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Competition Law and blockchain technology (Distributed Ledger Technology)

JAEM03 Master Thesis

European Business Law
30 higher education credits

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Term: Spring 2021

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Summary

This analysis elaborates on current questions and legal challenges regarding the application of blockchain technology in the light of competition law. It illustrates that such legal challenges start from the application of well-established definitions and terms to the identification of new forms of anticompetitive behaviour.

The analysis underlines the necessity for an open, modern approach regarding the application of Art. 101 TFEU in order to be able to address new technologies such as blockchain technology. It is crucial for the application of Art. 101 TFEU to distinguish between the different participants, the utilisation and types as well as layers of blockchain. Further, the technology is at an early stage of development. Therefore, an analysis such as the elaboration on the product or geographic market are not conclusively at the present stage.

Furthermore, the analysis outlines that the technical features of blockchain technology — for instance, real-time access, decentralised distribution, imputability, etc — raise concern and risk for competition law infringements. In this regard the analysis elaborates on an assortment of selected risks and scenarios of potential horizontal and vertical restraints to competition law such as exchange of information, price-fixing, resale price maintenance, tying, etc.

Conclusively, it is held that competition law frames the scope of business activities and collaborations between undertakings. These laws apply to the analogue world and the digital world, respectively. However, due to the early stage of the application of blockchain in conjunction with competition law the development of blockchain will have to be followed more closely in order to be able to provide further answers.

Acknowledgements

I would like to express my gratitude to my thesis supervisor, Anna Tzanaki,
who provided insightful comments and suggestions.
It was a pleasure having such a supervisor.

A special thanks to my beloved partner for being you.
Thank you, Michael A.

Preface

Technology and digitalisation are not only changing the way we are living our daily life but the 'new' digital world is also challenging the application of laws. One can say that digitalisation has an impact on the European internal market and competition. When looking back to 2019 one might remember the European Commission's President's Ursula von der Leyen's 'Mission Letter' to the Executive Vice President of the European Commission for 'A Europe Fit for the Digital Age' Margrethe Vestager where the prior underpinned the necessity and importance of a well functioning competition.[1]

The latter did not shy away from realising the European Commission's vision. However, when taking a closer look, it seems as if one technology is not (yet) getting the attention that it might deserve regards its potential and challenges to the well-functioning of a competitive internal market: blockchain technology (the distributed ledger technology).

Blockchain technology is emerging in multilayered varieties and areas of utilisation.[2] Thereby it is already starting to influence digitalisation processes and is shaping new economies. Despite the fact that blockchain technology is not yet a mainstream product there is a high probability that it will cause debates, challenges and questions in the field of competition law.

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[1] Ursula von der Leyen, 'Mission Letter' (Brussels, 1 December 2019) <https://ec.europa.eu/commission/commissioners/sites/comm-cwt2019/files/commissioner_mission_letters/mission-letter-margrethe-vestager_2019_en.pdf> accessed 15 January 2021.

[2] For instance, Yinsheng Li, 'Emerging blockchain-based applications and techniques', (Service Oriented Computing and Applications (2019, Springer) p. 279 f.

Abbreviations

Art	Article
Arts	Articles
cf	conferatur (compare)
DLT	Distributed ledger technology
ECJ	European Court of Justice
ed (s)	Editor (s)
edn	Edition
eg	exempli gratia
etc	etcetera
fn	footnote
EU	European Union
ibid	ibidem
TEU	Treaty on the European Union
TFEU	Treaty on the Functioning of the European Union
IFLR	International Financial Law Review
no	number
OUP	Oxford University Press
p	page
para	paragraph
supra	above
Vol	Volume

I. Introduction

A. Introductory remarks

The distributed ledger technology is forcing a "shift from internet of information to the internet of value, where money, financial assets, titles and deeds, intellectual property, and data can be moved, stored, and managed through blockchain technology."[3] Such a shift of content, application and utilisation bears not only benefits but raises questions in relation to competition law.

Such questions concern, for instance, what is the relevant market. It is not easy to define the market relating to blockchain. On the contrary, the question shall rather be formulated as: Does a Blockchain even constitute a market?[4] Furthermore, is it even possible to identify a cartel when everyone is anonymously acting on a blockchain? This leads to a follow-up challenge, namely, is it even a cartel just because information is stored on a blockchain?[5] Blockchain technology has many faces, layers and aspects.

The implications for competition law are potentially far reaching even though the technology in itself neither is harming nor benefiting competition but it is neutral.[6]

B. Method and materials

This thesis aims to explore blockchain technology in the light of European competition law. The focal point of the thesis is to elaborate on the question of applicability of Art. 101 TFEU. Moreover, in the further course the thesis focusses on risks and potential scenarios of anticompetitive behaviour on the vertical as well as horizontal level which are likely to occur due to the technological features of blockchain. Because of the novelty of the technology little analysis is found. However, the methodological outlining below illustrates that the

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[3] Marcia Narine Weldon, Rachel Epstein, 'Beyond Bitcoin: Leveraging blockchain to benefit business and society (Transactions: The Tennessee Journal of Business Law, Vol. 20) p. 837 (840).

[4] Cf. Falk Schöning, 'OECD publishes issues paper on blockchain and competition law' (Hogan Lovells, 2018) <https://www.hlmediacomms.com/2018/05/08/oecd-publishes-issues-paper-on-blockchain-and-competition-law/> accessed 04 April 2021.

[5] Cf. Ibid; Michael Ristaniemi, Klaudia Majcher, 'Blockchains in competition law — friend or foe?' (Kluwer Competition Law Blog, July 2018) <http://competitionlawblog.kluwercompetitionlaw.com/2018/07/21/blockchains-competition-law-friend-foe/> accessed 19 January 2021.

[6] Ibid.

concept of EU law and well-established methodological approaches provide some guidance in order to provide answers to the most relevant questions that are raised in this thesis.

European Union law is unique. It can be described as law '*sui generis*' because it does not fit into the categories of traditional legal concepts.[7] This fact has been underlined by the European Court of Justice in *Van Gend en Loos* when it stated that: "The conclusion to be drawn from this is that the Community constitutes a new legal order of international law for the benefit of which the states have limited their sovereign rights, albeit within limited fields, and the subjects of which comprise not only Member States but also their nationals. Independently of the legislation of Member States, Community law therefore not only imposes obligations on individuals but is also intended to confer upon them rights which become part of their legal heritage."[8]

Contrary to the law of Member States, EU law does not impose a clear hierarchy of sources. However, traditionally it can be distinguished between primary and secondary sources.[9] The Treaties are the primary sources: the Treaty of the European Union, the Treaty on the Functioning of the European Union and the EU Charter of Fundamental Rights. Regulations, directives, and decisions form the secondary sources of EU law.[10] Both sources of law are considered hard law and legally binding.[11]

Apart from the above described hard law exists soft law. Soft law is non-legally binding. However, even though soft-law lacks a legally binding effect it plays an important role in competition law. For instance, material provided by the European Union such as Commission's Guidelines, information papers, and other types of supplementary guidance/ information. Some authors point out that such "rules of conduct that are laid down in instruments which have not been attributed legally binding force as such, but nevertheless may have certain (indirect) legal effects, and that are aimed at and may produce practical effects."[12] Moreover, it is considered to be an umbrella concept in regard to all types of

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[7] For instance, Robert Schütze, 'Two-and-a-half Ways of Thinking about the European Union' (Politique Européenne 2016/3, No. 53).

[8] Case C-26/62 *NV Algemene Transport- en Expeditie Onderneming van Gend & Loos v Netherlands Inland Revenue Administration* EU:C:1963:1.

[9] Norbert Reich et al., 'Understanding EU Law: Objectives, Principles and Methods of Community Law' (2nd ed., Intersentia) p. 13.

[10] Ibid.

[11] Ibid. p. 14

[12] Linda Senden, 'Soft law and its implications for institutional balance in the EC' (Utrecht Law Review, 2005) <http://www.utrechtlawreview.org/> accessed 01 April 2021.

instruments which cannot be attributed a particular legal status,[13] and can be distinguished as "preparatory and informative instruments, interpretative and decisional instruments and steering instruments."[14] Especially the publications of the European Commission provide assistance for the interpretation of competition law.

Furthermore, in order to properly address the legal questions of blockchain technology in the light of competition law the main focus of the thesis is laid on the application of the teleological interpretative approach. This approach can further be detected in the ECJ's interpretation of the Treaties and secondary sources, and forms part of the '*effet utile*' principle.[15] Due to the fact that blockchain technology raises a broad spectrum of legal questions which are barely discussed in academia, literature, case-law, etc, it is necessary to approach the different questions in a comprehensive, modern and adaptable manner. It can be argued that this is in alignment with the idea of guaranteeing '*effet utile*' since the aforementioned approach guarantees that the terms and definitions are "interpreted with a view to effectively achieving the intent of legislation."[16] Due to the novelty of the technology the above mentioned method and approach arguably seems to be the most appropriate to address the legal questions.

Furthermore, to the extent that analogies can be drawn to this new technology, competition law related case-law is analysed in this thesis. Moreover, legislation and European Commission's Guidelines and other commentary work is being utilised because — as pointed out above — such sources have a strong impact on the interpretation of EU law. Additionally, academic articles, online contributions and other sources are included in order to compensate for the little in-depth analysis which is to be found on the matter. Furthermore, a vast amount of technology-related material is utilised in order to illustrate blockchain technology from a technical perspective.

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[13] Ibid.

[14] Ibid. p. 82.

[15] Cf. Katalin Gombos, 'Eu Law viewed through the eyes of a national judge' <https://ec.europa.eu/dgs/legal_service/seminars/20140703_gombos_speech_en.pdf> accessed 01 April 2021.

[16] Ibid.

C. Outlining

This thesis is composed of VII parts; including the introduction and conclusion.

Part II of the thesis outlines the technical aspects relating to blockchain technology whereby the reader is provided with the necessary technical details.

Part III identifies the applicable law combined with a brief outlining of European competition law with a focus on Art. 101 TFEU.

The analysis in Part IV provides an in-depth discussion regarding the application of Art. 101 TFEU regarding blockchain. Questions are raised relating to the requirements and conditions for the application of Art. 101 TFEU; for instance, it is discussed if a blockchain-based application is an 'undertaking' or if participants on a blockchain can conclude an 'agreement', etc.

The following Parts V and VI are elaborating on (potential) scenarios and risks of anticompetitive behaviour. Thereby, horizontal and vertical constellations of anticompetitive behaviour are discussed. Special focus is laid on the exchange of information, which might be considered the most important aspect due to the technological specifications of blockchain technology.

The thesis concludes with Part VII, the final remarks.

D. Delimitations

The limitation on the length of the analysis requires to narrow the research.

Thus, relevant legal aspects relating to Art. 102 TFEU, Regulation (EC) No 139/2004 (Merger Regulation) or other secondary legislation (for instance, block exemptions) do not form part of the discussion.

The thesis focusses solely on the application of Art. 101 para. 1 TFEU.

II. Description: What is Blockchain?

A. A new reality: Blockchain and the digital economy

The world's economy is different from traditional concepts. This so-called digital economy is characterised by, for instance, new business models, users as an asset, data as the new 'gold', digital applications, change of financial services and products, etc.[17]

It is an unchallenged momentum that digital applications such as web-based car-sharing, co-housing, online product markets are becoming more of a focal point of economic activities.[18] But it is not only such tools that are shaping our digitalised economy. One specific development linked to the mysterious person 'Satoshi Nakamoto' became an eye-catcher. The name is a pseudonym for the person(s) who invented the peer-to-peer electronic cash-system: Bitcoin.[19] The development was accompanied by the idea to provide transparency, trust and anonymity without having to cooperate with intermediaries.[20]

Developers, companies, etc focused on detaching the technology from its initial conceptualisation as a peer-to-peer payment solution in order to apply it beyond the traditional services. Thereby, further blockchain-based applications were introduced such as diversified payment-systems, security and storage solutions, smart contracts, supply chain solutions, public ledger administration, etc.[21]

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[17] Cf. OECD, 'The digital economy, new business models and key features' (2014) <https://www.oecd-ilibrary.org/docserver/9789264218789-7-en.pdf?expires=1603021091&id=id&accname=guest&checksum=D1EC2991F3700B286B591E656E4F4068> accessed 10 January 2021.

[18] Myriam Ertz, Emilie Boily, 'The rise of the digital economy: Thoughts on blockchain technology and cryptocurrencies for the collaborative economy' (International Journal of Innovation Studies, 2020) p. 84 (89).

[19] Satoshi Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' <https://bitcoin.org/bitcoin.pdf> accessed 12 January 2021.

[20] A U Mentsiev et al., 'Blockchain as a technology for the transition to a new digital economy' (2019 Journal of Physics: Conference Series, Vol. 1399, Issue 3).

[21] Melanie Swan, 'Blockchain: A Blueprint for a New Economy' (O'Reilly, 2015); Leeway Hertz, 'A complete Guide to Blockchain Development' <https://www.leewayhertz.com/blockchain-development/> accessed 19 January 2021; World Economic Forum, 'Shaping the Future of Technology Governance: Blockchain and Digital Assets' (2020) <https://www.weforum.org/platforms/shaping-the-future-of-technology-governance-blockchain-and-distributed-ledger-technologies> accessed 19 January 2021.

There is more to blockchain technology than one might imagine. For instance, it is argued that the circumstance that the blockchain-community decides by consensus without being obliged to conduct via a centralised intermediary disrupts markets.[22] A recent survey depicted that blockchain is a "[…] top-five strategic priority,[…]."[23] Thus, blockchain is a technological development which already plays — and exponentially increases to play — a pivotal role in a broad variety of work and challenges our understanding of the interplay between economy and law. Therefore, questions relating to the interrelation between competition and blockchain are relevant and critical evaluation is necessary at an early stage.[24]

B. Functioning: Blockchain technology

The founder of Bitcoin Satoshi Nakamoto described the technology as follows:"[…] peer-to-peer network using proof-of-work to record a public history of transactions that quickly becomes computationally impractical for an attacker to change if honest nodes control a majority of CPU power. The network is robust in its unstructured simplicity. Nodes work all at once with little coordination. They do not need to be identified, since messages are not routed to any particular place and only need to be delivered on a best effort basis. Nodes can leave and rejoin the network at will, accepting the proof-of-work chain as proof of what happened while they were gone. They vote with their CPU power, expressing their acceptance of valid blocks by working on extending them and rejecting invalid blocks by refusing to work on them. Any needed rules and incentives can be enforced with this consensus mechanism."[25] It can also be simplified and described as a new concept of transferring and storing information: encrypted chains of blocks filled with data.[26]

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[22] Cf. Christian Catalini, ' How Blockchain Technology Will Impact the Digital Economy' (2017) <https://www.law.ox.ac.uk/business-law-blog/blog/2017/04/how-blockchain-technology-will-impact-digital-economy> accessed 15 January 2021.

[23] Deloitte, '5 Blockchain Trends for 2020' (2020) <https://www2.deloitte.com/content/dam/Deloitte/ie/Documents/Consulting/Blockchain-Trends-2020-report.pdf> accessed 19 January 2021.

[24] Falk Schöning, Myrte Tara, 'Blockchain: Mind the gap! Lessons learnt from the net neutrality debate and competition law related aspects' (2018) p. 2 <https://ec.europa.eu/competition/information/digitisation_2018/contributions/falk_schoening_myrto_tagara.pdf> accessed 19 January 2021.

[25] Satoshi Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System', p. 9 <https://bitcoin.org/bitcoin.pdf> accessed 12 January 2021.

[26] Jimi S. (Good Audience), 'How does blockchain work in 7 steps — A clear and simple explanation' (2018) <https://blog.goodaudience.com/blockchain-for-beginners-what-is-blockchain-519db8c6677a> accessed 19 January 2021.

In order to illustrate the idea of Nakamoto, the following example sheds some light: A wants to provide a loan to B. A is located in Alaska, while B is located in a remote area in South East Asia. Thus, not only time differences, language but especially administrative requirements make a swift, resource saving money transfer difficult. Therefore, A and B decide to transfer money via 'Circle' with its (blockchain-based) international money transfer service.[27] A and B both possess a digital wallet and transfer the money digitally without spending time or resources. The same concept applies to any other type of data transfer or storage of data. For example, the handling of public property books. Some official administrations have commenced transferring deeds to blockchain-based publicly accessible property books.[28]

Thus, blockchain is a distributed and decentralised ledger of any kind of transaction/ information. The transactions can be stored in the ledger by the majority of participating nodes according to the consensus-mechanism. Depending on the type of blockchain there are different types of consensus-mechanism: most public blockchains do comprise a Proof-of-Work (PoW) or Proof-of-Stake (PoS) model. Private blockchains are mostly based on other forms of consensus.[29]

The process on a blockchain is as follows: Mining nodes[30] are users in the system who are trying to solve a mathematical problem and thereby are verifying or falsifying the input and output before the information is stored by all nodes.[31] A bundle of transactions are building a block. Importantly, each such block encompasses a unique key. This key is called a hash. The hash function provides the necessary validity and integrity of the data that are stored in a

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[27] Circle, <https://www.circle.com/en/> accessed 19 January 2021.

[28] Government Technology, 'Here's What a Blockchain Property Deed Looks Like' (2018) <https://www.govtech.com/biz/Heres-What-a-Blockchain-Property-Deed-Looks-Like.html> accessed 20 January 2021.

[29] Cryptopedia Staff, 'Types of Blockchains: PoW, PoS and Private' (2021) <https://www.gemini.com/cryptopedia/blockchain-types-pow-pos-private> accessed 27 March 2021; imi S. (Good Audience), 'How does blockchain work in 7 steps — A clear and simple explanation' (2018) <https://blog.goodaudience.com/blockchain-for-beginners-what-is-blockchain-519db8c6677a> accessed 19 January 2021.

[30] Cf. Jimi S. (Good Audience), 'How does blockchain work in 7 steps — A clear and simple explanation' (2018) <https://blog.goodaudience.com/blockchain-for-beginners-what-is-blockchain-519db8c6677a> accessed 19 January 2021.

[31] Jimi S., 'Blockchain: What are nodes and masternodes?' (2018) <https://medium.com/coinmonks/blockchain-what-is-a-node-or-masternode-and-what-does-it-do-4d9a4200938f> accessed 20 Mach 2021. It shall be kept in mind, that nodes can be any kind of device that contains a full copy via downloading the blockchain.

block with a timestamp and thereby constitutes the 'glue' to the previous block.[32] The process of hashing "[…] is irreversible, every key produced is unique and even the slightest change in the input generates a completely different key."[33] This provides enormous security, however, it also means that critical situations may arise such as a "disputed transaction, incorrect addresses, exposure or loss of private keys, data-entry errors, […]."[34] Eventually, the data (block) is stored in a public database (chain).[35]

Due to the fact that participation on a blockchain is anonymous but simultaneously publicly accessible it is necessary to provide for a specific concept so that it can be guaranteed that the identity and information are valid. This can be achieved by so-called asymmetric digital signatures (signing-key and verification-key).[36] In other words: there exists a private key for encryption, identification and ownership purposes (identification of the respective address) and a public key which is corresponding to the private key.[37]

C. Private blockchain v. public blockchain

Blockchain technology can be separated into two main groups: public and private blockchains. The first group is accessible for everyone. The only requirement is to download the blockchain and accept the consensus-mechanism.[38] This reassures transparency since the information is openly available for all users. Thus, it is possible to gain knowledge about every transaction on the respective blockchain while the identity of the participant is not

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[32] Hany F. Atlam, Gary B. Wills, 'Role of Blockchain Technology in IoT Applications' (2019) p. 4; see also, IBM, 'What is a blockchain technology?' (2021) <https://www.ibm.com/blockchain/what-is-blockchain> accessed 12 January 2021; Ameer Rosic, 'What is Blockchain Technology?'<https://blockgeeks.com/guides/what-is-blockchain-technology/> accessed 12 January 2021.

[33] Peter Ernst, 'How Do I Prove A Blockchain Transaction Is Mine?' (2019) <https://www.experfy.com/blog/fintech/please-tell-me-how-do-i-prove-a-blockchain-transaction-is-mine/> accessed 19 January 2021.

[34] Xiwei Xu et al., 'Architecture for Blockchain Applications' (2019, Springer) p. 97.

[35] PJ Surani, ' Blockchain in Action' (2019) <https://computerrock.com/blog/blockchain-in-action-16-inspirational-examples/> accessed 17 January 2021.

[36] Ibid.

[37] Blockchain Support Center, 'Public and private keys' (2021) <https://support.blockchain.com/hc/en-us/articles/360000951966-Public-and-private-keys> accessed 20 Januray 2021.

[38] Rosic (n 32).

revealed apart from the public address. If the data shall not be visible it has to be encrypted before uploading on a blockchain.[39]

On the other hand there exist so-called private blockchains which are not accessible for everyone. They are based on access control.[40] Thus, only a specific number of nodes are participating in the blockchain. Further, only nodes participating in the blockchain gain knowledge of transactions stored on the network. In other words: it is a 'permissioned' network and therefore can be considered to have more of a centralised character.[41]

D. Key aspects of blockchain technology

There are particular key aspects to the technology which have the potential to pose specific challenges for competition law.

First of all decentralisation is a key element. In its essence decentralisation forces market players to restructure their business models due to the circumstance that decentralised technology is simplified, faster and less resource-consuming.[42] Apart from this positive aspects it bears a challenge for competition law, for instance, in the light of absence of a centralised entity but a majority of users (nodes) it poses questions to the definition of an 'undertaking'.[43]

An other essential aspect of blockchain technology relates to transparency. It is possible to gain knowledge over all data that is stored on the blockchain even if the identity of the transactor is disguised: this means that data is accessible for other market players which has the potential to contribute to collusive behaviour.[44] For example, it may occur that an

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[39] Xiwei Xu et al., 'Architecture for Blockchain Applications' (2019, Springer) p. 99; Rosic (n 32).

[40] Toshedndra Kumar Sharma (Blockchain Council), 'Public v. Private Blockchain: A comprehensive comparison' <https://www.blockchain-council.org/blockchain/public-vs-private-blockchain-a-comprehensive-comparison/> accessed 20 January 2021.

[41] Ibid.

[42] Cf. Marcella Atzori, 'Blockchain Technology and Decentralized Governance: Is the State Still Necessary?' (2015) <https://associazioneblockchain.it/wp-content/uploads/2015/12/SSRN-id2709713.pdf> accessed 14 January 2021.

[43] See discussion regarding the term 'undertaking' in Part IV.

[44] Cf. Pavel Ciaian, 'Blockchain technology and market transparency' (2018) <https://ec.europa.eu/info/sites/info/files/law/consultation/mt-workshop-blockchain-technology-and-mt_ciaian_en.pdf> accessed 18 January 2021.

undertaking gains knowledge via the distributed ledger with regard to price development of a product of its competitors.[45]

E. Blockchain generations and layers

Blockchain can also be distinguished by its different generations: the first generation evolved in relation to blockchain, protocols and currency (for example, Bitcoin), the second generation evolved beyond these sectors and applies to contracts (Ethereum and smart contracts, smart property, crowdfunding) and the third generation applies to all sectors beyond the first two generations.[46]

The different layers on a blockchain are different softwares, algorithms or any form of code operating on a blockchain.[47] That means that layer 1 is the code-layer whereas layer 2 is the software operating on layer 1 relating to a service or product.[48]

The type of blockchain generation and layer that is utilised is detrimental for the analysis of competition law. In particular, the distinction is necessary in order to elaborate on and eventually determine the relevant market of a particular blockchain including clarifications to the kind of abusive behaviour.[49]

F. Use-cases of blockchain

Blockchain technology is most known in the field of financial services but blockchain provides further applications. One of the use cases which already has been implemented relates to supply chain and logistics. By applying a blockchain based solution for the functioning of a supply chain it reduces costs, administration and provides a more streamlined process.[50]

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[45] See discussion in Part V.

[46] For instance, Melanie Swan, 'Blockchain: Blueprint for a New Economy' (O'Reilly 2015).

[47] Cf. Christophe S. Hutchinson, 'Potential Legal Challenges for Blockchain Technology in Competition Law' (Baltic Journal of Law & Politics 13, 2020 p. 81 (91).

[48] Ibid. p. 92.

[49] See in Part IV, V and VI.

[50] Infopulse, 'Blockchain in Supply Chain Management: Key Use Cases and Benefits' (2019) <https://medium.com/@infopulseglobal_9037/blockchain-in-supply-chain-management-key-use-cases-and-benefits-6c6b7fd43094> accessed 18 January 2021.

An other example relates to elections. As it was demonstrated in the US elections of 2020 the current system of voting can be abused to claim fraud.[51] Blockchain provides security to avoid abuse. For instance, it has been proposed to implement "a geographically distributed network comprising of machines from both government and public infrastructure; this infrastructure houses two distinctly separate blockchains, one for voter information such as who has voted and the other for vote information such as what has been voted. […]"[52]

A further area of potential application of blockchain technology is anti-money laundering.[53] By implementing Anti-money laundering transaction monitoring functions it would be possible to automatically identify suspicious transactions or transactions by participants in the network who are not properly identified / registered.[54]

An other use-case which already attracted some attention is the processing and storing of data relating to real estate. The application of blockchain guarantees a simplified search process, due diligence and communication with public authorities for registration purposes as well as a simplified financial transaction. Furthermore, blockchain based applications contribute to more security since the data is stored decentralised and on a distributed ledger; making it difficult to tamper with ownership rights, borders, etc.[55]

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[51] Nick Corasantini et al., 'The Times Called Officials in Every State: No Evidence of Voter Fraud' (New York Times, 2020) <https://www.nytimes.com/2020/11/10/us/politics/voting-fraud.html> accessed 01 March 2021.

[52] Andrew Barnes et al., 'Digital Voting with the use of Blockchain Technology' (Plymouth University) <https://www.economist.com/sites/default/files/plymouth.pdf> accessed 17 January 2021.

[53] Yurika Ishii, 'Blockchain Technology and Anti-Money Laundering Regulations under International Law (American Society of International Law, Vol. 23, Issue 1, 2019) <https://www.asil.org/insights/volume/23/issue/1/blockchain-technology-and-anti-money-laundering-regulations-under> accessed 16 January 2021.

[54] DevTeam.Space, 'How to use blockchain to prevent money laundering' <https://www.devteam.space/blog/how-to-use-blockchain-to-prevent-money-laundering/#4> accessed 20 January 2021.

[55] Deloitte, ' Blockchain in commercial real estate: The Future is here' (2020) <https://www2.deloitte.com/us/en/pages/financial-services/articles/blockchain-in-commercial-real-estate.html> accessed 18 January 2021.

III. EU competition law

A. General considerations

In 2018 Commissioner Vestager pointed out: "Today, mobile internet makes up more than half of global internet traffic. It has changed the lives of millions of Europeans."[56] This statement underpins the development in the light of digitalisation. Further, in conjunction with the European Commission's emphasis and efforts, in 2020 it reached an agreement on 'long-term EU budget & Next Generation EU'. In its multi annual financial framework it is being reiterated that the strengthening of competitiveness within the EU is considered to be highly important.[57] The European Commission further is focusing on a variety of actions whereby blockchain shall be introduced to the internal market: The EC blockchain strategy. Focus is thereby laid on blockchain partnerships, funding for blockchain innovation pan-European government services, standards, etc.[58] However, there currently are no newly introduced competition laws.[59]

The Treaty of the European Union empowers the European Commission to investigate, analyse and enforce competition law issues: Art. 3 para. 1 lit. b TFEU where it is being stated that the EU has the exclusive competence to establish the competition rules necessary for the functioning of the internal market.[60]

The most relevant competition rules, which are of relevance for the present analysis, are embedded in primary EU law: Chapter 1, Title VII of Part Three, Articles 101 ff. TFEU; taking Art. 103 TFEU into consideration whereby it becomes possible to adopt "appropriate regulations or directives to give effect to the principles set out in Articles 101 and 102 shall

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[56] European Commission, 'Antitrust: Commission fines Google €4.34 billion for abuse of dominance regarding Android devices' (18 July 2018), <https://ec.europa.eu/commission/presscorner/detail/en/IP_18_4581> accessed 14 January 2021.

[57] European Commission, '2021-2027 long-term EU budget & Next Generation EU' (July 2020), <https://ec.europa.eu/info/strategy/eu-budget/long-term-eu-budget/2021-2027_en> accessed 17 January 2021.

[58] European Commission, 'Blockchain Technology' (2021) <https://ec.europa.eu/digital-single-market/en/blockchain-technologies> accessed 24 January 2021.

[59] The legislative proposal for a 'Digital Markets Act' has been forwarded by the EU Commission. It aims at tackling competition law issues that cannot be sufficiently identified and addressed with the currently existing competition laws. The proposal currently is discussed at the EP level. See, European Commission, 'The Digital Services Act package' (2020) <https://ec.europa.eu/digital-single-market/en/digital-services-act-package> accessed 12 March 2021.

[60] Consolidated versions of the Treaty on European Union and the Treaty on the Functioning of the European Union [2012] OJ C 326/01.

be laid down by the Council, on a proposal from the Commission and after consulting the European Parliament."[61]

B. The concept of Art. 101 TFEU

The key provision of Section 1 of Chapter 1 gives the Commission the power to investigate situations according to Art. 101 TFEU. The premise of Art. 101 TFEU can be described as the obligation for every undertaking to determine its own strategical, economic and commercial decisions in order to maintain competition.[62] In other terms: undertakings shall act independently on the market. The provision encompasses a prohibition that shall sanction undertakings who are not refraining from unlawfully collaborating on the market.[63] The ratio can be described as: "protection of competition is the primary objective of EC competition policy, as this enhances consumer welfare and creates an efficient allocation of resources."[64]

The provision does not require undertakings to meet a particular threshold in regard to market power and can therefore be applied without further restraints subject to the condition of fulfilling the general conditions for applicability.[65] Art. 101 para. 1 TFEU clarifies that the provision applies to situations where the following conditions are met: "agreements between undertakings, decisions by associations of undertakings and concerted practices which may affect trade between Member States and which have as their object or effect the prevention, restriction or distortion of competition within the internal market."[66] It shall be pointed out that any such behaviour which is required by and in alignment with national or European legislation does not lead to an applicability of Art. 101 TFEU due to a lack of autonomy for the undertakings concerned.[67]

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[61] Ibid. art. 103 TFEU.

[62] Cf. Konkurrence- og Forbrugerstyrelsen, 'Vejledning om konkurrenceloven: Vejledning om forbuddene mod konkurrencebegrænsende aftaler og misbrug af dominerende stilling' (2019) p. 10 <https://www.kfst.dk/media/53584/20190108-vejledning-om-konkurrenceloven.pdf> accessed 15 March 2021.

[63] Richard Whish, David Bailey, ' Competition Law' (8thedn, OUP, 2015); ibid.

[64] Demian MB Garard, 'The effects-based approach under Article 101 TFEU and its paradoxes: modernisation at war with itself?' (Seventh Annual Conference of the Global Competition Law Centre, College of Europe, October 2011); see also, Marcus Klamert, 'Commentary on the EU: Treaties and the Charter of Fundamental Rights' (OUP, 2019) p. 1002 para. 4; Whish (n 63) p. 4 ff..

[65] Klamert (n 64) p. 1002 para. 1.

[66] Consolidated versions of the Treaty on European Union and the Treaty on the Functioning of the European Union [2012] OJ C 326/01 Art. 101 para. 1.

[67] Klamert (n 64) p. 1002 para. 3.

Agreements or decisions which are anticompetitive in the sense of Art. 101 para. 1 TFEU are automatically void pursuant to Art. 101 para. 2 TFEU. However, for the purpose of justification, Art. 101 para. 3 TFEU provides an exemption of the unlawfulness of such agreements or concerted practices subject to the condition that the behaviour contributes to the improvement of production or distribution of goods, promotion of technical or economic progress subject to the condition that these improvements allow consumers for a fair share in regard to the benefit. Moreover, Art. 101 para. 3 TFEU requires that it does not impose restrictions which are not indispensable to the attainment of such benefits; and afford such an undertaking the possibility of eliminating competition in respect of a substantial part of the products concerned.[68]

C. Applicability of Art. 101 TFEU

Art. 101 TFEU is not limited to specific branches, areas or technologies. The provisions apply without distinction to behaviour of undertakings irrespective of the market they are active in. It constitutes a basic framework on the basis of which it has to be determined if such behaviour is anticompetitive and therefore unlawful.[69]

As pointed out above the applicability of Art. 101 TFEU is subject to the condition that particular conditions are met. Provided that the respective conditions are not met the laws do not apply.[70] In conjunction with this new technology this leads to questions such as, for example, is a blockchain-based application fulfilling the conditions for the applicability of Art. 101? Moreover, in case of an intended application of Art. 101 TFEU it is necessary that the behaviour constitutes an agreement, decision or a concerted practice — can a blockchain meet these requirements?[71]

The application of a new technology does not only bear questions in terms of applicability but it potentially also raises questions in regard to the identification of anticompetitive behaviour. Generally, it shall be kept in mind that blockchain technology as such is neither

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[68] Consolidated versions of the Treaty on European Union and the Treaty on the Functioning of the European Union [2012] OJ C 326/01 Art. 101 para. 3.

[69] Cf. Whish (n 63); Alexandre de Streel, 'The Relationship between Competition Law and Sector Specific Regulation: The case of electronic communications' (Reflets et perspectives de la vie économique 2008/1, Tome XLVII) <https://www.cairn.info/revue-reflets-et-perspectives-de-la-vie-economique-2008-1-page-55.htm> accessed 01 March 2021.

[70] Ibid.

[71] Generally, ibid. p. 103.

harming effective competition nor fostering competition. However, it does have the potential to have such impacts.[72] Or in other words: "Decentralized consensus [...] although essential to blockchain's effective functioning, such near-instant information distribution and resulting transparency may simultaneously strike as a collusion-conducive cocktail."[73]

Therefore, in the following Section focus is laid on the applicability of Art. 101 TFEU with a focus on the most relevant terms, definitions and requirements. The analysis further sheds light on potential collusive behaviour relating to the horizontal and vertical level.

IV. Implications: applicability of Art. 101 TFEU

A. The concept of 'undertaking' and blockchain

1. The concept of 'undertaking'

One of the challenges that blockchain raises relates to a basic requirement for the application of competition law: the necessity to constitute an undertaking. The predominant question is whether or not a decentralised group of members of a blockchain combined with miners and non-mining nodes provide an economic activity that constitutes an undertaking.[74]

The term 'undertaking' has not been defined in the TFEU but the ECJ clarified the meaning in its infamous *Höfner* judgement where it stated that: "It must be observed, in the context of competition law, first that the concept of an undertaking encompasses every entity engaged in an economic activity, regardless of the legal status of the entity and the way in which it is financed [...]."[75] Moreover, in *Pavlov* the ECJ specified previous case-law when emphasising that any economic activity referring to offering goods or services is such an activity.[76]

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[72] Ristaniemi (n 5).

[73] Ibid.

[74] Similar, Ioannis Lianos, Blockchain Competition (2018), in Ph. Hacker et al., 'Regulating Blockchain: Political and Legal Challenges' (OUP, 2019, Forthcoming) <https://ssrn.com/abstract=3257307> accessed 18 March 2021.

[75] Case C-41/90 *Klaus Höfner and Fritz Elser v Macrotron GmbH* EU:C:1991:161, para. 21.

[76] Cases C-180/98, C-184/98 *Pavel Pavlov and Others v Stichting Pensioenfonds Medische Specialisten* EU:C:2000:48, para. 75.

This approach has to be combined with a functional approach; meaning, that the conceptualisation of 'conducting an economic activity' can vary for one and the same entity due to different engagements.[77] For instance, the ECJ's judgement in *SELEX System Integrate SpA* exemplifies such a functional approach. The case concerned Eurocontrol which was entrusted with different tasks in relation to aviation, safety and other airspace activities. The ECJ had to elaborate on the question wether or not all activities carried out by Eurocontrol constituted an economic activity.[78] The ECJ ruled that: "[…] the activity of assisting the national administrations is separable from Eurocontrol's tasks of air space management and development of air safety. Although the assistance may serve the public interest by maintaining and improving the safety of air navigation, that relationship is only a very indirect one, since the assistance provided by Eurocontrol only covers technical specifications in the implementation of tendering procedures […]. Such an indirect relationship does not imply that there is a necessary link between the two activities. In that respect, the Court recalls that Eurocontrol only offers assistance in that field on the request of the national administrations. The activity of assistance is therefore in no way an activity which is essential or even indispensable to ensuring the safety of air navigation."[79] It further held that: "[…] activity whereby Eurocontrol provides assistance to the national administrations is an economic activity and that, consequently, Eurocontrol, in the exercise of that activity, is an undertaking."[80] This judgment illustrates that it may occur that not all activities which are executed by one and the same undertaking can be qualified as an 'economic activity'. Thus, as a consequence, the critical aspect is not to focus on the legal entity, its status, financing or composition but the main consideration is to identify what type of activity is being carried out by the entity[81] which is applied in a specific situation.[82]

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[77] Whish (n 63) p. 87.

[78] Case T-155/04 *SELEX Sistemi Integrati SpA v Commission of the European Communities* EU:T:2006:387.

[79] Ibid. para. 86.

[80] Ibid. para. 92.

[81] LexisNexis PSL, 'Article 101(1) TFEU–the prohibition on restrictive agreements—overview' (2021) <https://www.lexisnexis.com/uk/lexispsl/competition/document/391329/55KB-7MM1-F187-511S-00000-00/The_prohibition_on_restrictive_agreements_overview> accessed 19 March 2021.

[82] Cf. Alison Jones, 'The Boundaries of an Undertaking in EU Competition Law' (European Competition Journal, 8, 2012) 301 f.; Whish (n 63).

2. Nodes and miners on a blockchain

The analysis of 'what constitutes an undertaking' is depending on the specific circumstances of the use of blockchain because one and the same entity can be found to be economically active in one situation but not when being active in another.[83] There are opinions which do not focus on the question further apart from stressing the fact that a blockchain in itself does not constitute an undertaking in the sense of competition law but a technology, thus only the participants can potentially be classified as undertakings.[84] Others illustrate that no conclusive analysis can be provided at the current stage, for example, in relation to the Libra Association which shall introduce a cryptocurrency.[85] Other authors refer to a more functional, practical approach, stating that it is crucial to analyse the different activities that are carried out by (the owners of) the nodes on a blockchain in order to conclude on the character of the conduct; and thereafter, it shall be analysed if it is an entity.[86] The second step does not play a pivotal role in relation to defining an economic activity, however, it becomes relevant in the light of liability, sanctions and fines. One can describe it as a two-fold structure.[87]

Having that two-fold structure as a guiding principle in mind the activity on a blockchain is concentrated on the nodes: "Blockchain facilitates the transmission of data and economic value […] in the blockchain network ("the nodes")."[88] Thus, every node (electronic unit) is supporting the network by maintaining the distributed ledger and processing data.[89] Full nodes store a copy of the blockchain, guaranteeing the security and correctness of the data on the blockchain by validating data.[90] It is held that "to the extent that the owners of the nodes willingly contribute their computing resources to store and validate transactions, earning a

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[83] Whish (n 63) p. 87.

[84] Falk (n 25) p. 2.

[85] For instance, Deutscher Bundestag, 'Wettbewerbsrechtliche Implikationen von Kryptowährungen', WD 7 -3000 -103/19 (2019) p. 6 <https://www.bundestag.de/resource/blob/653462/85649dc602fdad43cb57ab89e43b1366/WD-7-103-19-pdf-data.pdf> accessed 20 March 2021.

[86] Cf. Lianos (n 74).

[87] Ibid; cf. Case T-372/10 *Bolloré v European Commission* EU:T:2012:325.

[88] Georgios Dimitropoulos, 'The Law of Blockchain' (Washington Law Review, Vol. 95, 2020) p. 1117 (1119).

[89] Ibid.

[90] John Evans, 'Blockchain Nodes: An in-depth Guide' (2021) <https://nodes.com/> accessed 22 March 2021.

transaction fee or a reward in the native token of the specific blockchain, they exercise an economic activity."[91]

The fact that nodes are working decentralised gives cause to raise doubts on the assessment as outlined above. It may be considered contradictory that unorganised, decentralised collaborating nodes are an undertaking. However, an argument that leaves scope for the classification of blockchain nodes as an undertaking is the focus on the interpretation of the term as "economic rather than legal entity."[92] This aspect substantiates the fact that the classification primarily is about the content of an activity; thus, the term 'undertaking' may vary. An undertaking can comprise of single individuals, two or more companies within a corporate group. For instance, it may comprise natural persons, legal persons and groups of persons.[93] The assessment of the activity of nodes can further be substantiated by an analogy to the findings in *Wouters* which resemble the nodes' activity of providing service in return for a fee; the ECJ had to elaborate on the question whether or not the Bar of the Netherlands constituted an association of undertakings. The first question to answer therefore was whether or not the members of the Bar were undertakings. The ECJ held that: "Members of the Bar offer, for a fee, services in the form of legal assistance in the drafting of opinions, contracts and other documents and representation of clients in legal proceedings. In addition, they bear the financial risks attaching to the performance of those activities […]."[94]

Consequently, it can be argued that this is similar in the case of nodes who also are acting as miners on the blockchain: they are offering a service in return for a transaction fee (reward).[95] Thus, mining nodes can be considered undertakings in the sense of Art. 101 TFEU.

3. Non-mining nodes on a blockchain

There is a downside to the argumentation above relating to mining nodes which is due to the structure of blockchain. It is correct that full nodes are contributing to the Bitcoin network, "[…] but only in the sense that other peers can now download the blockchain using your

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[91] Lianos (n 74) p. 78.

[92] Denys Beregovy, 'Parental Liability for competition Law violations: Lessons for emerging markets (CEU TD Collection, 2014) p. 21

[93] Jones (n 82) p. 301 (305); eg.: Whish (n 63).

[94] Case C-309/99 C. *J. Wouters, J. W. Savelbergh and Price Waterhouse Belastingadviseurs BV v Algemene Raad van de Nederlandse Orde van Advocaten* EU:C:2002:98, para. 49.

[95] Cf. Lianos (n 74) p. 78.

bandwidth. There are no transaction fees sent to anyone that is not mining."[96] Thus, there is a difference between nodes. Therefore the question arises if the activity of nodes who are not miners still is an economic activity. To a certain degree the situation of non-mining nodes reflects situations of non-profit activities: non-mining nodes are providing their computational power, network and storage without being rewarded.[97] In alignment with ECJ rulings, it can be argued that the lack of a profit-motive or other form of economic compensation does not hinder the classification as an 'undertaking' in the sense of Art. 101 TFEU.[98] This is based on the fact that "EU competition law does not make any distinction between altruistic entities and entities motivated by profits, as in both cases it is possible that the specific conduct reduces competition and/or welfare regardless of the motives and preferences of the producers."[99]

This leads to the conclusion that non-mining nodes are undertakings in the sense of Art. 101 TFEU.

4. Other intermediaries and blockchain

Blockchain does not only allow for participation as a node and/or mining node. The technology allows for a broad variety of participation opportunities. It is possible, for instance, to be involved in a blockchain activity as a provider for digital wallets or exchanges, mining pools[100] or even "third-party creation and management of cloud-based networks for companies in the business of building blockchain applications"[101] (also called BaaS) or Decentralised Application (DApp) which consists of "back-end code that runs on a decentralized peer-to-peer network. A DApp can also have a user interface, […] DAPPs do

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[96] Bitcoin, 'Can I earn transaction fees by running as a full node, verifying transactions, but not mining?' <https://bitcoin.stackexchange.com/questions/21668/can-i-earn-transaction-fees-by-running-as-a-full-node-verifying-transactions-b> accessed 29 March 2021.

[97] Similar, Lianos (n 74) p. 77 f.

[98] Cf. Case C-155/73 *Sacci v Italy* EU:C:1974:40 paras. 13, 14; Case C-67/96 *Albany International BV v Stichting Bedrijfspensioenfonds Textielindustrie* EU:C:1999:430, para. 79.

[99] Lianos (n 74) p. 78.

[100] Ibid.

[101] Jake Frankenfield, 'Blockchain-as-a-Service (BaaS)' (2020) <https://www.investopedia.com/terms/b/blockchainasaservice-baas.asp> accessed 29 March 2021.

not require a central authority to function: they allow for direct interaction between users and providers."[102]

In all these different intermediary situations the same two-fold approach applies: firstly, it has to be identified if the particular participant is offering a service or good, and in the further course the entity which is engaged in the economic activity shall be defined. In regard to the economic activity, generally, it can be argued that the intermediaries most likely are engaged in economic activities in the sense of Art. 101 TFEU.[103]

5. Second layer on a blockchain

The discussion above related to the activities of participants or intermediaries directly on the blockchain. One could raise the question: Does the term 'undertaking' also refer to the second layer on a blockchain?

It is quite common for blockchain applications to run a second layer above the primary code layer. This second layer allows for all types of applications to be run on the primary code.[104] For instance, a smart contract application that allows users to enforce their contractual obligations and duties on the code of Ethereum.[105] It is provided a script in form of a code (language), containing the data of the contract which are realised in a peer-to-peer manner. "[…] we refer to this principle as mining, the computers used to run the program are called nodes."[106]

It is reasonable to apply the same two-fold approach in relation to the second layer on a blockchain. Thus, for each individual situation it shall firstly be identified if the particular participant is offering a service or good, and in the further course the entity which is engaged in the economic activity shall be defined.[107]

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[102] Shaan Ray, 'What is a DAPP?' (2018) <https://towardsdatascience.com/what-is-a-dapp-a455ac5f7def> accessed 28 March 2021.

[103] Eg.: Lianos (n 74) p. 78 f.

[104] See Part II; cf. Hutchinson (n 47).

[105] Existek, 'What are Smart Contract. Examples and Use Cases' (2018) <https://existek.com/blog/what-are-smart-contracts-examples-and-use-cases/> accessed 29 March 2021.

[106] Ibid.

[107] Cf. Lianos (n 74).

6. Exceptions

It is established that not all activities are an economic activity that trigger the application of EU competition law. In this regard, specific focus is laid on activities relating to 'solidarity' and 'powers of a public authority'.[108]

The prior refers to situations where social protection is granted; for instance, social security, pensions, health insurance or healthcare.[109] The distinctive element is to be found in the fact that it has to be of an uncommercial character.[110] The concept has been defined by AG in *Sodemare:* "Social solidarity envisages the inherently uncommercial act of involuntary subsidization of one social group by another. Rules closely connected with financing such schemes are more likely to escape the reach of the Treaty provisions on establishment and services. Thus, pursuit of social objectives on the basis of solidarity may lead Member States to withdraw all or part of the operations of social security schemes from access by private economic operators."[111] From a technical perspective it can be argued that the application of social activities on a blockchain is possible and beneficial for society since ensuring transparency, avoiding fraud, shaping clarity and reducing costs.[112] Moreover, there are no reasonable, legal arguments to be found for the conceptualisation of 'solidarity' not to be applicable to such types of blockchain applications.

Further, another exception is 'public authority'.[113] The exercise of 'public authority' is not economic if it "[…] is connected by its nature, its aim and the rules to which it is subject with the exercise of powers relating to the protection of the environment which are typically those of a public authority."[114] For instance, blockchain technology already found acceptance in some areas of public authority: vaccination evidence. Ubrich, IBM and others have been announced to develop a vaccination evidence system ('vaccination booklet') which is based

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[108] Whish (n 63) p. 89 f.

[109] Ibid; Lianos (n 74).

[110] Eg.: ibid; Cases C-264/01, C-306/01, C-354/01 and C-355/01 *AOK Bundesverband u.a.* EU:C:2004:150.

[111] Case C-70/95 *Sodemare SA a.o.* EU:C:1997:301 Opinion of AG Fennelly, para. 36.

[112] Cf. Asure Network Team, 'Blockchain as the future of social security — Intro' (2018) <https://medium.com/asurenetwork/blockchain-as-the-future-of-social-security-intro-1-5-2a600e64ac7b> accessed 29 March 2021.

[113] Whish (n 63) 90 f.

[114] Case C-343/95 *Diego Cali & Gigli Srl* EU:C:1997:160, para. 23; further, Case C-364/92 *SAT Fluggesellschaft mbH* EU:C:1994:7; cf. Lianos (n 74).

on a blockchain technology application.[115] It can be argued that the activity of certifying individuals in a society with the proper vaccination evidence (booklets), listing the utilised vaccination, etc can be closely connected to the State and its function.

Moreover, the exercise of public power can be arguably observed in deeds which are run on a blockchain by a municipality.[116] A further example is the application of blockchain in governmental affairs such as elections of public authorities. If a blockchain-based voting system is implemented it can be argued that it comprises of elements from both government and public infrastructure in order to fulfil the task of providing for a voting system in a State.[117] Thus, the application arguably is utilised in order to exercise public authority.

7. 'Single economic entity': a blockchain entity?

In the following it shall be analysed whether or not a blockchain is an entity. The answer thereto would have significant impact not only on questions on liability for the actions taken, but, moreover, it impacts the applicability of Article 101 TFEU. The latter is not applicable to agreements or concerted practices between legal persons which are a legal or economic entity. This is based on the idea that they constitute a single unit / undertaking, and consequently they do not fulfil the requirement of 'agreement between them'.[118] Blockchain's design gives cause for discussion: Is a blockchain a single entity or are the nodes separate entities?[119]

As a starting point the findings of the ECJ in *Hydrotherm* are of guidance; it stated that: "In competition law, the term "undertaking" must be understood as designating an economic unit for the purpose of the subject-matter of the agreement in question even if in law that economic unit consists of several persons, natural or legal. The requirement […] is therefore fulfilled if one of the parties to the agreement is made up of undertakings having identical interests and controlled by the same natural person, who also participates in the agreement. For in those circumstances competition between the persons participating together, as a single

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[115] Heise Online, 'Digitaler Corona-Impfpass: IBM, Ulrich und fünf Blockchains' (2021) <https://www.heise.de/news/Digitaler-Corona-Impfpass-IBM-Ubirch-und-fuenf-Blockchains-5076161.html> accessed 29 March 2021.

[116] See exemplification of potential use-cases in Part II.

[117] Andrew Barnes et al., 'Digital Voting with the use of Blockchain Technology' (Plymouth University) <https://www.economist.com/sites/default/files/plymouth.pdf> accessed 17 January 2021.

[118] Whish (n 63) p. 95; Lianos (n 74) p. 79.

[119] Cf. Lianos (n 74).

party, in the agreement in question is impossible."[120] The ECJ further stated that an economic entity is characterised by: "[…] a unitary organization of personal, tangible and intangible elements which pursues a specific economic aim on a long-term basis […]."[121] Thus, the central question is whether or not the participants on a blockchain as well as other intermediaries that interconnect with / on a blockchain are defined as one single unit.

At first sight, the fact that a blockchain, due to its decentralised structure which lacks a traditional intermediary, does not have a central, controlling unit in the traditional sense leads to the conclusion that the nodes may not be considered to be a single economic entity. Moreover, since they are considered an undertaking in the sense of competition law anticompetitive agreements between them do fall within the scope of Art. 101 TFEU.[122]

However, situations may occur on a blockchain which mirror constellations where control is exercised, and thereby Art. 101 TFEU might not be applicable. The first situation refers to constellations on a public blockchain. It is possible that a node (or groups of nodes) controls the majority of the blockchain. One of the most illustrative examples is, for instance, a 51% attack which can be described as an attack whereby "controlling the majority of the computing power on the network, an attacker or group of attackers can interfere with the process of recording new blocks. They can prevent other miners from completing blocks, theoretically allowing them to monopolize the mining of new blocks and earn all of the rewards."[123] This phenomenon has to be understood in conjunction with the consensus protocol of a blockchain. For instance, if the blockchain is based on a Proof-of-work protocol (which most public blockchains currently are), it is the node(s) with the most computational power that has the control over the hashing and therefore over the other nodes.[124] One could argue that this may be such control as described by the ECJ in *Hydrotherm*. However, it shall also be taken into account that the nodes may not necessarily have identical interests. Therefore, arguing in favour of such an interpretation may lack reasonable arguments and requires a case-by-case analysis.

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[120] Case C-170/83 *Hydrotherm Gerätebau GmbH v Compact del Dott. Ing. Mario Andreoli & C. Sas* EU:C:1984:271, para. 11; further, Case C-217/05 *Confederación Española de Empresarios de Estaciones de Servicio* EU:C:2006:784, para. 40; Cases C-628/10P and C-14/11P *Alliance One International and Standard Commercial Tobacco v Commission and Commission v Alliance One International and Others* EU:C:2012:479, paras. 46 f.

[121] Case T-11/89 *Shell International Chemical Company v Commission* EU:T:1992:33, para. 311.

[122] Cf. Hutchinson (n 47); Lianos (n 74).

[123] Jake Frankenfield, '51% attack' (2019) <https://www.investopedia.com/terms/1/51-attack.asp> accessed 01 April 2021.

[124] Ibid.; Lianos (n 74) ; see also technical outlining in Part II.

A second scenario relates to intermediaries, for instance, a mining pool. A mining pool comprises of a group of cryptocurrency miners who are gathering their computational power/resources over a network in order to strengthen the probability of solving the mathematical riddle whereby a block is mined.[125] Due to the collective computational power they have decisive power and control over the blockchain and therefore over other nodes. The scope of existence of power, economic as well as legal links and control would have to be analysed in accordance with the respective protocol (PoW, PoS, or other forms of consent).[126] Moreover, in regard to mining pools, it can further be argued that miners may claim to be employees or agents of the mining pool and thereby Art. 101 TFEU does not apply.[127]

The third scenario concerns private blockchains. A private blockchain is "controlled by a centralized entity which determines who can interact with the blockchain, verify transactions, and who can view the information recorded on the blockchain."[128] Thus, it is arguable that a single economic entity exists because a centralised unit/entity is exercising decisive influence and control over other nodes, and the entity most likely is pursuing a specific economic purpose. The elements of control concern, for instance, the type of consensus, information flow and transaction interaction.[129] The conceptualisation of private blockchains leaves scope for the possibility that the single economic entity doctrine applies.

The scenarios described above have a common element; namely, that occasions may occur where nodes on a blockchain are not able to decide independently upon their own conduct. It can be stated that they are forced to follow the instructions by the controlling node(s). This would lead to a non-application of Art. 101 TFEU because the agreement is not concluded between two or more separate undertakings but forms part of a single economic entity.[130]

However, taking the well-established concept of 'functional approach' into consideration combined with the idea of 'effet utile', it has been observed that the ECJ tends to "[…] basing

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[125] Jake Frankenfield, 'What is a Mining Pool?' (2021) <https://www.investopedia.com/terms/m/mining-pool.asp> accessed 02 April 2021.

[126] Cf. Lianos (n 74) p. 79.

[127] Ibid. p. 85.

[128] Cryptopia Staff, 'Types of Blockchain: PoW, PoS and Private' (2021) <https://www.gemini.com/cryptopedia/blockchain-types-pow-pos-private> accessed 01 April 2021.

[129] Cf. ibid.

[130] Cf. Lianos (n 74).

itself, whenever possible, on what can be actually observed in the market."[131] Having said that, a result where Art. 101 TFEU inevitably is inapplicable in situations such as the scenarios mentioned above seems of an unconvincing nature. This is substantiated by the following arguments: it is likely that nodes not always enjoy autonomy and can be subject to control due to technical reasons. However, taking factors such as economic links into consideration or the organisational structure — from a functional and practical perspective — the application of the concept of a single entity in such constellations may be possible but also critical.[132] This is caused by the fact that nodes generally do not comprise of any such connections. The only way they are connected with each other is the fact that every node has a 'copy' of the ledger.[133] It seems difficult to argue that this comprises an organisational structure. Furthermore, there is no economic link between the nodes; apart from situations where nodes are grouping up in order to collectively mine in a pool and are sharing the reward.[134] Again, it seems though rather an unrealistic approach to argue in favour of the existence of economic links between nodes. Another aspect that substantiates the critical assessment relates to the legal links between nodes. Nodes are not subject to any type of legal connection. Every electronic device can constitute a node on the network without having to be subject to legal commitments apart from accepting the consent mechanism.[135]

However, the situation may be different in regard to the structure of private blockchains, mining pools or other specifically organised entities of such kind which follow a particular (collective) purpose. One may argue that they have some form of organisational structure and economic connection.[136] The evaluation would have to undertake a case-by-case study in order to be able to precisely determine the situation.

It can be concluded that the application of the single economic entity doctrine may be possible but bears difficulties. Moreover, from a practical point of view, it is a time and resource consuming and eventually even technically challenging task to establish the facts. For instance, Etherscan observed that at a given time were 2334895 nodes to be found on

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[131] Erik Kloosterhuis, 'Defining non-economic activities in competition law' (European Competition Journal, 13:1) p. 117 (124).

[132] Similar discussion in regard to agency and employment of miners. See Lianos (n 74).

[133] See technical outlining in Part II. Cf. Jimi S. (Good Audience), 'How does blockchain work in 7 steps — A clear and simple explanation' (2018) <https://blog.goodaudience.com/blockchain-for-beginners-what-is- blockchain-519db8c6677a> accessed 19 January 2021.

[134] Lianos (n 74).

[135] Similar, ibid.

[136] Ibid.

Ethereum.[137] Though, on the other hand, it seems unlikely that the European Commission would shy back from analysing who bears the liability of anticompetitive behaviour on a blockchain only because of challenges in establishing the facts.[138]

B. Agreements and concerted practices

1. General remarks: defining behaviour on a blockchain

As it has been outlined above one of the core elements or features of the technology is the real-time, easily accessible and permanently unchangeable data transfer (storage) on the blockchain ledger. This includes the storage of any type of data and can — but does not have to — involve other parties.[139] This leaves scope for questions regarding the application of Art. 101 TFEU because the provision only captures agreements between undertakings.[140] Thus, the challenge with the application of blockchain technology is to determine what and when behaviour on a blockchain constitutes unilateral behaviour, an agreement or concerted practice.

2. An agreement or concerted practice on a blockchain

The concept of agreement is described as any type of cooperation not subject to specific formalistic requirements. The concept is interpreted broadly and covers almost all types of commercial agreements.[141] The ECJ held that the term 'agreement' "centres around the existence of a concurrence of wills between at least two parties, the form in which it is manifested being unimportant so long as it constitutes the faithful expression of the parties' intention."[142] This includes gentlemen's agreements, simple memorandums of understanding, contracts, protocols or terms and conditions, etc.[143] Thus, it does not matter, whether the agreement is in written, informal, legally non-binding, verbal, etc. The concept of concerted

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[137] Etherscan, 'Nodes' (2021) <https://etherscan.io/nodetracker#> accessed 01 April 2021.

[138] Cf. Falk (n 25).

[139] Eg.: Ameer Rosic, 'What is Blockchain Technology?'<https://blockgeeks.com/guides/what-is-blockchain-technology/> accessed 12 January 2021.

[140] Whish (n 63).

[141] Whish (n 63) p. 103.

[142] Case T-41/69 *Bayer AG v. Commission of the European Communities* EU:T:2000:242, para. 69.

[143] Whish (n 63) p. 104.

practice covers situations whereby such an agreement has not been concluded but undertakings practically are cooperating.[144]

One may start the analysis with the following assumption: What applies to the analogue world also applies to the digital world. This means that it is irrelevant what tool is utilised to conclude an agreement or concerted practice competition law has to be complied with. By joining a blockchain all participants of the network are automatically covered by the applicable consensus mechanism, which forms an essential part of the transaction and verification process of data.[145] This also means that nodes are inevitably part of any process on a blockchain: for instance, A submits price information on a blockchain. The network (nodes) verifies the transaction in accordance with the respective Protocol and all nodes store the data.[146] As stated above, it is irrelevant whether an agreement is concluded by a human or a machine or a decentralised system working according to a protocol. By acceptance of the consent protocol on a blockchain, at first sight, one may argue that all nodes are entering into agreements.[147]

However, the following shall be considered, for instance, in conjunction with Bitcoin it can be observed that "miners contribute to the operation of the Bitcoin blockchain by validating the blocks, thus, exercising an economic activity, to the extent they may receive compensation for this activity. In performing this activity, they abide by the consensus process put in place by the blockchain protocol."[148] The question to be answered is whether such behaviour by nodes on a blockchain faithfully expresses such an intent to conclude an agreement? Examples of the analogue world shed some light, for instance, meetings of associations.[149] It is well-established that members of an association have to refrain from sharing sensitive information since being competing undertakings. Assuming the members are holding a meeting and sensitive information is shared by some it is the task of each

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[144] Beatrice Roxburgh, 'Competition Law 2020' (2020) para. 2.1.1. ff.

[145] Sebastian Louven, 'Antitrust by Design – kartellrechtliche Technik Compliance für Algorithmen, Blockchain und Plattformen?' (Zeitschrift für Innovations- und Technikrecht, 6. Jg., 2018) p. 165 (179).

[146] See more detailed in Part II and V.

[147] Cf. Lianos (n 74).

[148] Lianos (n 74) p. 81.

[149] Konkurrence,- og Forbrugerstyrelsen, 'Informationsaktiviter i brancheforeninger. Vejledning' (2014) <https://www.kfst.dk/media/1727/20141210-informationsaktiviteter-i-brancheforeninger.pdf> accessed 01 April 2021.

member to immediately, actively distance itself from the behaviour; since otherwise, it is assumed to be seen as an expression of an intent to collude.[150]

Nevertheless, when drawing an analogy to blockchain it bears the risk that everyone on the blockchain may be found to be a participant in a collusive agreement or concerted practice which seems a far reaching consequence especially when taking into consideration that unlawful behaviour could already be considered to occur the very moment information is stored on the blockchain without.[151]

3. Concurrence of wills on a blockchain

As stated above, in order for Art. 101 TFEU to be applicable it is necessary that there exists "concurrence of wills between at least two parties, the form in which it is manifested being unimportant so long as it constitutes the faithful expression of the parties' intention. For there to be an agreement within the meaning of Article 85(1) of the Treaty it is sufficient that the undertakings in question should have expressed their joint intention to conduct themselves on the market in a specific way."[152] There is not much material to be found in relation to blockchain and concurrence of wills. However, one author stated that "it is also possible that the conduct may fit into the category of concerted practice. In this case, it is not necessary to prove the existence of an offer and acceptance, but one should, at least, bring evidence that the concerted action is 'the result of a consensus', which equally encompasses 'tacit approval.'"[153]

Taking the technical outlining into consideration it can be held that nodes (best case) do not per se give their consent to anticompetitive behaviour. However, the fact that they continuously contribute to a specific operation may equal to acquiescence. This is based on the idea that validating a block by hashing requires a mutual understanding insofar as a node trusts the fact that other miners will accept newly mined blocks.[154] One may argue that the conduct of mining is considered as unilateral behaviour. However, actually the nodes are showing concurrence of wills which can be described as follows: "By authenticating the transaction, they make sure that the proof string really solves the encryption puzzle, these

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[150] Ibid.

[151] Cf. Falk (n 25).

[152] Case C-2/01 P and C-3/01 P *Bundesverband der Arzneimittel-Importeure eV* EU:C: 2004:2, para. 97. This relates to offer and acceptance; though, the ECJ accepts tacit acquiescence, eg.: Whish (n 63).

[153] Lianos (n 74) p. 82.

[154] Cf. ibid.

being considered as equivalent to 'voting' in favor of the integration of the transaction in the blockchain."[155]

Thus, conclusively, there are reasonable arguments for applying Art. 101 TFEU.

C. 'The relevant market' for a blockchain

1. General considerations

The definition of the relevant geographic and product market can be considered to be the most critical factor of competition law analysis. Especially with regard to the application of blockchain technology the proper definition of the relevant market plays a pivotal role in constellations relating to situations infringing Art. 101 TFEU (vertical and horizontal restraints).[156] The OECD held that the market definition is "[…] the most powerful tools competition authorities use to examine and evaluate competition problems."[157] The powerful character of the definition of the relevant market is based on the fact that it impacts the identification of competition constraints.[158]

At the time of issuing the Commission's Notice on Market Definition the Commission emphasised that the market definition is setting the boundaries of competition between undertakings and its purpose is to apply a systematic concept to identify the competitive restraints of the undertakings involved.[159] However, it shall also be taken into consideration that the Commission's Notice dates back to 1997 which means that the approaches and circumstances were different compared to the rather complex, digital economy of today. Some framed it as follows: "The Market Definition Notice remains valid in its core. It does

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[155] Ibid.

[156] Cf. Falk (n 25); cf. Thibault Schrepel, 'Is Blockchain the Death of Antitrust Law? — The Blockchain Antitrust Paradox' (Georgetown Law Technology Review, 2019) 281 (302).

[157] OECD, 'Defining the Relevant Market in Telecommunications' (2014) <https://www.oecd.org/daf/competition/Defining_Relevant_Market_in_Telecommunications_web.pdf> accessed 10 February 2021 p. 9.

[158] Ibid.

[159] Commissions Notice on Market Definition of relevant market for the purposes of Community competition law [1997] OJ C 372/5 para. 1.

however require updating to ensure that it continues adding value and provides guidance for both merger and antitrust analysis."[160]

The following analysis of the relevant product and geographic market shall provide an overview of the potential challenges in relation to the current approach to define markets.

2. The product market

The classic definition of the product market according to the Commission's Notice is described as follows: "A relevant product market comprises all those products and/or services which are regarded as interchangeable or substitutable by the consumer, by reason of the products' characteristics, their prices and their intended use."[161] The market definition adopts the so-called 'SSNIP-test' (hypothetical monopolist test)[162] and mainly bases its findings on demand substitutability.[163] The 'SSNIP-test' can be described as a "[…]speculative experiment, postulating a hypothetical small, lasting change in relative prices and evaluating the likely reactions of customers to that increase. The exercise of market definition focuses on prices for operational and practical purposes, and more precisely on demand substitution arising from small, permanent changes in relative prices."[164]

Applying the 'SSNIP-test' to blockchain technology leads to the central task to evaluate what type of products that the undertakings involved are offering "and the area in which they sell them, additional products and areas will be included in, or excluded from, the market definition depending on whether competition from these other products and areas affect or restrain sufficiently the pricing of the parties' products in the short term."[165] In order to illustrate the challenge of finding interchangeable products the following examples shall shed some light on the issues that can arise. Ethereum is probably one of the more commonly known blockchain product on the market. It is described as: "[…] an alternative protocol for building decentralized applications, providing a different set of tradeoffs […] for a large class of decentralized applications, […]. Ethereum […] is essentially the ultimate abstract

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[160] The European Consumer Organisation, "Market Definition in EU Competition Law Enforcement: Need for an Update" (2020) <https://www.beuc.eu/publications/beuc-x-2020-092_beuc_response_public_consultation_on_market_definition.pdf> accessed 12 March 2021.

[161] Commission (n 159) para. 7.

[162] Whish (n 63) p. 27.

[163] Ibid. p. 28.

[164] Commission (n 159) para. 15.

[165] Ibid. para. 16.

foundational layer: a blockchain with a built-in Turing-complete programming language, allowing anyone to write smart contracts and decentralized applications […].”[166] An other example is Bitcoin: it is possible to transfer Bitcoins, pay bills or prove credit worthiness or simply just store tokens.[167] A third example, that illustrates the broad functionality and application of the technology, is a blockchain application introduced by the Swedish Land Registry Authority (Lantmäteriet) which shall be utilised as a registry for land and property (ChromaWay private blockchain).[168] The examples of the different blockchain applications illustrate that the Commission's Notice might have to be interpreted more progressively — since blockchain technology comprises a vast variety of multilayered sets of applications, layers, use-cases and participants—[169] in order to answer the central question of which products may be interchangeable. For instance, is it the technology in itself in form of blockchain layer 1 that is forming part of one market or do the layers built on a blockchain form a market (combined or without layer 1)? Or does a progressive interpretation of the SSNIP-test even conclude with a market combining blockchain-applications and non-blockchain-applications?[170]

First of all, it shall be pointed out that blockchain in itself is a technology in form of a code. It can be argued that blockchain technology and applications relating to layer 1 (code) may constitute a market in itself.[171] This is based on the following considerations: Blockchain is a mathematically complex software code. Taking the above mentioned examples into consideration layer 1 (code) might be considered to be interchangeable relating to demand, subject to the condition that the different codes fulfil the same purpose. Thus, if it is possible for consumers in case of a 5% — 10% hypothetical price increase to switch the code of layer 1 for different types of applications there is a probability that it can be considered to constitute one product market. Moreover, regarding the supply substitutability, if it is possible for developers, coders, etc to swiftly make changes to their product in case of the 5% — 10% hypothetical price increase without investing tremendous resources, etc it supports the

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[166] Ethereum, 'Whitepaper' (2021) <https://ethereum.org/en/whitepaper/> accessed 12 March 2021.

[167] Bitcoin, <https://bitcoin.org/da/kom-i-gang> accessed 10 April 2021.

[168] GovChain, <https://govchain.world/sweden/> accessed 10 April 2021.

[169] See also technical description in Part II; cf. Organisation (n 160).

[170] Cf. Thibault Schrepel, 'Is Blockchain the Death of Antitrust Law? — The Blockchain Antitrust Paradox' (Georgetown Law Technology Review, 2019); Hutchison (n 48); Lianos (n 74).

[171] Cf. Falk (n 25); ibid.

assessment of different blockchain layer 1 (codes) constituting a market.[172] This can be substantiated by a comparison to 'classic' software applications. 'Software' codes form different markets based on their specific functions and interchangeability. For instance, the European Commission elaborated on the product markets in the light of the Microsoft - Skype merger which relates to software products. It concluded that: "The notified operation concerns the consumer and enterprise communications markets. Both consumers and enterprises rely on services which integrate a number of communications functionalities (mainly IM, voice and video calls) [...]."[173] In another example, the Commission elaborated on the market for softwares and found that there exists a specific market for "non OS-specific mobile web browsers."[174]

Moreover, as the Commission underlined: It is of importance for the assessment that it is not reduced to objective characteristics of a product, but focusses on conditions and the structure on the market.[175] Taking that approach into consideration it can be argued that layer 1 codes potentially fall within one market as long as they are substitutable. However, it has to be taken into consideration whether or not the respective blockchain comprises of specifications such as being established on a public or private basis. This has an impact on the assessment since the conceptualisation is of a different nature and is influencing the interchangeability from a demand perspective.[176] For instance, an undertaking privately wanting to store or exchange data for its business operations most likely will not consider a public blockchain such as Ethereum as a substitutable alternative; also due to the different consensus-mechanisms. Thus, it can be concluded that layer 1 codes may but do not have to form one product market;[177] however, it remains critical for the relevant blockchain product market to investigate the specific application on a case-by-case basis.

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[172] See, for instance, similar discussion in regard to market power. Thibault Schrepel, 'Is Blockchain the Death of Antitrust Law? — The Blockchain Antitrust Paradox' (Georgetown Law Technology Review, 2019).

[173] *Microsoft/Skype* (Case COMP/M.6281) Commission Decision [2011] 7279 (81) para. 10.

[174] *Google/Android* (Case AT.40099) Commission Decision [2018] 4761 final.

[175] Ibid. para. 212.

[176] Cf. Lianos (n 74); Hutchinson (n 47); Gianluca Faella, Valerio Cosimo Romano, 'Artificial intelligence and blockchain: an introduction to competition issues' (2019) <https://webcache.googleusercontent.com/search?q=cache:n0WZRMo1S80J:https://awards.concurrences.com/IMG/pdf/artificial_intelligence_and_blockchain_an_introduction_to_competition_issues.pdf%3F55894/44dd0a0e316128a152f192432abb469d8ad77cc5+&cd=1&hl=da&ct=clnk&gl=dk&client=firefox-b-d> accessed 01 April 2021.

[177] Cf. Discussion in regard to market power in Hutchinson (n 47); Faella (n 176).

A further relevant aspect relates to blockchain and off-blockchain applications.[178] Shall both types of applications constitute one or a separate market? Taking cryptocurrencies into account it can be stated that any type of blockchain that is used for financial transactions theoretically is in a market competing with other cryptocurrency applications. Moreover, there is a probability that such applications compete with a variety of other electronic payment-applications.[179] At first sight, one may tend to argue that these two types of transaction applications are too different since one relates to cryptocurrencies and the other to fiat currency.[180] Especially the volatility of cryptocurrencies suggests that these two products are not interchangeable from a consumer's perspective. However, the latest developments whereby stable coins (price-stable digital assets with underlying collateral structures) were introduced in order to reduce the volatility debilitate this assumption.[181] Eventually, it has to be identified on a case-by-case basis whether or not a specific blockchain-application is considered to be interchangeable with a non-blockchain application depending on the facts and the products or services concerned.

In relation to layer 2 on a blockchain it shall be pointed out that, generally, the application of a modern interpretation of the relevant product market is substantiated by other authors which emphasise that: "[…] competition may arise at different levels: among different blockchains, among blockchains and non-blockchain substitutable technologies, as well as at different levels of the supply chain, in relation to the input or output related to the blockchain."[182] Thus, it can be argued that the type of applications (products or services) that are running on a blockchain layer 1 in form of a layer 2 applications can further constitute a critical element.[183] Thus, when focusing on the functioning of the application (service and product) it leaves scope for the conclusion that the market shall not be too narrow since "other digital products or services, and potentially, non-digital alternatives"[184] may constitute potential competing (interchangeable) products.

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[178] Cf. ibid.; Lianos (n 74); Schrepel (n 172).

[179] Cf. Falk Schöning, 'OECD publishes issues paper on blockchain and competition law' (Hogan Lovells, 2018) <https://www.hlmediacomms.com/2018/05/08/oecd-publishes-issues-paper-on-blockchain-and-competition-law/> accessed 04 April 2021.

[180] Cf. more general Faella (n 176).

[181] Cryptopedia Staff, 'Fiat Money vs. Cryptocurrency' (2021) <https://www.gemini.com/cryptopedia/fiat-vs-crypto-digital-currencies> accessed 01 April 2021.

[182] Faella (n 176) p. 4.

[183] Thibault Schrepel, 'Is Blockchain the Death of Antitrust Law? — The Blockchain Antitrust Paradox' (Georgetown Law Technology Review, 2019) p. 281 (304); ibid.

[184] Ibid.

Nevertheless, it shall also be taken into consideration that due to the fact that blockchain technology is an emerging technology no market data evaluations (market studies, consumer surveys, categories of customer evaluation, opinions of competitors and consumers, evidence of switching between products, etc.)[185] are available at the present stage. Thus, it is barely possible to sufficiently elaborate on the relevant market since it is too speculative.

3. The geographic market

Blockchain does not only bear challenges regarding the definition of the relevant product market it also requires a different approach for the definition of the geographic market. The European Commission's Notice is of guidance when stating that the relevant geographic market "comprises an area in which the undertakings concerned are involved in the supply and demand of products or services, in which the conditions of competition are sufficiently homogeneous and which can be distinguished from neighbouring areas because the conditions of competition are appreciably different in those areas."[186] Thus, the definition of the relevant geographic markets requires analysing whether the competitive conditions are different in different geographic areas.[187] This requires a case-by-case analysis that is taking into account the services and products that are run on the blockchain. For instance, the probability that the relevant geographic market is extremely broad in case of cryptocurrencies does not necessarily apply to cases of a blockchain that functions as a ledger entry for public, health services, voting system or national vaccination register. Another factor which is of significance relates to the presence of competitors in the blockchain-service, alternative applications, other non-blockchain-based infrastructures.[188]

Moreover, it has to be taken into consideration how the different legislators in different areas are reacting to the emerging technology and thereby shaping heterogeneous conditions for trade. For instance, in the area of taxation, it can be observed that cryptocurrencies are subject to different tax legislations in different States causing different conditions for trade

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[185] Whish (n 63) p. 35 f.

[186] Commission (n 159) para. 8.

[187] GSMA, 'Competition Policy in the Digital Age. A practical Handbook' (2015) p. 56. <https://www.gsma.com/publicpolicy/wp-content/uploads/2016/09/GSMA2015_Handbook_CompetitionPolicyInTheDigitalAge_English.pdf> accessed 02 April 2021.

[188] Cf. ibid.; Lianos (n 74).

with the products.[189] It is possible that States will also impose different legal measures for services or goods that are interlinked with blockchain technology which may lead to changes in the market dynamics. Thus, this may have an impact on the relevant geographic market.

V. Art. 101 TFEU: horizontal agreements

A. General remarks on horizontal agreements

Horizontal agreements are defined as agreements which are concluded between competitors (actual or potential) who operate at the same level of production or distribution on a given market.[190] The ratio of competition law is that undertakings shall act independently on the markets and compete with each other on the merits in order to achieve the best possible outcomes in terms of allocation of resources as well as consumer welfare.[191] Thus, independent undertakings who are competing or potentially competing on a particular market shall not cooperate with each other whereby their behaviour leads to distortion of competition.[192]

Horizontal agreements can have as their object or effect the distortion of competition. The term distortion by object shall be interpreted in accordance with its objective meaning and the purpose of the agreement irrespective of any intention. That means that focus is laid solely on the content and nature of an agreement.[193] In this regard the ECJ held, that certain behaviour by its very nature is harmful whereby it becomes redundant to prove any negative effects for

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[189] Skat, 'Bitcoins and other cryptocurrencies' (2021) <https://www.skat.dk/skat.aspx?oid=2291754> accessed 01 April 2021; Forbes, Seven Countries Where Cryptocurrency Investment are Not Taxed' (2018) <https://www.forbes.com/sites/rogerhuang/2019/06/24/seven-countries-where-cryptocurrency-investments-are-not-taxed/> accessed 01 April 2021.

[190] European Commission, 'EU competition rules on horizontal agreements between companies' (2021) <https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/11886-EU-competition-rules-on-horizontal-agreements-between-companies-evaluation> accessed 15 March 2021; Lennart Ritter, W. David Braun, 'European Competition Law: A Practitioner's Guide' (Kluwer, 3rd edn) p. 165 f.

[191] Ibid; cf. Case C-40/73 *Coöperatieve Vereniging "Suiker Unie" UA and others v Commission of the European Communities* EU:C:1975:174.

[192] See, remarks on Art. 101 TFEU in Part III; Whish (n 64).

[193] Whish (n 63) p. 124.

competition.[194] The latter form of distortion of competition refers to the effects of an agreement. The ECJ ruled that where the effects of an agreement or coordination have to be determined "it is necessary to find that factors are present which show that competition has in fact been prevented, restricted or distorted to an appreciable extent."[195]

Horizontal agreements between undertakings can be established in different forms, variations and types.[196] Of particular concern are agreements which have as their main purpose the sharing of markets, exchange of (sensitive) information, the collective restriction of output of products, other forms of restriction on production, quotas or the fixing of prices are considered to be hard-core restrictions of competition and therefore prohibited.[197] Some authors state that if competition law has one prioritised agenda it is to eliminate such cartel behaviour.[198] However, horizontal coordination may also occur in forms such as cooperation agreements.[199]

Essentially, anticompetitive behaviour comprises all forms and types of horizontal agreements or concerted practices if "that regulates or influences market conduct."[200] In the light of blockchain technology it shall be borne in mind that particular use of blockchain applications may enhance coordinated behaviour amongst competitors or potential competitors whereby market conduct is influenced.[201] Generally, the technical specifications allow for secrecy, collaboration and access to information for authorised members without having to rely on meetings, a middleman or other types of communication activities.[202]

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[194] Case C-67/13 P *Groupement des cartes bancaires v. European Commission* EU:C: 2014:2204 para. 50 ff.

[195] Ibid. para. 52; Case C-32/11 *Allianz Hungária Biztosító Zrt and others v. Gazdasági Versenyhivatal* EU:C:2013:160, para. 32.

[196] Bundeskartellamt, 'Effective cartel prosecution: Benefits for the economy and consumers' (2016) <https://www.bundeskartellamt.de/SharedDocs/Publikation/EN/Brosch%C3%BCren/Brochure%20-%20Effective%20cartel%20prosecution.pdf?__blob=publicationFile&v=13> accessed 15 March 2021; Whish (n 64).

[197] Bundeswettbewerbsbehörde, 'Kartelle und Marktmachtmissbrauch' (2021) <https://www.bwb.gv.at/kartelle_marktmachtmissbrauch/> accessed 15 March 2021.

[198] Cf. Whish (n 63) p. 547.

[199] Cf. ibid.

[200] Ritter (n 190) p. 167.

[201] Cf. Hoffer/Mirtchev, 'Erfordert die Blockchain ein neues Kartellrecht?' <https://www.bindergroesswang.at/fileadmin/user_upload/Media_Library/Publications/PDF_Publications/NZKart_2019__Erfordert_die_Blockchain_ein_neues_Kartellrecht_239_-_beck-online.pdf> accessed 01 May 2021.

[202] Ibid.

Information is shared directly, in real-time without tampering with the data.[203] Some authors point out that by applying blockchain technology it "is believed this would promote trust among members and reduce the incentive to cheat on the cartel agreement."[204]

In the following analysis a selection of scenarios of potential anticompetitive behaviour on the horizontal level is discussed which either are likely to occur due to blockchain's conceptualisation, are of a general risky nature, pose other types of specific legal challenges or contribute to the establishment as well as continuation of a cartel. As indicated above due to the technology's concept the exchange, display and storage of information is of a central concern and therefore requires more detailed technical as well as legal analysis. Other potentially anticompetitive behaviour can be identified more easily which is mirrored in the different length of the individual chapters.

B. Exchange of information

1. Exchange of information and its anticompetitive character

In order to thrive on a market undertakings frequently exchange various types of information via different channels which, on the one hand, can lead to further competition, efficiency gains and transparency, and, on the other hand, it can lead to a facilitation of collusive behaviour.[205] An agreement or concerted practice whereby exchange of strategic information between competing or potentially competing undertakings takes place is considered to be one of the most significant risks to threaten competitive behaviour since it inevitably contributes to the reduction of strategic, economic uncertainty for competitors.[206] Further, it is "increasing the likelihood of coordination among the parties within or outside the field of the co-operation."[207]

However, information which does not by object or effect hamper competition is not leading to unlawful behaviour. Further, in other cases exchange of information could eventually be

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[203] See technical outlining in Part II.

[204] Ching Tat Chan, 'Collusive behaviour in permissioned blockchains' (FinTech Edition 2019, Queen Mary University London) p. 29 <https://www.qmul.ac.uk/law/media/law/docs/research/The-FinTech-Edition-2019.pdf> accessed 29 March 2021.

[205] OECD, 'Information Exchange Between Competitors under Competition Law' (2010) p. 9 <http://www.oecd.org/competition/cartels/48379006.pdf> accessed 16 March 2021.

[206] Eg.: Whish (n 63) p. 575 f.

[207] Commission Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements [2011] OJ C 11/1 para. 34.

justified by Art. 101 para. 3 TFEU, subject to the condition that the exchange of information brings efficiencies that meet the requirements of Art. 101 para. 3 TFEU.[208]

2. Exchange of information between competitors on a blockchain

Because of the sensitive character of information exchange between competitors the central question is as follows: What potential scenarios may occur in relation to the exchange of information on a blockchain? Taking the technical outlining of a blockchain into consideration it can be stated that there are inevitably potential risks when utilising a blockchain due to the technology's functioning: a tool for real-time and unfiltered exchange of information which is open and accessible to all participants (as well as any interested, potential participants), and decentralised as well as distributed amongst all participants. For example, assuming a transaction is taking place on a blockchain-based application, the transaction data is visible to all participants of the respective blockchain making it fully transparent as well as permanent.[209] This can be depicted by the following example: A transfers a particular amount of cryptocurrencies to B, the participants in the network (nodes) are verifying the transaction and gathering it in a block, closing it with a hash, and storing it on the blockchain; thus, making it visible for all.[210]

The same process takes place if a blockchain based application is utilised where participants — which could be competitors — are sharing other data than cryptocurrency transactions. For instance, a blockchain that allows its participants to store information relating to an undertaking's strategic data such as price-conditions, production information, customer data, etc. The respective data could be in form of minutes of meetings, strategic or decision papers, non-publicly available financial reports or other confidential internal records[211] since blockchain applications are not limited to cryptocurrencies but applicable to storing all types of data and transactions.

In situations where a blockchain-based application is of a public nature — meaning, the blockchain is universally accessible such as Bitcoin, Ethereum, etc — it consequently poses a high risk of anticompetitive behaviour because the information can be disseminated between

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[208] Cf. Ritter (n 190) p. 224.

[209] See technical illustration in Part II; cf. Falk (n 25).

[210] Eg.: Tradeix, 'Blockchain news' <https://tradeix.com/essential-blockchain-technology-concepts/> accessed 16 March 2021.

[211] Cf. Whish (n 63).

competitors and thereby reduces any economic and strategic risk for the undertakings.[212] Moreover, it shall be taken into consideration that blockchain technology provides an "almost real-time access to information around their competitors' activities"[213] making it by the very nature of the technology even more likely to constitute anticompetitive behaviour due to the broad insight undertakings gain without having to correspond to normal conditions and competition on the merits.[214]

One countervailing argument in the light of the above identified risk for anticompetitive behaviour due to exchange of sensitive information relates to a technical aspect of blockchain, namely, the transactions might be visible but the participant cannot necessarily be identified. This can be exemplified by Bitcoin-related transactions. It is outlined that: "addresses, private and public keys, and transactions, are all read in text strings, such as a public address, that in no way directly link to anyone's personal identity."[215] One can conclude that this minimises anticompetitive behaviour because the participants cannot be identified. However, this fact does not provide a strong argument based on the following consideration: firstly, it is technically not possible to be ruled out that a participant can be linked to the IP-address or other 'physical-world' identity;[216] and secondly, the fact that it is not possible to identify a specific participant on a blockchain does not per se eliminate the risk for anticompetitive behaviour. Moreover, it can be argued that the very idea of anticompetitive exchange of information is to transfer data in secrecy;[217] thus, the more secrecy the better and therefore blockchain — especially, private blockchains — is a useful tool to distribute information to competitors.

The above assessment relating to the potential risk for competition law infringements by exchange of information is in alignment with the general approach of the ECJ. For instance, in a case relating to exchange of information it ruled that: "[…] independence does not deprive economic operators of the right to adapt themselves intelligently to the existing or anticipated conduct of their competitors, it does, none the less, strictly preclude any direct or indirect contact between such operators by which an undertaking may influence the conduct

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[212] Cf. Lianos (n 74); Falk (n 25).

[213] Simmons&Simmons LLP, 'Blockchain and Anti-Trust (2018) <https://www.simmons-simmons.com/publications/ck0b3g41cec980b590iffp6j9/290318-blockchain-and-antitrust> accessed 16 March 2021.

[214] Ibid.

[215] Bitcoin Magazine, 'Is Bitcoin Anonymous?' (2020) <https://bitcoinmagazine.com/learning-bitcoin/is-bitcoin-anonymous> accessed 15 March 2021.

[216] Cf. ibid.

[217] Cf. Lianos (n 74).

on the market of its actual or potential competitors or disclose to them its decisions or intentions concerning its own conduct on the market where the object or effect of such contact is to create conditions of competition which do not correspond to the normal conditions of the market in question […]."[218] Thus, any kind of exchange of information in order to manipulate the behaviour of competitors on markets shall not occur.[219] This applies equally to the analogue world and the digital world.

Taking the above considerations into account, it can be concluded that the participation on a blockchain network can raise risks for anticompetitive behaviour. The very nature of the technology as an open, distributed and easily accessible technology makes it vulnerable to anticompetitive behaviour.[220] As a consequence, in case of exchange of information that is anti-competitive, it is important to publicly distancing oneself from the information received.[221] Moreover, the ECJ ruled that in case of absence of distancing from anticompetitive behaviour it is assumed that the infringement has not been brought to an end.[222] In the context of blockchain there are strong arguments that such a necessary distancing consequently means leaving the blockchain due to the fact that every participant owns a copy of the ledger and the ledger always is accessible. Moreover, due to the encryption the information cannot be deleted because this would lead to an invalidation of the blocks since the hashes would not be correct anymore.[223] Furthermore, there is a presumption that by receiving anti-competitive information it is accepted and the market conduct will be adapted.[224] This is of particular importance when applying a blockchain technology-based tool for storing and transferring information.

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[218] Case C-8/08 *T-Mobile Netherlands BV v. Raad van bestuur van de Nederlandse Mededingingsautoriteit* EU:C:2009:343, para. 33.

[219] Ibid. para. 61.

[220] Cf. Lianos (n 74); Falk Schöning, 'OECD publishes issues paper on blockchain and competition law' (Hogan Lovells, 2018) <https://www.hlmediacomms.com/2018/05/08/oecd-publishes-issues-paper-on-blockchain-and-competition-law/> accessed 01 May 2021.

[221] Cf. Case C-74/14 Eturas UAB and Others EU:C:2016:42, paras. 46 ff.

[222] Cf. Case T-377/06 *Comap SA v European Commission* EU:T:2011:108 paras. 76, 102.

[223] See Part II; cf. Falk (n 25) p. 8.

[224] Whish (n 63) p. 577.

3. Type of information on a blockchain

The general discussion above relating to the exchange of information underlines the risk for anticompetitive behaviour. However, as a general rule and as it is indicated above,[225] the analysis is depending on a variety of factors, especially, the type of information. For example, in the light of a blockchain application the assessment is dependent on the participants on the blockchain as well as the information that is shared.[226]

Information that relates to the strategic, sensitive part of an undertaking most likely constitutes (hardcore) anticompetitive behaviour.[227] Such sensitive information relates to "prices, discounts, increases, reductions or rebates, customer lists, production costs, quantities, turnovers, sales, capacities, qualities, marketing plans, risks, investments."[228] Thereby it does not make a difference if the information is shared via the blockchain or otherwise.

The conclusion is different in regard to historic information. If the information that is being exchanged is historic information, it may not necessarily raise competition concerns;[229] of course, depending on the potential impact of the information in terms of the conclusions that can be drawn to current business structures. For example, if the historic information allows a conclusion to current strategic decisions, etc, it still poses a risk to competition. However, information that is of a genuinely historic nature is less at risk of infringing competition law.[230] Furthermore, if it concerns a blockchain that distributes public information of undertakings[231] or uses the "technology for other legitimate purposes, such as a registry of executed transactions, would likely be on the safe side."[232]

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[225] Cf. ibid. p. 575 f.

[226] Cf. Lianos (n 74).

[227] Cf. Ritter (n 190) p. 224.

[228] Lianos (n 74) p. 67.

[229] Falk (n 25) p. 3; Simmons (n 213).

[230] David Wood, 'Information Exchange 2019' (2019) p. 3 <https://www.gibsondunn.com/wp-content/uploads/2019/07/Wood-Information-Exchange-2019-Eurorpean-Union-GCR-June-2019.pdf> accessed 17 March 2021.

[231] Eg.: Case C-89/85 Ahlström Osakeyhtiö and others v. Commission of the European Communities, EU:C:1993:120, para. 59;

[232] Falk (n 25) p. 3.

4. Type of blockchain

In the introduction to the technology of blockchain it has been pointed out that the technology allows for different types of access: publicly available and private blockchains which are not accessible for everyone since being based on access control and other limitations.[233] The two concepts can be of interest since both are generating benefits and restraints to competition.

A private blockchain only allows the nodes participating on the blockchain to gain knowledge of transactions stored on the network; or at least, the visibility of information can be limited.[234] Therefore, the application of a private blockchain can in some cases contribute to act in compliance with competition law since it makes it possible to exclude competitors or potential competitors to gain knowledge of the sensitive data whereas a public blockchain leads to the opposite conclusion.[235]

Some authors point out that it further depends on the market structure; namely, the type of blockchain that is utilised in an oligopolistic market has an impact on the assessment. A private blockchain "involving a small number of competitors sharing strategic and/or sensitive information is very likely to be prohibited."[236] It cannot be ignored that, for instance, the exchange of information on a blockchain could be a simplified method to facilitate a concerted practice in order to monitor already implemented transactions whereby a cartel could be maintaining price-fixing, quota or market allocation.[237] Thereby a technical detail or even paradox shall be taken into consideration which supports a more precautionary approach; namely, the identifiability of participants. As indicated above, blockchain, on the one hand, raises transparency, and, on the other hand, it is also known for providing anonymity. This can be exemplified by cryptocurrency transactions where it is known that: "[…] if you know the public address of one of these big companies, you can simply pop it in an explorer and look at all the transactions that they have engaged in."[238] This leaves scope for the necessary identification in order to constitute, contribute or maintain a cartel.

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[233] Toshedndra Kumar Sharma (Blockchain Council), 'Public v. Private Blockchain: A comprehensive comparison' <https://www.blockchain-council.org/blockchain/public-vs-private-blockchain-a-comprehensive-comparison/> accessed 20 January 2021.

[234] Cf. Hutchinson (n 47) p. 86 f.

[235] Cf. Swasti Gupta, 'Blockchain and Competition Law: New Technology, Old Challenges' (2018) <https://indiacorplaw.in/2018/10/blockchain-competition-law-new-technology-old-challenges.html> accessed 20 March 2021.

[236] Simmons (n 213).

[237] Cf. Linanos (n 84) p. 66 f.; Case T-148/89 *Tréfilunion SA v Commission of the European Union* EU:T:1995:68.

[238] Ameer Rosic, 'What is Blockchain Technology?' (2021) <https://blockgeeks.com/guides/what-is-blockchain-technology/> accessed 18 March 2021.

An interesting aspect of the application of a public blockchain relates to public exchanges of information. The Commission's Guidelines on horizontal agreements states that: "An information exchange is genuinely public if it makes the exchanged data equally accessible (in terms of costs of access) to all competitors and customers."[239] Such exchange of information is less likely hindering competition.[240] As it has been illustrated blockchain technology allows for the distributed and easy access of information for all participants at a low level of costs.[241] Thus, it can be argued that if undertakings share information which is then stored on the ledger and therefore accessible to all competitors, potential competitors, any other undertaking wishing to participate on the blockchain and customers it may serve as a beneficial knowledge to improve products and lower costs for everyone. It has to be highlighted that the "more the information is shared with customers, the less likely it is to be problematic."[242] Thereby consumers are less likely to suffer disadvantages.[243]

Eventually, it shall be kept in mind that it is a thin line between collusion and lawful exchange of information.[244] Moreover, as some authors correctly underpin: "The ledger is transaction-based, and it notes the prior transaction history. This information can be used to assess if the participant has sufficient funds, capacity, inventory, etc to complete the requested transaction based on the prior transactions that either have credited or debited the account."[245] This leaves scope for the assumption that the application bears the risk for anticompetitive behaviour.

C. Price-fixing: blockchain and its potential risk

Price-fixing equals to one of the heaviest forms of anticompetitive behaviour whereby undertakings cooperate in order to manipulate prices on a market.[246] The availability of a broad variety and vast amount of data provide undertakings with the possibility to utilise algorithms, automated decision-making tools, etc to better understand the market and price

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[239] Commission Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements [2011] OJ C 11/1 para. 94.

[240] Whish (n 63) p. 581.

[241] See Part II.

[242] Whish (n 64) p. 581.

[243] Cf. Ibid.

[244] Cf. Martin Gassler, 'Information Exchange Between Competitors in EU Competition Law' (Kluwer, 2021).

[245] Hutchinson (n 47) p. 86.

[246] Eg.: Whish (n 63) p. 557.

calculations,[247] and thereby it may have increased the probability for anticompetitive behaviour. Algorithms play a role in the light of blockchain and its potential risk for anticompetitive conduct.[248] Examples of pricing algorithms which give reason for competition-law concern also relate to blockchain. This is due to the fact that a layer 2 on a blockchain can comprise any type of algorithm while a blockchain provides the code on layer 1.[249]

Some competition authorities released studies which show that a vast majority of undertakings already use pricing algorithms.[250] It shows that pricing algorithms such as monitoring-algorithms are a well-suited tool for the observation of the market, prices and competitors.[251] For instance, algorithms can be used for reducing the risk of errors or deviations from an existent cartel price-decision. Further, algorithms are a form of facilitative tool to implement a pre-existing agreement.[252] Moreover, pricing algorithms themselves can lead to coordinated anti-competitive effects (even though an undertaking might not have intended to use an algorithm in such a manner).[253] National authorities as well as the European Commission are aware of this potential risk and it generally is held that automated tools have a further reaching impact by autonomously acting unlawfully.[254]

In the light of the above, the following shall be taken into consideration when applying algorithms in conjunction with blockchain: Algorithms provide for an easy tool to unlawfully collaborate while the colluders itself do not act on the surface and trust is established digitally.[255] For instance, in 2020 the Danish competition authorities decided on a case where

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[247] See, for instance, AI Multiple, 'Dynamic pricing: What it is, Why it matters & Top Pricing Tools' (2020) <https://research.aimultiple.com/dynamic-pricing/#leading-vendors> accessed 01 April 2021.

[248] See also Lianos (n 74).

[249] See, technical outlining in Part II; ibid. p. 66.

[250] For instance, Konkurrence,- og Forbrugerstyrelsen, 'Velfungerende Markeder' (Nr. 46, 2021) <https://www.kfst.dk/media/yecpmmxu/prisalgoritmer.pdf> accessed 01 April 2021; Bundeskartellamt, 'Algorithmen und Wettbewerb' (2020) <https://www.bundeskartellamt.de/SharedDocs/Publikation/DE/Schriftenreihe_Digitales/Schriftenreihe_Digitales_6.pdf?__blob=publicationFile&v=3> accessed 01 April 2021.

[251] Ibid.

[252] Kaela Murie, 'Pricing Algorithms: Should Competition Authorities be Worried?' (2020) <https://europeanlawblog.eu/2020/12/21/pricing-algorithms-should-competition-authorities-be-worried/> accessed 01 April 2021.

[253] Ibid.

[254] Konkurrence (n 250); Bundeskartellamt (n 250).

[255] Cf. Lianos (n 74); Kaela (n 252).

they found that Ageras (a digital platform) violated competition law by using a price-fixing mechanism. The price-fixing mechanism was a type of price algorithm that monitored prices on the platform and gave notice to the participants if prices were below a certain threshold. The competition authority considered that Ageras — by utilising the pricing mechanism — sought to influence one of the main parameters of competition, namely the price of the service provided via the platform.[256]

Combining the application of algorithms as exemplified by the aforementioned decision with the distributed, decentralised conceptualisation of blockchain anticompetitive behaviour becomes more easy to adopt and/or to maintain.[257] Thus, even though price-fixing as such is not directly caused by blockchain the rise of the technology provides for novel know-how and technical opportunities whereby the risk for anti-competitive behaviour rises as well.[258] For instance, blockchain is (almost) immutable, traceable and transparent. These features contribute to an increasing risk which may be read in conjunction with the fact that blockchain thereby provides for a high degree of trust and easy cooperation which is necessary to operate a cartel.[259] For instance, some authors even claim that "Blockchain has been posited as a solution to the problem, allowing a distributed network of individuals to reach consensus about every message, or transaction, that occurs within the network and access a record of what has occurred, without those records ever being able to be forged."[260] Blockchain technology has the potential to be the perfect tool to operate a cartel since it constitutes an enormous degree of trust and high probability that participants will abide with the agreed terms.[261]

For instance, when applying a smart contract application; meaning a layer 1 with an algorithm on layer 2 in form of a smart contract. By utilising a blockchain the following scenario could become a further aspect of competition law concern: "[..] smart contract between members of a cartel, which could condition the release of a 'guarantee', paid in cryptocurrency by each of the members of the cartel […] automatically if certain conditions

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[256] Konkurrenceråd, Afgørelse: Ageras (2020) <https://www.kfst.dk/media/ws5nbdtx/20200630-ageras-final-a.pdf> accessed 20 April 2021.

[257] Similar Lianos (n 74).

[258] Ibid. p. 66 f.; Ristaniemi (n 5).

[259] Cf. Michael Milnes, 'Blockchain: issues in Australian competition and consumer law' (Australian Journal of Competition and Consumer Law, 2018).

[260] Ibid.

[261] Cf. C. Pike, A. Capobianco, 'Antitrust and the trust machine' (2020), <http://www.oecd.org/daf/competition/antitrust-and-the-trust-machine-2020.pdf> accessed 02 April 2021.

with regard to the deviation of prices from the cartelised price are identified by one of the parties to this cartel arrangement. The implementation of this smart agreement could be ensured by algorithms relying on off-blockchain data […]."[262] Thus, a blockchain may be called an automated 'trust-apparatus' since it provides "real-time exchanges of information between network members, for example about production or pricing, in a format that can be trusted as being accurate by all network members, may well give rise to an increased likelihood of collusive behaviour between them."[263]

Thus, it can be argued that the technology constitutes a risk for anticompetitive behaviour when it is not carefully applied. This means that layer 1 as well as layer 2 have to be developed in a manner so that they are in alignment with competition law.

D. Quotas and other restrictions

An other potential risk posed by blockchain technology is raised by output restrictions, quotas and similar restraints. Restricting the output by the participants of a cartel is an other possibility to gain supra-competitive revenues and is a hardcore restriction.[264] There is little information to be found in relation to such anti-competitive behaviour on or via a blockchain. However, the following shall be taken into consideration.

As it has been argued regarding the exchange of information and price-fixing the technology in itself is not anti-competitive and therefore does not directly cause anticompetitive behaviour. However, due to its technical conceptualisation it leaves scope for the assumption that the application bears the risk to be utilised in an anticompetitive manner. In regard to limitation of output blockchain's feature to provide trust, real-time updates and knowledge about the market increase this risk. Thus, one may argue that the handling of a hardcore restriction is facilitated by blockchain.[265]

The above shall be illustrated by the following example, it is theoretically possible to establish a permissioned blockchain whereby access is only given to selected competitors.[266] These competitors decide to combine their production powers and resources in order to gain

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[262] Lianos (n 74) p. 66.

[263] Milnes (n 259).

[264] Whish (n 63) p. 568.

[265] Cf. Lianos (n 74); Simmons (n 206); Ristaniemi (n 5).

[266] See Part II; ibid.

more revenue by limiting the production output on a given market;[267] thereby, acting unlawfully. Thus, a self-executing smart contract is implemented on layer 2 of the blockchain and collusion takes place via an algorithm-based contract. For example, the smart contract automatically reduces deliveries or closes for orders if the prices fall since the output is too high. The participants receive the information on their blockchain in real-time, automatically and it is distributed to all participants. Thereby blockchain provides a high degree of trust.[268] The colluders do not have to meet because the code self-executes the information which it has been 'fed with'. Moreover, the algorithm (smart contract) automatically punishes deviators of the cartel agreement.[269]

This scenario is of a hypothetical nature but as it has been illustrated in conjunction with the application of algorithms it is possible that the technology may be used to facilitate such practices; especially, amongst businesses which already do participate in collusive behaviour.

E. Terms and conditions

Of a similar restrictive character as restrictions of quotas and other outputs are anticompetitive terms and conditions. Practical problems may occur, for instance, where small players on a market find themselves in competition with one or two powerful players.[270] The issue that arises is that there is a strong incentive "to coordinate and collectively negotiate terms and conditions of supply with the more powerful buyer."[271] Considering that smart contracts are automatically executing themselves — subject to the fulfilment of the requirements implemented in the underlying code — it seems intriguing to utilise such a technology.[272] A potential scenario may constitute the codification of particular anti-competitive terms and conditions which additionally set out punishments for

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[267] Cf. Lianos (n 74).

[268] Ibid.; Hutchinson (n 47); Milnes (n 259); similar, Ernst & Young LLP, 'Discussion Paper on blockchain technology and competition' (2021) p. 38 f. <http://www.cci.gov.in/sites/default/files/whats_newdocument/Blockchain.pdf> accessed 18 April 2021.

[269] In regard to information exchange and automatised punishment, see Lianos (n 74); Ristaniemi (n 5).

[270] Whish (n 63) p. 573.

[271] The Competition Authority, 'Notice on Activities of Trade Associations and Compliance with Competition Law' (2009) p. 20 <https://www.ccpc.ie/business/wp-content/uploads/sites/3/2017/05/N-09-002-Notice-on-Activities-of-Trade-Associations-and-Compliance-with-Competition-Law.pdf> accessed 23 April 2021.

[272] Cf. Ernst (n 268); Ristaniemi (n 5).

deviators.[273] Furthermore, it shall also be taken into consideration that standardisation measures bear a further, more general risk; namely, "standardisation efforts, by their nature, require communication and cooperation between competitors. If not carefully managed, this can spill over into unlawful information exchange."[274]

One can refer to the concept of blockchain which allows for enormously easy, open and fast information exchange which may lead to a higher incentive to exchange information. Thus, this may lead to a risk of anticompetitive behaviour on the blockchain via standardisation agreements, even though the technology itself does not directly cause the anticompetitive behaviour.[275]

Moreover, not only in cases where the participants share intent to collude but also unintended scenarios are possible. For instance, a trade association which has the necessary knowledge and data of competitors or potential competitors has to act even more carefully when codifying standardised terms and conditions so that no collusive behaviour occurs. In this regard the following aspect shall be borne in mind in the light of permissioned blockchains: In situations where trade associations fulfil its task via a permissioned blockchain and apply respective membership criteria which are not objectively necessary, for instance, membership is restricted on basis of economic power, area, etc. it may lead to anticompetitive effects if the criteria are not based on objective reasons such as cybersecurity, data protection, etc; further competition concerns can theoretically occur if blockchain-based standardisation activities such as terms and conditions are adopted lawfully but access to the permission-based blockchain is denied.[276]

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[273] Eg.: Ristaniemi (n 5).

[274] Simmons (n 213).

[275] Cf. Ristaniemi (n 5); Simmons (206).

[276]Simmons (n 213).

VI. Art. 101 TFEU: vertical agreements

A. General remarks on vertical agreements

Contrary to the constellations discussed above (horizontal agreements) vertical agreements concern non-competing undertakings.[277] In this regard, Regulation 330/2010 provides a useful definition:"[…] 'vertical agreement' means an agreement or concerted practice entered into between two or more undertakings each of which operates, for the purposes of the agreement or the concerted practice, at a different level of the production or distribution chain, and relating to the conditions under which the parties may purchase, sell or resell certain goods or services."[278]

Generally interaction between undertakings which are operating at different levels on a particular market is considered to be less harmful than interaction between competitors or potential competitors (horizontal level).[279] Therefore, it has been controversial whether or not Art. 101 TFEU shall be applicable to vertical agreements.[280] Eventually, it is commonly accepted that Art. 101 TFEU can be applied because vertical agreements can have as their object the restriction of competition; thus, they may be unlawful.[281] Moreover, with regard to an effects-based approach it also is accepted that vertical agreements are "likely to raise competition concerns only where there is a degree of market power at the level of the supplier or buyer or at both levels."[282]

The Commission's Guidelines on Vertical Restraints identify 4 main areas of concern: firstly, vertical agreements can lead to "anticompetitive foreclosure of other suppliers or other buyers by raising barriers to entry or expansion;"[283] secondly, it can lead to a "softening of competition between the supplier and its competitors and/or facilitation of collusion amongst

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[277] Whish (n 63) p. 655 f.

[278] Commission Regulation (EU) No 330/2010 of 20 April 2010 on the application of Article 101(3) of the Treaty on the Functioning of the European Union to categories of vertical agreements and concerted practices, OJL 102 [2010] Art. 1 para. 1 lit. a.

[279] Eg.: Case C-32/11 *Allianz Hungária Biztosító Zrt. and Others v Gazdasági Versenyhivatal* EU:C:2013:160, para. 43.

[280] Whish (n 63) p. 661.

[281] Cf. Demian MB Garard, 'The effects-based approach under Article 101 TFEU and its paradoxes: modernisation at war with itself?' (Seventh Annual Conference of the Global Competition Law Centre, College of Europe, October 2011).

[282] Whish (n 63) p. 662.

[283] Commissions Notice on Guidelines on Vertical Restraints [2010] SEC (2010) 411 para. 100.

these suppliers, often referred to as reduction of inter-brand competition"[284]; thirdly, it can also lead to a "softening of competition between the buyer and its competitors and/or facilitation of collusion amongst these competitors, often referred to as reduction of intra-brand competition if it concerns distributors' competition on the basis of the brand or product of the same supplier;"[285] and lastly, it can lead to "the creation of obstacles to market integration, including, above all, limitations on the possibilities for consumers to purchase goods or services in any Member State they may choose."[286] Further, different anticompetitive restraints which are considered to be hardcore restrictions have been identified; for instance, resale price maintenance, territorial protection, customer restrictions, etc.[287]

It can be argued that due to the technological conceptualisation of blockchain it may be a highly efficient tool for streamlining vertical commercial relations. For instance, it seems likely that blockchain technology can be used to gain supply chain automatisation, more sophisticated monitoring and reporting mechanisms, easier information distribution, real-time information update on markets, etc.[288]

The application or implementation of blockchain-based tools in vertical agreements is not in itself anti-competitive, however, there is a probability that such technologically advanced tools — depending on their application — may lead to anticompetitive behaviour such as resale price maintenance, tying agreements, etc. The risk for anticompetitive behaviour stems from the fact the technology's features facilitate such behaviour; especially, if it is combined with further layers of algorithms.[289]

B. Tying agreements

Tying agreements are a not an unknown phenomenon in the world of competition law and technology. For instance, Microsoft became renowned when having been obliged "to address competition concerns related to the tying of Microsoft's web browser, Internet Explorer, to its

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[284] Ibid.

[285] Ibid.

[286] Ibid.

[287] Eg.: Whish (n 63) p. 702 f.

[288] See outlining of use cases in Part II.

[289] Cf. Ristaniemi (n 5); Ernst (n 268); Simmons (n 213).

dominant client PC operating system Windows."[290] As the example already indicates, tying agreements arise in situations where a supplier of a particular product (the 'tying product') imposes conditionally on a particular buyer the obligation to purchase a further, separate product.[291] The Vertical Guidelines point out that in relation to vertical agreements such tying agreements are subject to Art. 101 TFEU "where it results in a single branding type of obligation […] for the tied product."[292]

In regard to blockchain applications the following scenario may occur: Similarly to the Microsoft-case, a provider of mining hardware ties its buyers to use other, particular products which the hardware producer offers.[293] This scenario is not utopian given the circumstance that there seems to be a fiercer market for mining hardware and semiconductors. For instance, it has been stated that: "There are millions of individual ASICs running at any given time, though these are turned on and off based on the difficulty, competition and, ultimately, the profitability of bitcoin mining at any moment."[294] Taking the market of mining hardware and other semiconductor products into consideration a manufacturer may tend to tie its own products to specific other products which — depending on the circumstances — may result in anticompetitive behaviour.

A further example relates to Facebook and the Libra-Association with its Libra cryptocurrency and Calibra as the wallet that operates within the Facebook ecosystem (Messenger, WhatsApp, etc). Some scholars point out that there is a risk for anticompetitive tying agreements. For instance, there is a probability that Facebook may automatically create a cryptocurrency-wallet (Calibra) for each Facebook user whereby it is tying the two products.[295]

The examples illustrate that the technology in itself does not lead to anticompetitive behaviour. However, the features of blockchain such as easy access and use, real-time

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[290] European Commission, 'Antitrust: Commission sends Statement of Objections to Microsoft on non-compliance with browser choice commitments' <https://ec.europa.eu/commission/presscorner/detail/en/IP_12_1149> accessed 16 April 2021.

[291] Whish (n 63) p. 685.

[292] Commissions Notice on Guidelines on Vertical Restraints [2010] SEC (2010) 411 para. 214.

[293] Cf. Ernst (n 268) p. 40

[294] Bitcoin Magazine, 'Bitcoin Mining Hardware' (2020) <https://bitcoinmagazine.com/guides/bitcoin-mining-hardware> accessed 01 May 2021.

[295] Thibault Schrepel, 'Libra: A Concentrate of "Blockchain Antitrust"' <http://michiganlawreview.org/libra-a-concentrate-of-blockchain-antitrust/> (Michigan Law Review) accessed 18 May 2021.

updates, distribution and decentralisation increase the likelihood for anticompetitive use of the technology.

C. Non-compete obligations

Another contractual obligation which can have an anticompetitive impact relates to non-compete obligations. Art. 5 lit. a of Regulation 330/2010 states that clauses in vertical agreements which do contain "any direct or indirect non-compete obligation, the duration of which is indefinite or exceeds five years"[296] are not exempted by the Block exemption; thus, they are unlawful. With regard to the definition of non-compete obligations the wording is not clear, however, Art. 1 lit. d of the Regulation 330/2010 provides for further guidance when stating that: […]"'non-compete obligation' means any direct or indirect obligation causing the buyer not to manufacture, purchase, sell or resell goods or services which compete with the contract goods or services, or any direct or indirect obligation on the buyer to purchase from the supplier or from another undertaking designated by the supplier more than 80 % of the buyer's total purchases of the contract goods or services and their substitutes on the relevant market […]".[297] In other words: a supplier shall not impose obligations on the buyer whereby the latter is forced to concentrate its purchases of more than 80 % on one particular supplier. It is important to notice that the obligation only falls within the application to competition law when applied to the buyer.[298]

Non-compete obligations are implemented in a broad variety of agreements.[299] Therefore, it does not seem unrealistic to consider the following: a blockchain provider, developer or any other intermediary that provides a blockchain layer 1 or layer 2 application enters into agreements whereby nodes which are participating on the blockchain are required to utilise only this respective application.[300] The blockchain provider is — for the purpose of the agreement[301] — acting on a different level on the market as the nodes are active on, and therefore the agreement between these participants is qualified as a vertical agreement. In the present scenario, the clause equals to an unlawful non-compete clause since the nodes are

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[296] Commission Regulation (EU) No 330/2010 of 20 April 2010 on the application of Article 101(3) of the Treaty on the Functioning of the European Union to categories of vertical agreements and concerted practices, OJL 102 [2010] Art. 5 lit. a.

[297] Ibid. Art. 1 d.

[298] Frank Wijckmans et al., 'Vertikale Aftaler og Konkurrenceret. EU - Danmark' (Hans Reitzels Forlag, 2020) p. 258.

[299] Cf. ibid. p. 257 f.

[300] Cf. Ernst (n 268) p. 40

[301] Eg.: Frank (n 298).

forced to only use one particular blockchain to an extent of more than 80 % of their usage with no time-limitation (5 years as a maximum) whereby the nodes are prohibited to participate on competing blockchains.

Another scenario that potentially may cause competition concerns relates to the usage of wallets and exchanges.[302] One can argue that it may occur that either a blockchain provider or a wallet or exchange provider imposes non-compete obligations in relation to the wallets or the exchange that shall be utilised on a particular blockchain.[303] Thus, if the obligation imposes the requirement to purchase more than 80 % of the required amount and extending a period of 5 years it constrains competition.[304]

As the examples illustrate, the technology as such — again — does not cause anticompetitive behaviour. However, the technology in fact does give incentives to be used unlawfully because of its technological features.

D. Resale-Price-maintenance

One of the more aggressive forms of vertical anticompetitive behaviour relates to agreements which are concluded between suppliers and distributors of products or services whereby it is directly or indirectly intended to impose a fixed, minimum or other restrictive price level on the distributor. The price-agreement relates to the buyer's position when reselling the respective products or services to his or her customers.[305] As stated in the introductory remarks, such fixed resale price maintenance is qualified as a restriction on competition by object and consequently assessed as a hardcore restriction.[306]

The Commission's Notice on Vertical Restraints provides for examples, such as, " fixing the distribution margin, fixing the maximum level of discount the distributor can grant from a prescribed price level, making the grant of rebates or reimbursement of promotional costs by the supplier subject to the observance of a given price level, linking the prescribed resale price to the resale prices of competitors, threats, intimidation, warnings, penalties, delay or

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[302] Cf. Ernst (n 268) p. 40; Lianos (n 74).

[303] Ibid.

[304] Cf. Whish (n 63).

[305] Eg.: ibid. p. 686.

[306] Commissions Notice on Guidelines on Vertical Restraints [2010] SEC (2010) 411 para. 47; Art. 4 a. Regulation 330/2010.

suspension of deliveries or contract terminations in relation to observance of a given price level."[307]

Blockchain technology raises incentives to utilise the technology for distribution agreements since its technological specifications provide a perfect system of transparency, decentralisation and distribution of information.[308] In relation to vertical agreements problematic situations arise where the technology is utilised to enforce fixed resale prices or minimum prices or even "penalties, delay or suspension of deliveries or termination of contracts"[309] in case of non-compliance with particular price levels. The Commission's Guidelines underpin the risk of collusive behaviour from a general perspective — which theoretically can be adapted to the technology due to blockchain's enormous transparency and distributed structure — when stating that it might be facilitated "by enhancing price transparency in the market, thereby making it easier to detect whether a supplier deviates from the collusive equilibrium by cutting its price."[310]

For example, a private blockchain can be established whereby a supply chain — involving different participants acting at different levels of production and distribution — shall be analysed, monitored and information exchanged between the participants. The layer 1 code (the blockchain) is equipped with a layer 2 which is a code encompassing a smart contract. The latter executes any coded transaction between the nodes. At first sight, the utilisation of a blockchain seems an efficient application, however, if the underlying code is fed with information that particular price levels have to be met harm to competition occurs. In particular, if the layer 2 code contains a predefined, fixed minimum resale price as a condition for the execution of the layer 2 contract is a hardcore restriction.[311]

A further hypothetical scenario is as follows: The code on layer 2 does not contain a specific fixed minimum price, however, the code encompasses indirect means of fixing resale prices by a combination of algorithmic mechanisms such as monitoring, reporting and reaction mechanism. One can argue that it is not unlawful as a supplier to monitor the market and sales of its distributors since it is important to the business, nevertheless if such measures are combined with sanctions, penalties or other forms of negative impacts on the distributor in

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[307] Ibid. para. 48.

[308] See, technical outlining in Part II.

[309] Commissions Notice on Guidelines on Vertical Restraints [2010] SEC (2010) 411.

[310] Ibid. para. 224.

[311] Cf. Ayush Verma, 'Implications of competition law on blockchain technology' (2021) <https://blog.ipleaders.in/implications-competition-law-blockchain-technology/> accessed 20 April 2021; Ernst (n 268); Lianos (n 74).

case of deviation of prices as implemented in the code, it most likely will be found unlawful.[312] One author phrased the risk of blockchain as follows:"[…] may enable better monitoring and tracking of information, which may bring efficiency gains, but may also be used to monitor the implementation of some vertical foreclosure strategies […]."[313]

Generally, it shall though be pointed out — again — that the application of the technology in itself does not harm competition but the assessment depends on the data and conditions that are set forth via the code on layer 1 and layer 2.[314]

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[312] Cf. Commissions Notice on Guidelines on Vertical Restraints [2010] SEC (2010) 411; ibid.

[313] Lianos (n 74) p. 75.

[314] Cf. Ristaniemi (n 5).

VII. Conclusion

The analysis illustrates that competition law constitutes a limit to the scope of business activities and cooperation between competitors as well as potential competitors. European commotion law has been introduced to respond to situations which do not include the digitalised world.

Thus, due to the extraordinary conceptualisation of blockchain technology there are a variety of legal challenges relating to the application of well-established terms and definitions, and new areas of concern relating to anti-competitive behaviour. The analysis exemplifies that a modern, open approach to definitions has to be applied in order to sufficiently address competition law to blockchain technology.

Moreover, in regard to business behaviour blockchain technology as such is neutral which means that the technology in itself does not lead to anticompetitive behaviour. The classification of behaviour of participants as anticompetitive is dependent on a case-by-case analysis which takes into consideration the different types of participants, types and layers of a blockchain and data which is transferred and stored.

It shall be kept in mind that competition law not only constitutes a limitation for the analogue world but also for the digital world. In other words: what applies to undertakings offline, also applies to undertakings when acting online on a blockchain. Thus, conclusively, it can be pointed out that the technology has to be followed closely in the light of competition law since a broad variety of questions cannot be answered at the present stage of technological development and application.

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