 (2016).

[5] *Sorkin/Warner/Kessler/de la Merced*, An A.I.-Generated Spoof Rattles the Markets, *New York Times*, 23 May 2023, available at https://www.nytimes.com/2023/05/23/business/ai-picture-stock-market.html.

[6] However: *Annunziata* (n. 4), p. 109 et seqq.; *Consulich/Maugeri/Milia/Poli/Trovatore* (n. 4), pp. 45 et seqq. See also *SEC*, SEC Office of Compliance Inspections and Examinations Announces 2020 Examination Priorities, 7 January 2020, Rel. No. 2020-4, ('OCIE recognizes that advancements in financial technologies, methods of capital formation and market structures, as well as registered firms' use of new sources of data (often referred to as 'alternative data'), warrant ongoing attention and review.").

[7] *Yadav*, Insider Trading and Market Structure, 63 UCLA L. Rev. (2016) 968, 971 et seqq.

[8] On the successful use of machine learning by US investor Jim Simons see *Zuckerman*, The Man Who Solved The Market, 2019, passim. Further *Economist*, 16 November 2019, p. 70.

[9] *Goldman*, What is DeepSeek, the Chinese AI startup that shook the tech world?, *CNN*, 27 January 2025, available at https://edition.cnn.com/2025/01/27/tech/deepseek-ai-explainer.

[10] *Shen/Ranganathan*, After DeepSeek, Chinese fund managers beat High-Flyer's path to AI, *Reuters*, 14 March 2025, available at https://www.reuters.com/technology/artificial-intelligence/after-deepseek-chinese-fund-managers-beat-high-flyers-path-ai-2025-03-14/.

GPT to work as an independent stock broker and make profits.[11] The AI was also instructed that the use of inside information for trading shares is prohibited. However, when the AI system was leaked inside information about the imminent takeover of a listed company, it began to buy shares of the target. When the researchers subsequently asked the AI whether it had processed inside information, it denied and emphasized that it had only used publicly available data.

Following 2014, the European Market Abuse Law is tested once again, this time in the context of novel developments through AI. The question therefore arises as to what extent the Market Abuse Regulation (MAR) needs to be adapted to counter market abuse facilitated by advanced technology, or whether it is already able to meet the new challenges posed by AI and big data and strike an appropriate balance between openness to innovation on the one hand and responsibility for the functioning of the market on the other.

In order to answer this question, this paper first examines the development of AI on the capital market and the AI-related rules (B.). It will then analyse whether and to what extent the Market Abuse Regulation covers algorithmic insider trading (C.), before moving on to the significance of AI for the issuer's ad hoc disclosure obligation (D.) and concluding with an outlook on the need for reform.

B. Development and Regulation of AI on capital markets

I. From automated to autonomous trading systems

1. Automated trading systems

Algorithms have been used on the capital market since the transition from floor trading to electronic trading in the 1970s: e.g. to prepare investment decisions as part of portfolio optimization, for investment advice in the form of robo-advice or for securities trading.[12] A specific form of algorithmic trading is high-frequency trading, which is characterized by its exceptionally high speed.[13] Due to their geographical proximity to the trading venues (colocation), high-frequency traders leverage every millisecond and frequently employ systems that make independent investment decisions in order to improve decision-making and increase transmission speed. Nevertheless, the less sophisticated algorithms employed in this respect are still based on the 'if-then' principle,[14] whereby input is converted into output according to a predefined logic,[15] such as: '*Sell the shares if the share price drops below 50 euros*'. However, in the complex and rapidly changing capital markets, it is almost impossible to anticipate all

[11] *Scheurer/Balesni/Hobbhahn*, Large Language Models can Strategically Deceive their Users when Put Under Pressure, 9 November 2023, available at arXiv:2311.07590.
[12] *Gomolka*, Algorithmic Trading, 2011, p. 194.
[13] In the time it takes Usain Bolt to react to the starting gun for the 100-metre race, a high-frequency trading platform could complete around 165,000 separate trades (High-frequency trading and the $ 440m mistake, *BBC*, 11 August 2012, available at https://www.bbc.com/news/magazine-19214294).
[14] On these 'expert systems' *Russel/Norvig*, Artificial Intelligence: A Modern Approach, 4th ed. 2021, pp. 40 et seq.
[15] *Azzutti* (n. 4), pp. 53 et seqq.

conceivable future trading situations (*if*) and to programme appropriate responses (*then*) in advance.

2. Autonomous trading systems

This is why AI systems – which no longer function according to pre-programmed rules but can learn independently from data how human investors react in comparable situations –[16] are spreading rapidly on capital markets.

a. Training methods of machine learning (Machine Learning)

AI systems are based on different methods of machine learning: In the context of supervised learning, they are trained on the basis of pre-labeled empirical data, such as historical price-sensitive events, to enable them to predict future price movements.[17] In the context of unsupervised learning, algorithms function independently to derive patterns, such as regularities, from unlabeled data, e.g. that the share price of a pharmaceutical company rises after the announcement of the development of a life-saving and profitable drug.[18] In both cases, the systems are able to learn from empirical data and can thus help to automate trading on the capital markets. However, for these machine learning methods, human assistance is essential for the trading systems to be able to react to unforeseen events and changing capital market conditions.[19] Consequently, autonomous trading without human intervention is not feasible with these methods.

It can be observed that investors are increasingly using algorithms that learn by trial and error to achieve a specific goal – such as profit maximization – within an uncertain and dynamic environment, as is the capital market.[20] In this so called reinforcement learning model, the AI works without labeled data and rather acquires knowledge through the reception of feedback subsequent to completing a task, with the feedback being positive or negative in nature.[21] The AI responds by modifying its own programming in a way that ensures the reception of positive feedback in the future.[22] In this respect, the AI models demonstrate a similarity to human

[16] Illustrative *Russell/Norvig* (n. 14), p. 669.
[17] *Azzutti* (n. 4), p. 61.
[18] *Azzutti* (n. 4), p. 62.
[19] *Azzutti* (n. 4), p. 63.
[20] *ESMA*, ESMA TRV Risk Analysis – Artificial intelligence in EU securities markets, 1 February 2023, ESMA50-164-6247, p. 13, available at https://www.esma.europa.eu/node/200277; *Hambly/Xi/Yang*, Recent Advances in Reinforcement Learning in Finance, 33 Math. Fin. (2023) 437; *Ozbayoglu/Gudelek/Sezer*, 93 Appl. Soft Comput. J. (2020) 106384; *Deng/Bao/Kong/Ren/Dai*, Deep Direct Reinforcement Learning for Financial Signal Representation and Trading, 28 IEEE 653 (2016); *Li/Zheng, W./Zheng, Z.*, Deep Robust Reinforcement Learning for Practical Algorithmic Trading, 7 IEEE Access 108014 (2019), available at https://ieeexplore.ieee.org/document/8786132; *Magnuson*, Artificial Financial Intelligence, 10 Harv. Bus. L. Rev. (2020) 337, 344.
[21] *Sutton/Barto*, Reinforcement Learning: An Introduction, 2018, p. 1 et seqq.; *Russell/Norvig* (n. 14), p. 840 et seqq.
[22] *Russell/Norvig* (n. 14), p. 840: 'Imagine playing a new game whose rules you don't know; after a hundred or so moves, the referee tells you, "You lose". That is reinforcement learning in a nutshell'.

investors by learning from positive and negative 'experiences' to develop strategies to achieve their investment goals.[23] These methods thus form the technical basis for fully autonomous securities trading without human intervention.[24] There is a clear trend in the realm of capital markets from automated to autonomous, i.e. self-learning and adaptable technologies.[25] This phenomenon is further substantiated by the significant increase in the proportion of AI content in patent applications relating to algorithmic trading.[26]

b. Artificial neutral networks (deep learning)

The most advanced AI systems consist of artificial neural networks that are modeled on the human brain and are often referred to as 'deep learning'.[27] In this multi-layer network, data is fed as input (input layer) through a substantial number of nodes (hidden layers) to an output (output layer).[28] By using deep learning, complex and extensive data sets, such as information from conventional media and social media platforms (e.g. X), stock forums or satellite imagery, can be collected, analyzed and evaluated in fractions of a second in order to make optimal investment decisions – i.e. to buy, sell or hold securities. The general ability of AI systems to process large amounts of both structured and unstructured data faster and more comprehensively as well as the prompt realization in transactions, enhances information efficiency, as new information is incorporated in market prices more quickly.[29] By automatically acting, AI systems can help to increase the trading speed and reduce transaction costs, thereby

[23] *Azzutti* (n. 4), p. 68 et seq.

[24] See for example *Zhang/Zohren/Roberts*, Deep Reinforcement Learning for Trading, 25 J. Fin. Data Sci. 1 (2020); *Ringe/Azzutti/Stiehl*, Künstliche Intelligenz und Marktmanipulation, ZBB 2022, 341, 343. In general *Magnuson* (n. 20), p. 344.

[25] With regard to the technical potential that machine learning has for securities trading, the BaFin stated in a study in 2018 that although real AI-based algorithms are not yet a dominant phenomenon in the trading execution of institutional investors, machine learning is already playing a major role in development (*BaFin*, Study 'Big Data meets artificial intelligence', 2018, p. 149; available at https://www.bafin.de/SharedDocs/Downloads/EN/dl_bdai_studie_en.html;jsessionid=7AF5968E8B1EBB60BE9C644FEDCBA83B.internet961). Three years later, IOSCO published a study in which it stated that the use of AI and machine learning by financial intermediaries and asset managers was increasing worldwide (*IOSCO*, Final Report, The use of artificial intelligence and machine learning by market intermediaries and asset managers, September 2021, pp. 6 et seqq.; available at https://www.iosco.org/library/pubdocs/pdf/IOSCOPD684.pdf). ESMA concluded in 2023 that there are many examples of AI applications on the capital market: Particularly, natural language processing is used to analyse large amounts of unstructured and alternative data and to identify specific information (*ESMA*, (n. 20), p. 6).

[26] *IMF*, Global Financial Stability Report 2024, pp. 83 et seq., available at https://www.imf.org/en/Publications/GFSR/Issues/2024/10/22/global-financial-stability-report-october-2024.

[27] Further *Goodfellow/Bengio/Courville*, Deep Learning, 2016, passim*; Russell/Norvig* (n. 14), pp. 750 et seqq.; *LeCun/Bengio/Hinton*, Deep Learning, 521 Nature (2015), pp. 436 et seqq.

[28] *Russell/Norvig* (n. 14), p. 801.

[29] *IMF* (n. 26), p. 79, 87 et seqq.

increasing liquidity of the overall market.[30] Therefore, the use of autonomous AI systems promises mostly positive effects for the functioning of the capital market. Nevertheless, the use of AI and autonomous trading systems can, under certain conditions, pose risks to market integrity. For instance, these systems may process and act on unverified or even incorrect information,[31] e.g. from social media, potentially causing price movements that diverge from fundamental values. Furthermore, AI systems could be utilized by announcement traders[32] to monitor disclosures and execute trades before the new information is reflected in the stock price, thereby profiting from a timing advantage. While such practices are not prohibited under EU law, they consume scarce resources and may ultimately impair liquidity.[33] In order to capitalize on the predominantly beneficial impacts of AI in capital markets, it is imperative to establish legislation that facilitates beneficial activities while prohibiting any potentially detrimental effects.

A further issue that must be addressed is that the complexity and multi-layered nature of neural networks can pose significant challenges for developers and users in comprehending and articulating the rationale behind the output of particularly powerful models. Due to the 'black box'-nature of such models, the output of artificial neural networks can often neither be predicted nor retraced.[34] It is therefore not surprising that the risks associated with accelerated, more complex and less transparent algorithms are progressively garnering attention.[35]

II. Regulation of automated trading

1. MAR and MiFID II

In response to the identified risks associated with algorithmic trading and high-frequency trading in the capital market, European legislators responded by establishing specific rules in 2014: The prohibition of market manipulation in the MAR was, for instance, expanded to include a regulatory example for algorithmic trading (Art. 12 para. 2 lit. c) MAR) and additional organizational obligations were introduced in MiFID II for regulated markets (Art. 48 MiFID II) and for investment firms (Art. 17 MiFID II; Delegated Regulation (EU) 2017/589). Consequently, an investment firm engaging in algorithmic trading is obligated to comply with special organizational requirements. This includes the duty "to have in place effective systems and risk

[30] *FSB*, Artificial intelligence and machine learning in financial services, Market developments and financial stability implications, November 2017, available at https://www.fsb.org/wp-content/uploads/P011117.pd; *IOSCO* (n. 25), p. 1; *ESMA* (n. 20), p. 6; *IMF* (n. 26), p. 79.
[31] *Dahl/Magesh/Suzgun/Ho*, Large Legal Fictions: Profiling Legal Hallucinations in Large Language Models, 16 J. Leg. Anal. 64, 67 (2024).
[32] *Fox/Glosten/Rauterberg*, Informed Trading and Its Regulation, 43 J. Corp. L. 817, 844 (2018).
[33] *Fox/Glosten/Rauterberg* (n. 32), p. 845.
[34] However, intensive work is already being done on methods of explainable AI (*Explainable AI*) (see *Arrieta* et al., Explainable Artificial Intelligence (XAI): Concepts, Taxonomies, Opportunities and Challenges Toward Responsible AI, 58 Information Fusion 82, 84 (2020); *Azzutti* (n. 4), pp. 88 et seq.).
[35] See for example *Annunziata* (n. 4), pp. 71 et seq.; *Consulich/Maugeri/Milia/Poli/Trovatore* (n. 4), pp. 75 et seqq.

controls to ensure the trading systems cannot be used for any purpose that is contrary to Regulation (EU) No 596/2014".

2. European Regulation on Artificial Intelligence (AI Act)

In light of these special rules for algorithmic trading, the European legislator has deliberately and expressly abstained from categorizing securities trading using AI as a 'high-risk AI system' within the meaning of Art. 6 AI Act, which will be applicable from August 2026, and thus from imposing the increased requirements pursuant to Art. 8 et seq. AI Act.[36]

Only high-risk AI systems, which are, for example, used in critical infrastructure and pose a substantial risk of harm to the health, safety, or fundamental rights of natural persons,[37] are subject to intensive requirements and obligations for providers and operators. For other non-high-risk AI systems, which include AI-assisted trading in securities, the sole requirement is that people using them must have a sufficient level of AI literacy (Art. 4 AI Regulation). This means that the direct impact of the AI Regulation on the use of AI within the capital market is negligable. However, at the time the European legislator revised the capital market rules ten years ago, the focus was solely on automated systems that use algorithms according to the 'if-then" principle (see Recital 38 s. 2 MAR; Recital 59 s. 2 MiFID II). Autonomous trading systems, which have since developed and advanced, and the new risks associated with them were hereby not yet taken into consideration.

C. AI and the prohibition of insider trading

Therefore, the question arises as to whether and to what extent European market abuse law needs to be adapted once more to meet the new challenges for the capital market posed by autonomous trading systems. The substantial increase in data (i.e. big data) and the significant alterations in the manner in which price-sensitive information can be obtained and processed using machine learning provide users of AI and big data on the capital market – typically institutional investors such as high-frequency traders, fund or asset managers – with a profitable advantage over other market participants. This poses the risk of insider trading, which is regulated "to protect the integrity of the financial market and to enhance investor confidence, which is based, in turn, on the assurance that investors will be placed on an equal footing and protected from the misuse of inside information" (see Recital 24 s. 3 MAR). The underlying rationale is to establish a level playing field for investors. According to Art. 8 para. 1 MAR, insider trading occurs when a person possesses inside information and uses it to acquire or sell financial instruments such as shares or bonds. According to Art. 7 para. 1 lit. a) MAR, inside information is defined as precise and price-sensitive information which is linked to an issuer and has not been made public.

[36] Commission Staff Working Document Impact Assessment Accompanying the Proposal for a Regulation of the European Parliament and of the Council Laying Down Harmonised Rules On Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Unions Legislative Acts, COM(2021) 206 final, mn. 237.
[37] See Art. 6 paras. 2, 3 in conjunction with Appendix III no. 2 AI Act.

I. 'Structural insider trading" through technological advantage ?

Whether the advantage being obtained by the use of AI and big data actually creates an unfair advantage under insider trading law, initially depends on where inside information plays a role in the AI system: It can either be processed as input or be the result of an analysis as output.

1. Inside information as input

Initially, inside information can enter the system through human input or an independent search by the AI itself, as was the case in the laboratory experiment described in the introduction. However, as long as the input of an AI system consists solely of price-sensitive information which has been made public,[38] the principle of equal access to information is not affected. This reasoning holds even in scenarios where AI systems can process published information faster and more comprehensively than humans. Provided that the prohibition of insider trading is intended to create a level playing field, the non-public character of the information should substantially depend on its actual availability to the investing public (see Recitals 23, 24 s. 3 MAR). It is not required that all market participants have actually taken note of the information. If an AI system exclusivley processes information that is published, for example, through the media or by ad hoc disclosure, there is no occurance of an unfair advantage and therefore no 'structural' insider trading can be observed.[39]

2. Inside information as output

a) Processing of alternative data

The particular advantage of AI in the context of capital markets is its independence from traditional capital market information, such as ad hoc disclosures, annual reports of the issuer or financial analyses. Rather, AI combines a large number of individual data into a 'mosaic', enabling the system to rapidly draw conclusions regarding price-sensitive information. The alternative data may originate from a wide variety of sources, ranging from online available newspaper articles to comments on social media and to images and videos transmitted by drones or satellites.[40] *Dataminr*, a US-based AI company, is said to have uncovered the VW emissions scandal by analyzing Twitter messages three days prior to the market's reaction.[41] Another striking example is the daily observation of supermarket parking lots by satellites, the gathered data being used to derive forecasts for annual sales figures and the development of stock prices.[42] Moreover, an artificial intelligence system could potentially gain access to

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[38] For a definition of public knowledge, see e.g. Ventoruzzo/Mock/*Ventoruzzo/Picciau*, Market Abuse Regulation, 2nd ed. 2022, B.7.65. In German literature see Klöhn/*Klöhn*, Marktmissbrauchsverordnung, 2nd ed. 2023, Art. 7 MAR mn. 126; Ebenroth/Boujong/*Poelzig*, Handelsgesetzbuch: HGB, 5th ed. 2024, Vol. 2, Art. 7 MAR mn. 17.

[39] Explicitly so for the US insider trading law *Yadav* (n. 7), p. 971.

[40] On the term of alternative data *Montemarano*, 15 Brook. J. Corp. Fin. & Com. L. (2021) 263, 265 et seqq.

[41] *Montemarano* (n. 40), p. 263.

[42] *Credit Suisse*, The Rise of the Machines Enabled Investing, 2017, p. 4, available at https://cdn.e-fundresearch.com/files/white_paper_technology_enabled_investing_via_local_entities.pdf; For further examples *Montemarano* (n. 40), 263, 265 ff.

confidential information by circumventing security protocols through the use of hacking techniques.[43]

However, algorithms possess the capacity to not only derive fundamentally relevant information as an output from alternative data, but also to make predictions about the future investment behavior of other market participants (*order anticipation*): Examples of this are so-called 'algo-sniffing'-methods, whereby algorithms monitor substantial trading orders from other algorithms to anticipate them and profit from future price movements,[44] or so-called 'social sentiment investing', whereby algorithms can draw conclusions about future trading behavior from the communication behavior of small investors. As in the case of *Gamestop*, these conclusions were derived from posts in online stock forums.[45]

b) Privilege according to Recital 28 s. 1 MAR

Provided that the predictions in question represent the output of an AI system that is accessible exclusively to the user and has not been further disseminated, it can be classified as non-public information. Such information, if it is also precise and price-sensitive, generally fulfills the criteria for being considered inside information as outlined in Art. 7 para. 1 MAR. Both fundamental value-related information, such as sales and business figures, and trading-related information about future investment behavior can be price-sensitive. However, Recital 28 s. 1 MAR provides an important privilege: If price-sensitive non-public information is the result of research and estimates that are based on publicly available data, it should not per se be regarded as inside information. The public availability of data does not require its prior publication, as stipulated in Art. 7 Abs. 1 MAR. Information is considered to be publicly available if it can be obtained by observation by members of the public without infringing upon the rights or obligations of privacy, property or confidentiality.[46] The rationale of Recital 28 s. 1 MAR is to protect securities research and analysis based trading from the insider trading prohibition.[47] In such cases, there is no unfair information advantage relevant under insider trading law, as each investor can obtain the information either on the basis of their own abilities and research or by commissioning appropriately qualified persons. While the recitals are not incorporated into the normative part of the Regulation, they must be considered when interpreting Art. 8 MAR.

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[43] *Colesanti*, Accountable AI and Insider Trading: The Other 'Black Box' Problem, 61 Cal. W. L. Rev. 1, 6 (2024).
[44] *Cooper/Davis/Van Vliet*, The Mysterious Ethics of High-Frequency Trading, 26 Business Ethics Quarterly (2016) 1, 5.
[45] *Arnold/Russ*, Listening to the noise: On price efficiency with dynamic trading, 93 Int. Rev. Econ. & Fin. 103, 105 (2024).
[46] See the definition in *FCA*, Handbook MAR 1.2.12: "(4) whether the information can be obtained by observation by members of the public without infringing rights or obligations of privacy, property or confidentiality". Further: "For example, if a passenger on a train passing a burning factory calls his broker and tells him to sell shares in the factory's owner, the passenger will be using information which has been made public, since it is information which has been obtained by legitimate means through observation of a public event."
[47] *Gilotta*, The Regulation of Outsider Trading in EU and the US, ECFR 2016, 631, 659.

The processing of alternative data by algorithms to price-sensitive information falls under Recital 28 MAR if the data originates from publicly available sources, such as social media, stock forums or satellites. Admittedly, the power-intensive use of AI currently still incurs considerable costs, so that only a small proportion of institutional investors in particular can actually access and process substantial volumes of alternative data. However, it is not the actual availability of the data that is decisive for the privilege, but rather its legal availability.[48] Furthermore, there are now a number of professional data providers, including Eagle Alpha, IHS Market, Bloomberg and Thomson Reuters, that offer everyone real-time access to such alternative data.[49] This means that the level playing field underlying insider trading law is upheld and price-sensitive information, regardless of its relevance to the fundamental value or its trading-related nature,[50] is not subject to the insider trading ban as the output of an AI.

II. Autonomous insider trading

Accordingly, an unfair advantage that insider trading law tries to prevent, only exists if price-sensitive information enters the system as input as long as it is not yet publicly known, for example by the user entering the information himself or by the AI system independently searching the Internet (see C. I. 1.)). If algorithms learn to use such inside information for trading without being given any direct instructions to do so, the question arises as to whether and to what extent European market abuse law is sufficiently equipped to address such autonomous insider trading. The definition of insider trading within the meaning of Art. 8 para. 1 MAR requires that a natural or legal person who possesses inside information uses it to acquire or dispose of financial instruments. The terms of acquisition and disposal refer to the purchase or sale of financial instruments, such as shares or bonds.[51] The possession of information is conventionally equated with positive knowledge of a person.[52] In the case of fully autonomous trading, which will be possible in the future due to advanced AI systems, typically no human takes note of the processed input or triggers the trading order. As the AI itself has no legal personality and therefore cannot be categorised as either a natural or legal person within the meaning of Art. 3 para. 1 no. 13 MAR,[53] it is not itself an addressee of the prohibition.

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[48] *Poelzig/Dittrich*, Insider Dealing by Outsiders in the U.S. and EU, ECFR 2023, 692 (707). See also in German literature *Langenbucher/Hau/Wentz*, „Aktivistische Leerverkäufer" – eine Überlegung zur Markteffizienz und deren Grenzen im Kapitalmarktrecht, ZBB 2019, 307, 315; *Poelzig*, Shortseller-Attacken im Aufsichts- und Zivilrecht, ZHR 184 (2020), 697, 732 et seq.; Klöhn/*Klöhn* (n. 38), Art. 7 MAR mn. 347.

[49] *Montemarano* (n. 40), p. 265 et seqq.

[50] *Poelzig/Dittrich (n. 48)*, p. 692, 707; Klöhn/*Klöhn* (n. 38), Art. 7 MAR para. 345; *Bayram/Meier*, Pinging, Front Running und Quote Matching – Verbotene Handelspraktiken nach der Marktmissbrauchsverordnung?, WM 2018, 1295, 1299 et seqq.

[51] Kalss/Oppitz/Torggler/Winner/*Winner*, EU Market Abuse Regulation, 2021, Art. 8 mn. 8.044; Ventoruzzo/Mock/*Hansen* (n. 38) B.8.82 et seq.; Ebenroth/Boujong/*Poelzig* (n. 38), Art. 14 MAR mn. 15.

[52] Kalss/Oppitz/Torggler/Winner/*Winner* (n. 51), Art. 8 mn. 8.016; Ventoruzzo/Mock/*Hansen* (n. 38) B.8.147; see also Ebenroth/Boujong/*Poelzig* (n. 38), Art. 14 MAR para. 5.

[53] On the proposals to attribute legal personality to the AI de lege ferenda as an 'ePerson', see only *Teubner*, 218 AcP 155 et seqq. (2018); *Mayinger*, Die künstliche Person, 2017, p. 227 et seqq. each with further references. See also European Parliament Resolution of 16 February 2017 containing recommendations to the Commission on civil law rules on robotics (2015/2103(INL)) Refer to section 59, letter f), in which the

1. Knowledge and behaviour attribution

It is therefore debatable who should be held accountable for the knowledge possessed by AI and its behaviour. Questions concerning the attribution of knowledge and behaviour of AI systems are thoroughly discussed in German civil law – for example the attribution of tortious conduct in the case of accidents caused by autonomous driving or the attribution of knowledge in contract law. In the legal systems of other Member States, such discussions are seldom held, and knowledge is generously attributed to the user of the AI system.[54] In the present context, however, the answer must be sought in European law. According to its recitals, the objective of the MAR is to ensure that 'that all persons follow the same rules in all the Union' (Recital 5 s. 4 MAR). Therefore, the central question of which behaviour and which knowledge of the AI should be attributed to a person cannot be left to national law to answer.[55]

Unlike in the case of market manipulation (see Art. 12 para. 2 lit. c MAR; Recital 38 s. 2 MAR), the MAR does not provide any specific examples of insider trading by algorithms. Recital 38 s. 1 MAR states, however, that the MAR 'should provide measures regarding market manipulation that are capable of being adapted to new forms of trading or new strategies that may be abusive. In accordance with the meaning and purpose of the Regulation, the use of new technologies that enable autonomous trading cannot therefore exempt a company from its responsibility to comply with the applicable rules. The wording of Art. 8 para. 1 MAR is also sufficiently flexible to cover new forms of insider trading, such as autonomous insider trading. The ban on insider trading is defined 'objectively without the intention behind such dealing being referred to explicitly in its definition'.[56] Accordingly, a voluntary element and thus ethically charged discussions about the self-determination and responsibility of autonomous systems are unnecessary.

a) Acquisition or disposal of financial instruments

The MAR's definition of insider trading requires that a person directly or indirectly acquires or disposes of financial instruments. Even in Member States that adhere to the principle of separate legal effectiveness of contracts and the change in legal ownership, such as Germany, the prevailing consensus is that the MAR refers to the conclusion of a contract, from which a claim to the transfer of property results.[57] The question of which natural or legal person AI-generated

solution discussed included, among others,: 'creating a specific legal status for robots in the long run, so that at least the most sophisticated autonomous robots could be established as having the status of electronic persons responsible for making good any damage they may cause, and possibly applying electronic personality to cases where robots make autonomous decisions or otherwise interact with third parties independently'.

[54] *Annunziata* (n. 4), p. 93.

[55] Klöhn/*Klöhn* (n. 38), Art. 8 MAR mn. 86, 111.

[56] See also ECJ, 23 December 2009 – C-45/08, mn. 35 – Spector Photo Group.

[57] Kalss/Oppitz/Torggler/Winner/*Winner* (n. 51), Art. 8 mn. 8.045; specifically for German law see also Assmann/Schneider/Mülbert/*Assmann*, Wertpapierhandelsrecht, 8th ed. 2023, Art. 8 MAR mn. 18; Fuchs/Zimmermann/*Jakovou*, Wertpapierhandelsrecht, 3rd ed. 2024, Art. 8 MAR mn. 55;

transactions are to be attributed to cannot possibly be answered based on the national law of the Member States, but solely on the provisions of the MAR.[58] Conversely, this principle is derived from Art. 9 para. 1 MAR, which grants legal entities a compliance defence through the implementation of appropriate and effective measures to prevent insider trading by natural persons. The transactions of natural persons are the responsibility of the legal entity, as long as the natural person acts in their organisational area and 'on behalf of' the legal entity (see also Recital 30 s. 3 MAR).[59] However, this principle is equally applicable in the context of an autonomous AI system acting instead of an employee. The natural or legal person who uses the autonomous AI in their organisational area must therefore permit the attribution of algorithmic trading orders to them.

b) Possession of inside information

This line of reasoning can also be applied if an individual possesses inside information that is input to an AI but remains unnoticed by the individual. The ECJ's case law and the wording of its rulings permit the functional application of AI trading systems in order to take account of changing technical and economic circumstances (see recital 38, sentence 1 MAR). This is because in various language versions Art. 8 MAR does not explicitly use the phrase 'knows' or 'ought to know' in para. 1 — unlike as in para. 4 — but instead refers to the 'possession' of an inside information. According to the text's precise wording, the subjective knowledge of the information by an individual is not necessarily required.
However, the sufficiency of mere availability of information, for example via big data, is questionable in the context of an AI's possession of inside information. It is imperative to ascertain whether the information must have been received as input for the AI to be considered as having a sufficient understanding of the subject matter. The ECJ's Spector Photo Group decision established the foundation for the codification of the ban on insider trading in Art. 8 MAR. In this decision, the presumption of the use of inside information possessed by an individual is based on the fact that, in view of its particular importance, this information is generally regarded as an integral part of the decision-making process for the conclusion of transactions.[60] When using an AI, inside information can only become an integral part of the decision-making process if it is used as input by the AI.[61] The mere availability of inside information is therefore not sufficient. In scenarios where the input is provided by an individual, the possession of inside information is not in doubt, as the individual had prior possession of the information itself. Conversely, inside information utilized by the AI as input, which is a search

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Meyer/Veil/Rönnau/*Veil*, Handbuch zum Marktmissbrauchsrecht, 2nd ed. 2023, § 7 mn. 27; Schwark/Zimmer/*Kumpan/Schmidt*, Kapitalmarktrechts-Kommentar, 5th ed. 2020, Art. 8 MAR mn. 36; BeckOK WpHR/*Nietsch*, Werpapierhandelsrecht, 14. Edition, Status: 1.1.2025, Art. 8 MAR mn. 9 et seq.; Ebenroth/Boujong/*Poelzig* (n. 38), MAR Art. 8–14 mn. 15.

[58] Klöhn/*Klöhn* (n. 38), Art. 8 MAR mn. 86; Schwark/Zimmer/*Kumpan/Schmidt* (n. 57), Art. 8 MAR mn. 50.

[59] Fuchs/Zimmermann/*Poelzig/Dittrich* (n. 57), Art. 9 MAR mn. 30; Kalss/Oppitz/Torggler/Winner/*Winner* (n. 51), Art. 9 mn. 9.011.

[60] ECJ, 23 December 2009 – C-45/08, mn. 36 – Spector Photo Group.

[61] Klöhn/*Klöhn* (n. 38), Art. 8 MAR mn. 97.

performed by the AI and, consequently, as an integral component of the algorithmic decision-making process must be attributed to the user of the AI. This is due to the fact that the transactions of the AI are also attributed to the user as a result of the decision-making process (see C. II. 1. a)). Consequently, in the context of autonomous insider trading, the "knowledge" and the "trading" by the AI are attributable to the individual who utilizes them within their organizational domain with full responsibility

2. Use of inside information and 'compliance by design' defence

a) Rebuttable presumption

According to Art. 8 MAR, the insider must also have used the inside information for the transaction. The inside information must therefore have been causal for the investment decision.[62] However, the decision-making process of self-learning AI systems differs from human decisions. AI systems make decisions based on probabilities and patterns: If certain information in the past, such as the takeover of a company or the development of life-saving drugs, has regularly led to a rise in the share price, the AI assumes that, given the relevant inside information, a rise in the price of the shares concerned is also predominantly likely to be expected this time. Thus, AI systems function on the basis of correlations rather than causal relationships.[63]

The MAR establishes a rebuttable presumption that the possession of inside information was causal for the acquisition or sale, i.e. that it was 'used' in the meaning of Art. 8 para. 1 MAR. But since the person who deploys AI systems within their organisation is typically unable to retrace the decision-making process in retrospect due to its 'black box'-nature (see B. I. 2. b)), they will hardly ever be able to rebut the presumption. This would effectively rule out the use of particularly powerful AI systems in association with big data. In view of the potential possibility of unlimited access to price-sensitive information, which is not publicly known, for example in social media, the risk of insider offences would be significant in view of the drastic penalties under criminal and administrative sanction law.

b) Application of Art. 9 para. 1 MAR to the use of AI by legal entities

In order to avoid disincentivizing market actors from leveraging AI for the benefit of the market, it may be advisable to consider an exemption to the insider trading prohibition for specific applications of AI. In Art. 9 MAR, the European legislator categorized several cases of so-called 'legitimate actions' which serve the functioning of the capital market and are therefore not

[62] BaFin, Issuer Guidelines — Module C, I.4.2.5.2.2; Assmann/Schneider/Mülbert/*Assmann* (n. 57), Art. 8 MAR mn. 31; Klöhn/*Klöhn* (n. 38), Art. 8 MAR mn. 119; Meyer/Veil/Rönnau/*Veil* (n. 57), § 7 mn. 38; Ventoruzzo/Mock/*Hansen* (n. 38) B.8.71.

[63] *Hildebrandt*, Smart Technologies and the End(s) of Law, 2016, pp. 37 et seqq.; *Wall*, Some financial regulatory implications of artificial intelligence, 100 J. Econ. Bus. 55, 60 (2018); *Selbst/Barocas*, The Intuitive Appeal of Explainable Machines, 87 Fordham L. Rev. 1085, 1097 et seq. (2018); *Brandstetter*, Nicht ohne Grund!, *MPG*, 4 October 2021, available at https://www.mpg.de/17651253/ki-kausalitaet.

considered to be a violation of the insider trading prohibition even in instances where the relevant person possessed inside information during the course of trading in financial instruments.[64] Even if there is no specific regulation for algorithmic trading, Art. 9 para. 1 MAR provides for a precedent. Accordingly, legal entities that employ natural persons for trading in financial instruments and are, in principle, responsible for their insider violations can rely on a compliance defence. This privilege requires that the legal entity has taken appropriate organisational measures to ensure that the natural person does not obtain inside information, for example by erecting information barriers such as ethical walls.[65] If, despite appropriate organisational precautions by the legal entity, insider trading is nevertheless carried out by persons employed by it, the transaction cannot be attributed under Art. 9 para. 1 MAR (see Recital 30 s. 3).[66] Consequently, the determination of insider trading by legal persons is not contingent upon the subjective knowledge of a natural person within the company, which would be challenging to prove, but rather on the objectively verifiable control measures of the legal person.[67] The legal entity in question is not held liable – irrespective of whether and when an executive body or employee acts with knowledge of inside information – provided that the appropriate organisational precautions have been implemented.

The compliance defence available to legal entities under Art. 9 para. 1 MAR in the event of insider trading violations by employees can be applied to the use of AI systems through teleological extension. The provision is designed to mitigate the broad consequences of imputing individual conduct within legal entities[68] and to incentivize the implementation of effective organisational measures to prevent insider trading. This rationale is particularly relevant for legal entities that contribute significantly to market liquidity, such as credit institutions and institutional investors. Art. 9 para. 1 MAR enables such entities to continue trading even if inside information is held elsewhere within their organisation,[69] provided adequate compliance structures are in place. In practice, the use of AI systems by legal entities is typically mediated through natural persons — such as employees who input data or configure trading algorithms. Any potential misconduct by

[64] Ventoruzzo/Mock/*Hansen* (n. 38) B.9.15; Fuchs/Zimmermann/*Poelzig/Dittrich* (n. 57), Art. 9 MAR mn. 16.
[65] Kalss/Oppitz/Torggler/Winner/*Winner* (n. 51), Art. 9 mn. 9.015; Fuchs/Zimmermann/*Poelzig/Dittrich* (n. 57), Art. 9 MAR mns. 42 et seqq.
[66] Fuchs/Zimmermann/*Poelzig/Dittrich* (n. 57), Art. 9 MAR mn. 42 et seqq. According to another widely held view in the literature, the causality of knowledge of the inside information for the purchase or sale transaction does not apply or the attribution of knowledge is not possible if the requirements of Art. 9 para. 1 MAR are met (*Klöhn*, Die (Ir-)Relevanz der Wissenszurechnung im neuen Recht der Ad-hoc-Publizität und des Insiderhandelsverbots, NZG 2017, 1285 (1290); Meyer/Veil/Rönnau/*Veil* (n. 57), § 7 mn. 54; Schwark/Zimmer/*Kumpan/Schmidt* (n. 57), Art. 9 MAR mn. 14; BeckOK WpHR/*Nietsch* (n. 57), Art. 9 MAR mn. 8).
[67] Klöhn/*Klöhn* (n. 38), Art. 9 MAR mn. 9; Fuchs/Zimmermann/*Poelzig/Dittrich* (n. 57), Art. 9 MAR mn. 38. Similar Kalss/Oppitz/Torggler/Winner/*Winner* (n. 51), Art. 9 mn. 9.028.
[68] Fuchs/Zimmermann/*Poelzig/Dittrich* (n. 57), Art. 9 MAR mn. 33; see also Ventoruzzo/Mock/*Hansen* (n. 38) B.9.25.
[69] On the meaning and purpose of Art. 9 para. 1 MAR Ventoruzzo/Mock/*Hansen* (n. 38) B.9.26; see also Fuchs/Zimmermann/*Poelzig/Dittrich* (n. 57), Art. 9 MAR mn. 32 et seqq. Further *Klöhn*, Die Regelung legitimer Handlungen im neuen Insiderrecht (Art. 9 MAR), ZBB 2017, 261, 264.

an AI system is thus first attributable to the natural person who deployed or configured the system, and only subsequently to the legal entity via standard attribution principles. Accordingly, for the privilege of Art. 9 para. 1 MAR for legal entities it is irrelevant whether the natural person makes a trading decision directly or through an AI system. In both cases, the legal entity has no direct influence on the specific decision. Therefore, the same compliance defence should apply— namely, that the legal entity can avoid liability if it has taken appropriate organisational measures tailored to the use of AI systems. Such measures may include internal policies governing AI use, restricting the access of the AI system to sensixtive data that is being stored in internal servers or cloud environments, and targeted training for employees interacting with the AI. As long as these safeguards are in place, legal entities should remain free to utilize AI systems in trading. This is not only consistent with the logic of Art. 9 para. 1 MAR but also beneficial for capital markets as legal entities can continue their trading activities by using AI and thus enhancing market liquidity and information efficiency (see B.I.2.b)).

c) Analogous application of Art. 9 para. 1 MAR to the use of AI by natural persons

In the event of insider trading violations involving AI systems, Art. 9 para. 1 MAR cannot be applied directly to the natural persons operating the AI in the course of their employment. This leads to an imbalance: while the legal entity may exculpate itself through appropriate organisational measures, the individual employee could remain liable without the possibility to rebut the presumption of using inside information. Given the opaque, 'black box' nature of AI, proving non-causality is often practically impossible. This outcome is not only unsatisfactory but also conflicts with Recital 24 sent. 3 MAR, which calls for equal treatment of all investors— natural and legal persons alike.[70] Moreover, heightened insider risk associated with AI use creates a disincentive for individuals to employ such systems, potentially placing them at a technical and informational disadvantage compared to legal entities. Given the apparent reglatory gap and the comparable interests involved, the exculpation rule in Art. 9 para. 1 MAR can, however, be applied analogously[71] to natural persons. It is possible to draw an analogy despite the fact that insider trading is subject to criminal penalties and fines, even considering the principle of certainty in accordance with Art. 49 CFR, as it is an analogy in favour of the insider. Since the European legislator had automated trading by algorithms in mind when

[70] The English version of the MAR – "This Regulation will require that all persons follow the same rules in all the Union." – clarifies that Recital 5 merely serves the purpose of emphasizing the Regulation's harmonization objective. It does not mandate equal treatment of legal and natural persons. This interpretation is supported by the Spanish, Portuguese, and French versions, all of which use the neutral term "person" without distinguishing between legal and natural persons. However, in the German version of Recital 5 sentence 4 MAR, the text states: „Diese Verordnung wird zur Folge haben, dass in der gesamten Union alle natürlichen und juristischen Personen die gleichen Regeln zu befolgen haben." This wording could be interpreted as pursuing the objective of subjecting legal and natural persons to the same rules.

[71] On the formation of analogies in European law ECJ, 30 January 1974 –159/73, ECLI:EU:C:1974:9 – Hannoversche Zucker AG /Hauptzollamt Hannover; ECJ, 12 December 1985 – 165/84, ECLI:EU:C:1985:507 – Krohn/BALM; also: ECJ, 11 November 2010 – C-152/09, ECLI:EU:C:2010:671, mn. 41 – Grootes/Amt für Landwirtschaft Parchim. Further *Langenbucher*, Argument by Analogy in European Law, 57 Camb. L. J. 481 (1998).

adopting the MAR, but not yet the advanced possibilities of autonomous trading with the help of AI and big data and the resulting risks of insider trading (see B. II. 1.), there is an unintended regulatory gap. In addition, the interests underlying Art. 9 para. 1 MAR are comparable to autonomous trading: when a legal entity delegates trading decisions to an independently acting natural person, it relinquishes control not only over the final decision but also over the upstream processing of information. Insider trading committed autonomously by a natural person as delegate should not be attributed to the legal entity if it has implemented reasonable organisational safeguards. A nearly identical situation arises when a natural person uses an AI system that independently processes information and executes trades. In both cases, the decision lies beyond the immediate control of the delegating person. Consequently, the presumption of use should be rebutted if a natural person uses an AI system and has taken all reasonable measures to prevent insider trading.

d) Implications for the application

In order to achieve an appropriate balance between responsibility for and openness to innovation, according to Art. 9 para. 1 MAR (analogous), those persons who use autonomous AI systems for securities trading should be exempted from any further obligations beyond implementing the reasonable technical efforts to prevent insider trading. Accordingly, technical measures are required that can reasonably be expected, taking into account the state of the art, the risk and imminent extent of insider offences and the necessary expenditure (see also Art. 25 GDPR).[72] Since an advantage relevant under insider trading law, taking into account the fundamental principle of equal treatment of information, results primarily from the fact that inside information enters the AI as input and is processed, but not that it is generated as output on the basis of publicly available information (see C. I.), it must be ruled out 'by design' that inside information is processed as input. If autonomous insider trading by the AI occurs despite the implementation of adequate technical precautions, there is no violation of the prohibition of insider trading by the user because he can make use of a 'compliance by design' defence in accordance with Art. 9 para. 1 MAR (applied analogously). If insufficient technical precautions were taken, autonomous insider trading is attributable to the user. In the context of proceedings concerning insider trading involving the utilization of AI systems, the crux of the matter is not the processing of inside information as input by the AI, which is difficult to prove, but rather whether the legal or natural person has implemented adequate technical precautions to prevent autonomous insider trading.

III. Enforcement of the insider trading ban

Although the MAR already covers 'autonomous insider trading' and ensures that respective violations can be attributed to the person who uses the AI system within their organisation, significant challenges arise, particularly in enforcing the ban on insider trading.

[72] See generally to Art. 9 para. 1 MAR *Klöhn* (n. 66), p. 265.

1. *Ex-post* enforcement

Enforcement of the ban on insider trading is primarily predicated on administrative and criminal law measures and sanctions pursuant to Art. 30 ff. MAR; Art. 3 ff. CRIM-MAD (*public enforcement*), which are linked ex-post to offences committed.[73] As algorithms become increasingly autonomous and the flood of data continues to rise, the already difficult task of detecting insider trading will become even more complex and time-consuming in the future.[74] To this end, the use of AI by the supervisory authorities themselves (*SupTech*) will be essential for detecting violations and ensuring effective supervision.[75] The utilization of AI has the potential to improve detection of anomalies[76] that may indicate market abuse.[77] While traditional supervisory methods are limited to detecting offences that have already occurred, AI – in conjunction with big data – also makes it possible to predict offences in advance.[78] Both the German BaFin and other EU supervisory authorities are therefore already developing and testing the use of AI, in particular to detect insider offences.[79] Beyond mere detection, AI can even be used to issue decisions.[80] However, it will also be important in the future to utilise and exploit the advantages of AI to enhance the efficacy of supervision without transgressing legal boundaries. For instance, the ECJ has noted that AI systems — particularly deep learning models — function as 'black boxes' that lack traceability and thus make it difficult to determine the

[73] Claims for damages due to insider trading are conceivable at best in exceptional cases, to that extent Ebenroth/Boujong/*Poelzig* (n. 38), Art. 14 MAR mn. 73 et seqq.

[74] *Sadaf/McCullagh/Sheehan/Grey/King/Cunneen*, Algorithmic Trading, High-frequency Trading: Implications for MiFID II and Market Abuse Regulation (MAR) in the EU, 15 May 2021, p. 16, available at https://ssrn.com/abstract=3846814.

[75] On the positive experiences in the USA *Ehret*, SEC's advanced data analytics helps detect even the smallest illicit market activity, *Reuters*, 30 June 2017, available at https://www.reuters.com/article/bc-finreg-data-analytics/secs-advanced-data-analytics-helps-detect-even-the-smallest-illicit-market-activity-idUSKBN19L28C/. On the potential possibilities *Grimm*, Das Insiderhandelsverbot zwischen Rechtstheorie und Rechtspraxis, 2022, p. 395 et seqq.; *James/Leung/Prokhorov*, J. Bank. Fin. 148 (2023) 106735.

[76] *Chandola/Banerjee/Kumar*, Anomaly detection: A survey, 41 CSUR 1 (2009).

[77] *Annunziata* (n. 4), p. 170.

[78] *Letta*, Much More than a Market ('Letta-Report'), April 2024, p. 128.

[79] See particularly on BaFin's automated alarm and market monitoring system ('ALMA') *Hufeld*, Künstliche Intelligenz – Eine Revolution in der öffentlichen Verwaltung, 3 January 2020 available at https://www.bafin.de/SharedDocs/Veroeffentlichungen/DE/RedenInterviews/re_191127_3-Public-Sector-Roundtable_P.html. A similar situation applies to the Italian *Consob*, Italy's Consob tests AI for market supervision, insider trading detection, *Reuters*, 25 June 2024, available at https://www.reuters.com/technology/artificial-intelligence/italys-consob-tests-ai-market-supervision-insider-trading-detection-2024-06-25/. While the European supervisory authorities are still testing AI models, the Australian supervisory authority has been using sophisticated data analyses with Market Analysis Intelligence (MAI) since 2013 to identify suspicious trading in real time and across markets and uncover insider trading on a larger scale (*ASIC*, ASIC's next generation market surveillance system commences, , 25 November 2013, available at https://asic.gov.au/about-asic/news-centre/find-a-media-release/2013-releases/13-316mr-asic-s-next-generation-market-surveillance-system-commences/).

[80] The German administrative law, for instance, already permits fully automated administrative acts *de lege lata*, which do not require human intervention. See sec. 35a VwVfG.

rationale behind infringements on fundamental rights. As a result, these models may potentially contravene with the right to an effective judicial remedy under Art. 47 CFR.[81]

Even if autonomous insider trading can be detected by AI systems, the challenge is to prove the necessary culpability for the sanctioning under criminal or fine law (see sec. 119 para. 3 WpHG and sec. 120 para. 14 WpHG). As far as human actors are unable to predict the investment decisions as the output of autonomous AI systems due to their black box character, they may not be given the right to make decisions with regard to the presumption of innocence pursuant to Art. 48 CFR[82], so that neither intent nor negligence or recklessness can be proven.[83]

2. Ex-ante enforcement

This further underscores the importance of the existing organizational duties for algorithmic securities trading under MiFID II and sec. 80 WpHG, which require ex-ante measures to prevent trading systems from being used to violate market abuse laws (sec. 80 para. 2 s. 3 no. 3 WpHG). However, these requirements have thus far been centered on automated trading systems with algorithms based on the 'if-then' principle (see B. II. 1.) and must be adapted and specified for the special features of autonomous trading systems.[84] The provisions for high-risk AI systems in Art. 8 et seqq. AI Regulation can provide respective guidance. The categorisation as a high-risk AI system is primarily intended to safeguard 'public interests with regard to health, safety and fundamental rights' (Recital 7 AI Regulation). However, algorithmic trading was initially considered high-risk before the regulation was introduced but was ultimately not classified as a high-risk AI system due to the existing capital market rules (see B. II. 2.). The extensive catalogue of requirements for high-risk AI systems pursuant to Art. 8 et seqq. AI Regulation includes, in particular, the duty to implement a risk management system (Art. 9 AI Regulation); requirements for the training, validation and test data sets used (Art. 10 AI Regulation) as well as documentation, recording and transparency duties (Art. 11 to 13 AI Regulation). Above all, however, it must be ensured in accordance with Art. 14 AI Regulation that the risks to the protected public interests are minimised through human supervision when using high-risk AI systems ('human-in-the-loop').

[81] ECJ, 21 June 2022 – C-817/19, mn. 194 et seq. – Ligue des droits humains/Conseil des ministers. = EuZW 2022, 706.
[82] On the classification of administrative sanctions for market abuse as penalties see ECtHR, 4 March 2014 – 18640/10, 18647/10, 18663/10, 18668/10 and 18698/10 – Grande Stevens and Others/Italy = BeckRS 2014, 21796 mn. 22. For antitrust law already EGMR, 27 September 2011 – 43509/08 – A. Menarini Diagnostics S.R.L./Italy = BeckRS 2012, 80668. Cf. also Ebenroth/Boujong/*Poelzig* (n. 38), Vor Art. 1 MAR mn. 25; Assmann/Schneider/Mülbert/*Spoerr* (n. 57), sec. 120 WpHG mn. 424 et seqq.
[83] *Annunziata* (n. 4), p. 155; *Consulich/Maugeri/Milia/Poli/Trovatore* (n. 4), pp. 75 et seqq.
[84] *Ringe/Azzutti/Stiehl* (n. 24), p. 351 et seqq.; more general also *Azzutti/Ringe/Stiehl* (n. 4), p. 115.

D. AI and the public disclosure of inside information

AI and big data used in trading do not only pose risks but also create opportunities to enhance information efficiency in capital markets, as they can identify and generate price-sensitive information on an unprecedented scale.

I. Use of AI by the issuer

A potentiel field of application could be issuers disclosure obligations —primarily the obligation to disclose price-sensitive information pursuant to Art. 17 MAR.[85] It is questionable if issuers are entitled or even obligated to use AI systems to fulfill their ad hoc disclosure obligations. According to a recent study, two thirds of the surveyed companies already use AI systems in financial communication.[86] Currently, AI applications are mainly limited to translations as well as language and text analysis. But AI systems also have the potential to generate forecasts or detect patterns indicating imminent regulatory breaches – which could constitute price-sensitive inside information according to Art. 7 para. 1 MAR[87] – in real time.

1. The right to use AI

When assessing the extent to which issuers can utilize AI, it is important to differentiate between the phases of ad hoc disclosure. A complete delegation of compliance, including the decision to defer or disclose information, is legally precluded under capital markets law. While, according to the prevailing opinion, postponing disclosure under Art. 17 para. 4 MAR does not require a formal resolution with the mandatory involvement of a board member, the decision remains the issuer's own responsibility.[88] Additionally, for the notification of delayed disclosure under Art. 17 para. 4 subpara. 4 s. 3 MAR, as well as the disclosure of inside information, the identity of the responsible person must be provided pursuant to Art. 2 para. 1 subpara. 2 lit. b) and Art. 4 para. 1 lit. b) Implementing Regulation (EU) 2016/1055. This implies that the notification of the delay and the disclosure cannot be carried out autonomously by an AI system without human involvement. In contrast, there are no legal objections to the preliminary use of AI, such as for searching, identifying, or analyzing inside information.

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[85] On this *Klöhn*, Wertpapierhandelsrecht diesseits und jenseits des Informationsparadigmas, 177 ZHR 349, 350 et seqq. (2013).

[86] Study by EY and DIRK, Artificial intelligence in financial communications and disclosure, 2 July 2024, available at https://www.dirk.org/veranstaltungen/dirk-konferenz/#inpage-target-3; *Steinbach*, KI macht vor der Finanzkommunikation nicht halt, *Börsen-Zeitung*, 29 June 2024, p. 2.

[87] Ebenroth/Boujong/*Poelzig* (n. 38), Art. 7 MAR mn. 47; Klöhn/*Klöhn* (n. 38), Art. 7 MAR mn. 406 et seq.; *Klöhn/Schmolke*, Der Aufschub der Ad-hoc-Publizität nach Art. 17 Abs. 4 MAR zum Schutz der Unternehmensreputation, ZGR 2016, 866, 868 et seqq.; *Thelen*, Schlechte Post in eigener Sache: Die Pflicht des Emittenten zur Ad-hoc-Mitteilung potentieller Gesetzesverstöße, 182 ZHR 62, 69 et seqq. (2018).

[88] Ventoruzzo/Mock/*Pietrancosta* (n. 38) B.17.73. For the broad discussion in Germany see also Ellenberger/Bunte/*Hopt/Kumpan*, Bankrechts-Handbuch, 6th ed. 2022, § 86 mn. 151; Klöhn/*Klöhn* (n. 38), Art. 17 MAR mn. 191 et seq.; Schwark/Zimmer/*Kumpan/Schmidt* (n. 57), Art. 17 MAR mn. 280; Fuchs/*Pfüller*, Wertpapierhandelsgesetz, 2nd ed. 2016, sec. 15 WpHG mn. 421; Ebenroth/Boujong/*Poelzig* (n. 38), Art. 17 MAR mn. 56 et seq.

2. Duty to use AI?

It is questionable whether the right to make preparatory use of AI systems can even evolve into a corresponding duty on the part of the issuer.[89]

a) Disclosure obligation dependent on knowledge vs. independent of knowledge

Ultimately, the answer to this question depends on one's position on the controversial debate held in Germany of whether the ad hoc disclosure obligation under Art. 17 para. 1 MAR arises only when the issuer becomes aware of the information,[90] or whether it arises independently of this, with the objective existence of inside information directly concerning the issuer.[91] The discourse surrounding these issues arises from the German translation of the MAR, which employs the term "unverzüglich." This term is also utilized in civil law, where it is delineated by a rule as "without culpable hesitation." To the best of our knowledge, a similar debate is not held in other Member States, and it is in turn primarily relevant for issuers operating within Germany's jurisdiction. If the ad hoc disclosure obligation is only triggered when the inside information is positively known by the issuer,[92] the use of AI is not required on the basis of Art. 17 para. 1 MAR.

aa) No unwritten knowledge requirement

The wording of Art. 17 para. 1 MAR does not advocate for a knowledge requirement though: While the insider offences, in particular Art. 8 para. 1 MAR, expressly require that a person possesses inside information (see C. II. 1.), there is no corresponding wording in Art. 17 para. 1 MAR. An

[89] The obligation of the issuer to use AI must be separated from any internal obligation of the management towards the company. On this very question in U.S. corporate law see *Zhao*, Artificial Intelligence and Corporate Decisions: Fantasy, Reality or Artificial Intelligence and Corporate Decisions: Fantasy, Reality or Destiny, 71 Cath. U. L. Rev. 663 (2022); specifically on the interplay of AI and the Business Judgment Rule *Helleringer/Möslein*, AI & The Business Judgment Rule: Heightened Information Duty, The University of Chicago Law Review Online (available at https://lawreview.uchicago.edu/online-archive/ai-business-judgment-rule-heightened-information-duty).

[90] In particular Assmann/Schneider/Mülbert/*Assmann* (n. 57), Art. 17 MAR mn. 50 et seqq.; BeckOK WpHR/*Buck-Heeb* (n. 57), Art. 17 MAR mn. 123; *Koch*, Die Ad-hoc-Publizität: Veröffentlichungs- oder Wissensorganisationspflicht?, AG 2019, 273, 276; *Koch*, Ad-Hoc-Pflicht: Knowledge statt Knowledge Governance, AG 2024, 97, 102 et seqq.; *Nietsch*, Emittentenwissen, Wissenszurechnung und Ad-hoc-Publizitätspflicht, ZIP 2018, 1421, 1424 et seqq.; similarly *Ihrig*, Wissenszurechnung im Kapitalmarktrecht – untersucht anhand der Pflicht zur Ad-hoc-Publizität gemäß Art. 17 MAR, 181 ZHR 381, 382 et seqq. (2017).

[91] *Bekritsky*, Wissen und Ad-hoc-Publizität, 2022, p. 276 et seqq.; *Breuer*, Wissen, Zurechnung und Ad-hoc-Publizität, 2020, p. 38 et seq.; *Denga*, Zurechnung, 2022, p. 253 et seq.; Assmann/Schneider/Mülbert/*Hellgardt* (n. 57), secs. 97, 98 WpHG mn. 89; *Hopt/Kumpan*, Insidergeschäfte und Ad-hoc-Publizität bei M&A, ZGR 2017, 765, 782; Klöhn/*Klöhn* (n. 38), Art. 17 MAR mn. 112 et seqq.; *Klöhn* (n. 66), p. 1289; Schwark/Zimmer/*Kumpan/Grütze* (n. 57), Art. 17 MAR mn. 85 et seqq.; *Kumpan/Misterek*, Ad-hoc-Publizität und Emittentenhaftung bei Konzern- und Beteiligungsverhältnissen, AG 2023, 633, 637; *Neumann*, Wissenszurechnung bei juristischen Personen nach der Reform der Ad-hoc-Publizität und des Insiderhandels durch die MAR, 2020, pp. 108 et seqq.; Ebenroth/Boujong/*Poelzig* (n. 38), Art. 17 mn. 31; *Thomale*, Kapitalmarktinformationshaftung ohne Vorstandswissen, NZG 2018, 1007, 1008 et seq.

[92] Particularly so *Koch* (n. 90), AG 2024, 97, 106 et seqq.

unwritten knowledge requirement is justified primarily by the fact that nothing impossible can be demanded of the issuer ('ultra posse nemo obligatur').[93]

But even without an unwritten knowledge requirement Art. 17 para. 1 MAR does not require the impossible, since the issuer is not obliged to publish the inside information as soon as it comes into existence, but rather without delay and therefore 'as soon as possible'.[94] Publication is therefore not considered compliant if it does not occur by the time the inside information could have been disclosed objectively, had the organization been properly managed.[95] In order to be able to fulfil the ad hoc disclosure obligation without delay, the issuer must organise itself in a way that inside information directly affecting the issuer can be identified, analysed, passed on and disclosed. This aligns with the view of BaFin, which holds that the issuer 'must take all necessary and reasonable organizational measures and precautions to ensure compliance with the requirement of immediacy'.[96] ESMA also assumes that issuers who do not maintain a sufficient knowledge organisation run the risk of violating the obligation to publish without delay.[97] Finally, this also corresponds to the supervisory practice of other Member State authorities, which recommend organisational measures for the identification and management of inside information in their non-binding guidelines.[98] Art. 17 para. 1 MAR implicitly requires the issuer to take measures for knowledge management in order to fulfill their ad hoc disclosure obligations. Knowledge management, therefore, does not constitute a 'true' legal duty, which could be enforced through legal action or sanctioned in case of non-compliance.[99] A violation thus only leads to sanctions if the publication is omitted, delayed or incorrect due to a lack of sufficient knowledge organisation.

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[93] *Ihrig* (n. 90), p. 385; Assmann/Schneider/Mülbert/*Assmann* (n. 57), Art. 17 MAR mn. 50 n. 1; BeckOK WpHR/*Buck-Heeb* (n. 57), Art. 17 MAR mn. 122; *Koch* (n. 90), AG 2024, 97, 104. On the former version of sec. 15 WpHG OLG Stuttgart, 29 March 2023 – 20 Kap 3/17.

[94] Ventoruzzo/Mock/*Ventoruzzo/Picciau* (n. 38) B.7.87.

[95] *BaFin*, Issuer Guidelines — Modul C, I.3.4.; Klöhn/*Klöhn* (n. 38), Art. 17 MAR mn. 116; Ebenroth/Boujong/*Poelzig* (n. 38), Art. 17 MAR mn. 32; *Blassl*, Ad-hoc-Compliance: Informationsorganisationspflichten von Emittenten, 2022, p. 111; *Klöhn*, Ad-hoc-Publizität und Insiderverbot im neuen Marktmissbrauchsrecht, AG 2016, 423, 430; *Kumpan*, Ad-hoc-Publizität nach der Marktmissbrauchsverordnung, DB 2016, 2039, 2042 f.

[96] *BaFin*, Issuer Guidelines – Module C, I.3.4.

[97] *ESMA*, Final Report – MAR Review, 23 September 2020, ESMA70-156-2391, mn. 234: '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.'; *Denga* (n. 91), pp. 251, 254; *Nietsch*, Zur Haftung für fehlerhafte Sekundärmarktinformation im Lichte der Hypo Real Estate-Entscheidung des BGH, ZBB 2021, 229, 240. See also *Gutekunst*, Die Ad-hoc-Publizität nach Artikel 17 MAR unter Berücksichtigung der kapitalmarktrechtlichen Compliance-Perspektive, 2021, passim.

[98] See for the detailed specifications of the italian supervisory authority *Consob*, Linee Guida - Gestione delle informazioni privilegiate, October 2017, p. 13, available at https://www.consob.it/documents/1912911/1987745/LG_Gest_Inf_Priv_20171013.pdf. For further evidence *Annunziata* (n. 4), p. 76 et seqq.

[99] *Neumann* (n. 91), p. 153.

bb) No modification by the Listing Act

The Listing Act (Regulation (EU) 2024/2809)[100], which recently came into force, does not modify this legal situation: Recital 67 s. 8 Listing Act states that in the case of 'non-protracted processes related to a one-off event or set of circumstances, notably when the occurrence of that event or set of circumstances does not depend on the issuer, the disclosure should take place as soon as the issuer becomes aware of that event or set of circumstances'.[101] This suggests that the purpose of this passage was to add a knowledge requirement for the ad hoc disclosure obligation, through the process of clarification.[102] However, the wording of the recital is explicitly limited to non-protracted processes involving a one-time event, the occurrence of which does not depend on the issuer itself. Furthermore — especially in the case of protracted events — the issuer is required, according to Recital 67 s. 5 MAR, to disclose the (final) event 'as soon as possible after the occurrence'. If one takes the recital literally, the disclosure obligation for non-protracted events would be knowledge-dependent, whereas for protracted events, it would be knowledge-independent. However, there are no substantive reasons for such a differentiation. Therefore, protracted and non-protracted events should be treated uniformly with regard to the knowledge requirement. The Listing Act's history suggests that the disclosure obligation arises independently of knowledge. In the context of the Listing Act, ESMA had considered whether and to what extent Art. 17 MAR should be supplemented with an organizational obligation for issuers to establish appropriate systems and controls for the detection, handling, and disclosure of inside information.[103] ESMA rejected a written rule regarding the knowledge organisation on the grounds that a corresponding obligation is already sufficiently clearly expressed in the wording of Art. 17 MAR ('as soon as possible').[104] However, the question of knowledge being a requirement for the disclosure obligation was never the subject of the legislative process.[105] Therefore, even after the enactment of the Listing Act, the disclosure obligation remains knowledge-independent, and must be fulfilled without delay—that is, as soon as possible, given adequate knowledge management.

b) Necessity and reasonableness of the use of AI

If one rejects an (unwritten) knowledge requirement and instead demands an adequate knowledge management system for the immediacy of disclosure, the obligation to use AI systems depends on whether such use is considered part of the necessary and reasonable

[100] 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 November 2024.

[101] Recital 60: 'In the case of non-protracted processes related to a one-off event or set of circumstances, notably when the occurrence of that event or set of circumstances does not depend on the issuer, the disclosure should take place as soon as the issuer becomes aware of that event or set of circumstances.'.

[102] *Koch* (n. 90), AG 2024, 97 mn. 46 et seqq.; likewise *Kührt/Schreiber*, Der neue EU-Listing-Act und die Ad-hoc-Publizität, BKR 2023, 351 mn. 15.

[103] ESMA (n. 97), mn. 231 et seqq.

[104] ESMA (n. 97), mn. 234.

[105] *Veil/Wiesner/Reichert*, Ad Hoc Disclosure under the EU Listing Act, AG 2023, 57 mn. 65.

organizational measures. Since the issuer is subject to the ad hoc disclosure obligation as the 'least cost information provider',[106] the use of AI can only be required on the basis of a cost-benefit analysis to the extent that the additional costs for the issuer are lower than the additional benefit for the market.[107] While the issuer generally has no comparative cost advantage over other market participants in the case of information external to the company,[108] the reasonableness of the use of AI systems for disclosure of internal company information depends on the circumstances of the individual case. The higher the price relevance of the information and, consequently, the market's interest in the information, and the more superior and cost-effective the technical capabilities are compared to human abilities — especially in the case of data volumes that can no longer be managed manually — the more justified the use of AI becomes.

II. Significance of deep fakes

Deep fakes, i.e. image, sound or video content generated or manipulated by AI that resembles real people and would falsely appear to a person to be genuine or truthful, poses a significant risk to capital market-oriented companies (see Art. 3 para. 1 no. 60 of the AI Regulation).[109] For example, with the help of generative AI, it is possible to create and disseminate fake video messages of an issuers board member by imitating facial expressions and gestures by exchanging faces (face swap), synchronising lip movements with an audio file (lip sync) and imitating voices (voice cloning). Short sellers, for example, could use this for a short-seller attack by disseminating deceptively real-looking statements from the CEO of a listed company about the company's financial difficulties in order to manipulate the share price.[110] Such erroneous capital market information disseminated via the internet is prohibited as market manipulation under Art. 12 para. 1 lit. c) MAR and is in Germany punishable under sec. 119 para. 1 WpHG in cases of intent.[111] It is, however, questionable whether this can also result in an ad hoc disclosure obligation to correct the information by the issuer concerned.

From the issuer's point of view, untrue facts are generally not inside information pursuant to Art. 7 para. 1 MAR, that would be subject to disclosure.[112] But according to the case law of the German Federal Court of Justice (BGH), issuers must correct false secondary market information, such as press releases, if knowledge of the true facts constitutes inside information pursuant to

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[106] *Köndgen*, Festschrift Druey, 2002, p. 791, 796: 'cheapest information provider'; *Klöhn* (n. 66), p. 1287: 'least cost information seeker'; Ebenroth/Boujong/*Poelzig* (n. 38), Art. 17 MAR mn. 31.
[107] Klöhn/*Klöhn* (n. 38), Art. 17 MAR mn. 9; *Klöhn*, Die Regelung selektiver Informationsweitergabe gem. § 15 Abs. 1 Satz 4 u. 5 WpHG – eine Belastungsprobe, WM 2010, 1869, 1878; *Seibt*, Europäische Finanzmarktregulierung zu Insiderrecht und Ad hoc-Publizität, 177 ZHR 388, 393 (2013).
[108] Klöhn/*Klöhn* (n. 38), Art. 17 MAR mn. 121; *Blassl* (n. 95), p. 134; *Neumann* (n. 91), p. 163 et seq.
[109] See *Linnartz/Weber*, Deepfake im Kapitalmarkt: Was tun, wenn's so weit ist?, *Börsen-Zeitung*, Sonderbeilage, 29 June 2024, p. 4.
[110] Giving this example *Linnartz/Weber* (n. 109), p. 4.
[111] *Schmolke*, „Leerverkaufsattacken" und Marktmissbrauch, ZGR 2020, 291, 304 et seqq.; *Poelzig*, Shortseller-Attacken im Aufsichts- und Zivilrecht, 184 ZHR 697, 721 et seqq. (2020).
[112] Klöhn/*Klöhn* (n. 38), Art. 7 MAR mn. 63.

Art. 7 para. 1 MAR.[113] This can be assumed if the secondary market information is incorrect in a price-sensitive respect and the market expectation based on the incorrect information actually materialised[114] or was maintained.[115] Although the BGH case law concerned erroneous press releases published by the CEO on behalf of the issuer, the same applies to secondary market information, which, thanks to generative AI, could create the misleading impression of having originated from the issuer, from the perspective of a reasonable investor. If a reasonable investor would consider the issuer's correction as part of their investment decision, and price reactions are to be expected, then knowledge of the falsehood and awareness of the true facts constitute disclosable inside information under Art. 7 para. 1 MAR. This requires the issuer to correct price-sensitive deep fakes as soon as they gain knowledge of them. However, there is no duty to monitor the market, such as searching for deep fakes.[116]

E. Need for reform?

The previous explanations have demonstrated that market abuse law, in particular the ban on insider trading, is capable — with adjustments primarily at the enforcement level — of coping with the risks associated with AI and big data for the fundamental principal of equal treatment of market participants in terms of information. Some scholars nevertheless identify a greater need for reform in light of technological progress.[117] This is mainly justified by the fact that AI and big data disrupt the integration of information into price formation, thereby challenging nothing less than the economic foundation of capital markets law.[118]

I. Economic consequences of AI on the capital markets

The European capital markets law is generally considered to help markets to reach a semi-strong form of the efficient capital market hypothesis (ECMH)[119], meaning that the market accurately reflects the fundamental value of a financial instrument on the basis of all publicly available information (allocation efficiency).[120] The task of market abuse law is therefore to protect the allocative functioning of capital markets by creating incentives for informed traders to search for and analyse price-sensitive information.[121] Such market protection in turn also protects

[113] BGH, 17 December 2020 – II ZB 31/14 = NZG 2021, 377 mn. 214, 219. Previously to sec. 15 WpHG old version BGH, 13 December 2011 – XI ZR 51/10 = BGHZ 192, 90 mn. 16 et seq., 30 et seqq.
[114] BGH, 17 December 2020 – II ZB 31/14 = NZG 2021, 377 mn. 224.
[115] Klöhn/*Klöhn* (n. 38), Art. 17 MAR mn. 566.
[116] Klöhn/*Klöhn* (n. 38), Art. 17 MAR mn. 121; *Blassl* (n. 95), p. 134; restrictive *Neumann* (n. 91), p. 162 et seqq.
[117] See *Rauterberg*, How Artificial Intelligence Will Shape Securities Regulation, The University of Chicago Law Review Online (available at https://lawreview.uchicago.edu/online-archive/how-artificial-intelligence-will-shape-securities-regulation).
[118] So particularly *Annunziata* (n. 4), p. 106 et seq., 175; *Consulich/Maugeri/Milia/Poli/Trovatore* (n. 4), p. 74.
[119] Seminal *Fama*, Efficient Capital Markets. A Review of Theory and Empirical Work, 25 J. Fin. (1970), 373 et seqq.
[120] See *Fischel*, Efficient Capital Markets the Crash and the Fraud on the Market Theory, 74 Cornell L. Rev. 907, 913 (1989): 'value efficiency'; *Stout*, The Mechanisms of Market Inefficiency: An Introduction to the New Financ, 28 J. Corp. L. 635, 640 et seqq. (2003): 'fundamental value efficiency'.
[121] *Goshen/Parchmovsky*, The Essential Role of Securities Regulation, 55 Duke L. J. 711, 723 (2006).

investors[122], since in efficient markets even investors who lack price-sensitive information can make informed investment decisions on the basis of market prices.[123] At first glance, AI and big data fit perfectly into this model of the ECMH, as they strengthen information efficiency by processing and incorporating publicly available information into market prices on a large scale and at high speed.[124] As far as they process information relevant to fundamental values, they also strengthen allocation efficiency.

The explanations at the beginning have, however, shown that AI systems have access to an unregulated 'flood' of alternative data[125] and can spy out and anticipate the future investment behaviour of other market participants through algo-sniffing or sentiment analysis, among others (see C. I.). Such electronic front running or order anticipation harms the capital market: It increases transaction costs for informed market participants, as they can only purchase financial instruments at a premium and can no longer fully utilise their information advantage.[126] The incentives to search for information relevant to fundamental values are reduced and allocation efficiency is impaired.[127] Thus, particularly powerful autonomous AI systems certainly have the potential to detach market prices from their fundamental value, or to distance the reality of capital markets from the semi-strong form of the ECMH. It is, of course, not new that the economic model underlying the MAR does not fully reflect reality; human actors do not always act rationally or in accordance with fundamental value.[128] However, the sheer volume and power of unregulated alternative data accessible to algorithms, coupled with the expected advancement of autonomous trading systems in the capital market, make it necessary to consider alternative regulatory approaches.

II. Regulatory strategies de lege ferenda

To slow down the algorithmic decision-making process, speed limits (speed bumps) and interruptions (circuit breakers) are particularly discussed in the context of high-frequency

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[122] *Hopt*, Grundsatz- und Praxisprobleme nach dem Wertpapierhandelsgesetz - insbesondere Insidergeschäfte und Ad-hoc-Publizität -, 159 ZHR 135, 159 (1995) ('zwei Seiten derselben Medaille' ['two sides of the same coin']).

[123] *Easterbrook/Fischel*, Mandatory Disclosure and the Protection of Investors, 70 Va. L. Rev. 669, 694 (1984): 'price-protected'.

[124] *Sun/Liu/Xu/Zeng/Shi/Hu/Jiang/Abraham*, Alternative data in finance and business: emerging applications and theory analysis, 10 Financial Innovation 127 (2024); *Barbopoulos/Dai/Putnins/Saunders*, Market Efficiency in the Age of Machine Learning, NYU Stern School of Business Research Paper Series, available at https://ssrn.com/abstract=3783221; *Begenau/Farboodi/Veldkamp*, Big data in finance and the growth of large firms, 97 Journal of Monetary Economics 71 (2018); *Chen/Kelly/Wu*, Sophisticated investors and market efficiency: Evidence from anatural experiment, 138 J. Fin. Econ. 316 (2020).

[125] *Montemarano* (n. 40), p. 265 et seqq.

[126] See *Fox/Glosten/Rauterberg*, The New Stock Market, 2019, p. 100; also *Harris*, Trading and Exchanges: Market Microstructure for Practitioners, 2003, p. 245 et seqq.; in German literature see *Bayram/Meier* (n. 50), p. 1300; Klöhn/*Klöhn* (n. 38), Art. 7 MAR mn. 300.

[127] *Arnold/Russ* (n. 45), p. 105.

[128] On the objections regularly raised against the ECMH as the basis of the information paradigm under securities trading law and the counter-arguments *Klöhn* (n. 85), p. 359 et seq.

trading.[129] However, the effectiveness of such measures is questionable, and their use is controversial.[130] Moreover, interventions in the market should be carried out with caution. Some scholars advocate for a recalibration of the issuer's ad hoc disclosure obligation, which plays a key role in the current securities trading information paradigm[131] and is being overshadowed by the dramatically increasing importance of alternative data.[132] Other scholars suggest directly regulating all "finfluencers" — social media influencers with significant follower numbers who focus on financial topics — including mandating the disclosure of any qualifications and any conflicts of interest.[133]

However, a more convincing approach is to focus on the information processing by autonomous AI systems, thereby regulating autonomous securities trading itself.[134] In this regard, at the very least, market-damaging order anticipation should be limited. It is worth considering expanding the privilege in Recital 28 s. 1 MAR, which applies to the analysis of both fundamental value-relevant and trading-related information (see C. I. 2. b)),[135] to include an exception for market-damaging behavior such as order anticipation, in Recital 28 s. 2 MAR. Given the anticipated further increase in the importance of analyses and evaluations by AI systems in the future, the privilege in Recital 28 s. 1 MAR should, at the very least, be transferred from the recitals into the operative part of the MAR and be further specified.

F. Summary

1. With the advance of digitalisation, algorithmic trading and high-frequency trading have taken on an important role in modern capital markets. The risks posed by automated trading systems, which use algorithms based on the 'if-then' principle, were already addressed by the European legislator in 2014 through specific amendments to the ban on market manipulation (Art. 12 para. 2 lit. c) MAR) as well as organizational obligations for investment firms (Art. 17 MiFID II; Delegated Regulation (EU) 2017/589; sec. 80 paras. 2-5 WpHG) and regulated markets or exchanges (Art. 48 MiFID II; sec. 26d BörsG).

2. Since then, machine learning and big data have dramatically further changed securities trading. The development of autonomous systems and the ability of self-learning algorithms to comprehensively and rapidly process information generally serves information efficiency and

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[129] See *Chesterman*, We, the Robots?, 2021, p. 24; *Hu*, Intentional Access Delays, Market Quality, and Price Discovery: Evidence from IEX Becoming an Exchange, 15 March 2019, available at https://ssrn.com/abstract=3195001.
[130] In detail to this matter *ESMA*, MiFID II Review Report – MiFID II/MiFIR review report on Algorithmic Trading, 28 September 2021, ESMA70-156-4572, p. 96 et seqq. mn. 493 et seqq.
[131] On this *Klöhn* (n. 85), p. 375 et seq.
[132] See *Annunziata* (n. 4), p. 105 et seqq.; *Balp/Strampelli*, Preserving Capital Markets Efficiency in the High-Frequency Trading Era, U. Ill. J. L. Tech & Pol'y 349, 399 (2018).
[133] *Manfredo*, How to Make $1 Million in 30 Seconds or Less: The Need for Regulations on Finfluencers, 84 La. L. Rev. 791 (2024)
[134] See also *Consulich/Maugeri/Milia/Poli/Trovatore* (n. 4), p. 74.
[135] See already *Bayram/Meier* (n. 50), p. 1300.

thus the functionality of capital markets, but also challenges market abuse law and, in particular, the securities trading information paradigm.

3. AI provides its users with a 'structural insider advantage' compared to other market participants: AI systems can both receive and process price-sensitive information faster as input and generate it as output through data analysis. As long as AI processes only publicly known price-sensitive information (e.g., ad-hoc announcements, trading data) as input or generates price-sensitive information by analyzing publicly available alternative data (e.g., from traditional and social media, satellite images, etc.) (Recital 28 s. 1 MAR), the informational advantages gained are not based on privileged access to information and therefore do not violate the fundamental principle of equal access to information underlying European insider trading law (Recital 24 s. 3 MAR).

4. Autonomous insider trading is characterized by the usage of inside information within the meaning of Art. 7 para. 1 MAR as input for trading by self-learning algorithms. The technology-neutral MAR in its current form is already capable of covering autonomous insider trading as a violation of the insider trading prohibition of Art. 8 para. 1, Art. 14 lit. a) MAR. The natural or legal person using the AI systems in their organizational area 'possesses' the inside information that the AI processes as input. Trades executed by autonomous AI systems are also attributed to the user as 'indirect acquisition.' However, users of AI have the opportunity to rebut the presumption of use (see Recital 24 s. 2 MAR) by designing the used AI systems in compliance with market abuse law, i.e., through a 'Compliance by Design' defense in accorcance with Art. 9 para. 1 MAR for legal entities and analogously to Art. 9 para. 1 MAR for natural persons.

5. With increasing autonomy, the 'black box' nature of the systems will complicate the ex-post enforcement of insider law, dependent on fault (sec. 119 para. 3, sec. 120 para. 14 WpHG). The ex-ante organizational obligations for investment firms (Art. 17 MiFID II; sec. 80 paras. 2-5 WpHG) should therefore be adapted de lege ferenda to the peculiarities of autonomous trading systems and specifically supplemented by an obligation to prevent market abuse through the design of technology ('Compliance by Design' obligation).

6. AI and big data offer issuers significant opportunities in preparing for and fulfilling their ad hoc disclosure obligations under Art. 17 MAR, as they can facilitate the search, detection, and analysis of inside information, especially with large and complex data sets. However, a comprehensive delegation of ad-hoc disclosure obligations to AI, including the decision on whether to delay or disclose, is precluded from a capital markets law perspective.

7. Even if the issuer's ad hoc disclosure obligation is understood as a knowledge-independent obligation to organize information, it currently (still) does not include a general obligation to use AI systems for searching, detecting, and analyzing inside information. With advancing technological development, this will change for internal company circumstances: the higher the price relevance and thus the market's interest in the information, and the more superior the

technical capabilities compared to human abilities, the more likely the use of AI may be legally required.

8. If the issuer gains positive knowledge of price-sensitive deep fakes, i.e., misleadingly realistic AI-generated false market information, an obligation to correct this misinformation by ad hoc disclosure under Art. 17 para. 1 MAR arises.

9. European market abuse law is capable, with minor adjustments but without fundamental changes, of addressing the risks posed by autonomous securities trading to the informational equality of market participants, without hindering innovations that promote information efficiency.

10. However, the growing influence of AI and big data increases the risk that capital market prices will diverge from the fundamental value of the respective financial instruments and thus real price formation will increasingly detach from the basic model of the Efficient Capital Market Hypothesis (ECMH), especially if algorithms are used to infer trading-related inside information, such as in algo-sniffing. Therefore, the privileging of analyses based on publicly available data according to Recital 28 s. 1 MAR should de lege ferenda be restricted for cases of market-damaging order anticipation. Given the increasing significance of analyses of alternative data by AI systems in the future, it is advisable to clarify the regulation of the privileging of analyses and evaluations in the compulsory part of the MAR rather than in the recitals.

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