

CAN BLOCKCHAIN TECHNOLOGIES RESOLVE THE U.S. ANTITRUST ENFORCEMENT PROBLEM?

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The U.S. antitrust enforcement mechanism is criticized for being ill-adapted to ensuring competition in digital platforms. In the United States, several bills have been introduced in Congress with the aim to create a new antitrust regulatory framework for digital platforms. This Article proposes a different solution by exploring the adoption of a blockchain system and smart contracts to make the present antitrust enforcement more efficient. In the United States, approximately ninety percent of no-merger antitrust proceedings are settled by means of consent decrees. However, the consent decree procedure is criticized for a lack of transparency and there is often the need for more coordination among different antitrust enforcers in the definition of remedies. This begs the question of whether a distributed ledger can assist in making the consent decree mechanism more transparent by enhancing coordination and data consistency. Furthermore, verifying companies’ compliance with antitrust remedies enshrined in consent decrees is typically costly and time-consuming for an antitrust agency and these remedies can become ineffective. This Article investigates a blockchain system to tackle the lack of transparency and coordination in reaching the antitrust consent in the context of the FTC consent decree procedure. It further investigates the use of smart contracts and blockchain-based smart contracts to enforce antitrust remedies enshrined in antitrust consent decrees by using FTC remedies as an example. Antitrust does not really need a new regulatory framework, what it does need is to explore the adoption of new tools and resources to make the antitrust enforcement more efficient through a technologically managed solution.

“The real problem lies on the institutional side: the enforcement agencies and the courts do not have adequate technical resources, and do not move fast enough, to cope effectively with a very complex business sector

that changes very rapidly.”¹

I. INTRODUCTION

Antitrust seems to have an enforcement problem because economic theories and standards, such as the “consumer welfare standard,” seem to be insufficient to tackle antitrust issues in today’s fast-moving technological markets.² A recurring suggestion has been the enactment of new antitrust rules that would impose pro-competitive remedies by default on digital platforms based on their size. On June 11, 2021, a set of bills have been introduced in the United States, which would make this suggestion a reality.³ On March 25, 2022, the EU Parliament and Council reached a provisional agreement on the Digital Markets Act (DMA), which establishes a new ex ante regulatory framework for digital platforms that meet specific thresholds related to turnover, number of users (hence size).⁴ In September 2022, the

1. Richard A. Posner, *Antitrust in the New Economy*, 68 ANTITRUST L.J. 925, 925 (2001).

2. See, e.g., Lina M. Khan, Note, *Amazon’s Antitrust Paradox*, 126 YALE L.J. 710 (2017) (“[T]he current framework in antitrust—specifically its pegging competition to ‘consumer welfare,’ defined as short-term price effects—is unequipped to capture the architecture of market power in the modern economy. We cannot cognize the potential harms to competition posed by Amazon’s dominance if we measure competition primarily through price and output. Specifically, current doctrine underappreciates the risk of predatory pricing and how integration across distinct business lines may prove anticompetitive.”); see also, Daniel D. Sokol & Roisin E. Comerford, *Antitrust and Regulating Big Data*, 23 GEO. MASON L. REV. 1, 129 (2015) (“Commentators generally are split into two camps: one in favor of more proactive antitrust enforcement in the Big Data realm, and one opposing such intervention, considering antitrust inappropriate for regulation of Big Data.”). For a literature review related to competition issues in digital markets, see Filippo Lancieri & Patricia Sakowski, *Competition in Digital Markets: A Review of Expert Reports*, 26 STAN. J.L. BUS. & FIN. 65 (2021).

3. For an overview of the various U.S. antitrust bills, see Randy Picker, *The House’s Recent Spate of Antitrust Bills Would Change Big Tech as We Know It*, PROMARKET (Jun. 29, 2021), <https://promarket.org/2021/06/29/houseantitrust-bills-big-tech-apple-preinstallation/> [<https://perma.cc/2T59-T649>]. See also, American Innovation and Choice Online Act, S. 2992, 117th Cong. § 1 (2021) (proposing regulations on large digital platforms in the United States); Eric Cortellessa, *Senate Vote on Big Tech Antitrust Bill Unlikely Before Election, Key Players Say*, TIME (Sept. 15, 2022), <https://time.com/6214028/tech-antitrust-bill-senate-vote/> [<https://perma.cc/8PZG-DYUA>] (discussing the Senate’s vote on recent antitrust bills related to regulations on tech companies).

4. Press Release, European Commission, Digital Markets Act: Rules for Digital Gatekeepers to Ensure Open Markets Enter into Force (Oct. 31, 2022), https://ec.europa.eu/commission/presscorner/detail/en/IP_22_6423 [<https://perma.cc/A9HZ-9HZY>]; *Proposal for a Regulation of the European Parliament and of the Council on Contestable and Fair Markets in the Digital Sector (Digital Markets Act)*, COM (2020) 842 Final (Dec. 15, 2020); Press

DMA became law, and entered into force on November 1, 2022.⁵

This Article proposes a different solution by exploring new tools and resources for antitrust agencies. In the United States, approximately ninety percent of antitrust cases are settled by means of consent decrees, which means that the company subject to investigation offers some pro-competitive remedies to close the antitrust proceeding without finding an antitrust violation. Companies are encouraged to offer such remedies because an antitrust decision can be used as *prima facie* evidence in courts,⁶ and anyone harmed by antitrust conduct can sue a company asking for treble damages. Therefore, consent decrees represent a win-to-win solution by avoiding both the government and the company under investigation the uncertainty and the time necessary for a trial.

However, antitrust consent decrees are not perfect. The antitrust consent procedure is typically criticized for a lack of transparency⁷ because the

Release, EU Council of the European Union, Digital Markets Act (DMA): Agreement Between the Council and the European Parliament (Mar. 25, 2022), <https://www.consilium.europa.eu/en/press/press-releases/2022/03/25/council-and-european-parliament-reach-agreement-on-the-digital-markets-act/> [<https://perma.cc/Y7EX-3EL4>]. See generally COMPETITION & MKTS. AUTH., A NEW PRO-COMPETITION REGIME FOR DIGITAL MARKETS: ADVICE OF THE DIGITAL MARKETS TASKFORCE (2020), https://assets.publishing.service.gov.uk/media/5f9e7567e90e07562f98286c/Digital_Taskforce_-_Advice.pdf [<https://perma.cc/Q86Q-Z7K2>] (discussing UK's effort in building a regulatory regime for digital platforms).

5. Regulation (EU) 2022/1925 of the European Parliament and of the Council of 14 September 2022 on Contestable and Fair Markets in the Digital Sector and Amending Directives (EU) 2019/1937 and (EU) 2020/1828 (Digital Markets Act), 2022 O.J. (L 265) 1 [hereinafter DMA].

6. See PHILLIP E. AREEDA & HERBERT HOVENKAMP, ANTITRUST LAW: AN ANALYSIS OF ANTITRUST PRINCIPLES AND THEIR APPLICATION ¶ 327c (5th ed. 2020) (“[W]hile Clayton Act §5(a) allows a litigated decree to be used as prima facie evidence of liability in subsequent private actions against the defendant, it explicitly prohibits that use of pretrial consent decrees. Indeed, wherever liability has not been adjudicated, the consent decree almost invariably states that it is neither an adjudication on the merits nor an admission of liability on the part of the defendant.” (footnotes omitted)). See Giovanna Massarotto, *The Deterrent and Enunciating Effects of Consent Decrees*, 11 J. COMPETITION L. & ECON. 493, 496 (2015) (noting that there are no treble damages or punitive damages in Europe).

7. See Joshua D. Wright & Douglas H. Ginsburg, Org. for Econ. Cooperation & Dev [OECD], *The Costs and Benefits of Antitrust Consents*, at 4, DAF/COMP/WD(2016)81 (Oct. 26, 2016), [https://one.oecd.org/document/DAF/COMP/WD\(2016\)81/en/pdf](https://one.oecd.org/document/DAF/COMP/WD(2016)81/en/pdf) [<https://perma.cc/FGU4-5858>] (“[T]he reduced transparency and predictability inherent in consent decrees relative to litigation creates uncertainty for third parties.”); Maureen K. Ohlhausen, *The Federal Trade Commission at 100: Recommendations for Improving Agency Performance*, in 2 WILLIAM E. KOVACIC: AN ANTITRUST TRIBUTE – LIBER AMICORUM 101, 106–07 (Nicolas Charbit, Elisa Ramundo & Jessica Rebarber eds., 2014), https://www.ftc.gov/system/files/documents/public_statements/581651/140910kovacictribute.pdf [<https://perma.cc/54FE-82EW>] (“In my dissents . . . , I took issue with, among other things, the lack of transparency

remedies offered by the company are published only when the agency agrees on the remedies (thus, at the end of the negotiation process). In addition, in the United States, there are a variety of antitrust enforcers, including the U.S. Federal Trade Commission (FTC), the Department of Justice (DOJ), State Attorneys General, and potentially any company or consumers harmed by antitrust conduct, which can generate overlaps and a lack of coordination in the enforcement action.

What this Article suggests is that antitrust enforcers explore the adoption of a blockchain infrastructure to make the consent decrees procedure more transparent and efficient by increasing the exchange of information and coordination among them. Privacy and security can be protected by using a permissioned blockchain, which can limit the access to data to specific participants by creating different chains or through encryption. I use the present FTC consent decree procedure to show the *status a quo* and how blockchain can be adopted to make such a procedure more transparent and increase coordination among antitrust enforcers by sharing the same data set view.

Another issue related to antitrust consent decrees is the costs of monitoring companies' compliance with conduct remedies. Typically, these remedies are enforced for about ten years and require dedicated staff to monitor companies' compliance with these remedies periodically. Part III of this Article explores how smart contracts and blockchain-based smart contracts can be used to tackle the costs and the time that the agency usually spends in verifying the compliance filings. Smart contracts are computer programs that can potentially automate the verification of companies' compliance with antitrust remedies by saving costs and making the enforcement of such remedies more efficient. In blockchain-based smart contracts, the results of compliance or no-compliance with remedies could be recorded and stored simultaneously in all ledgers that are part of the blockchain by increasing coordination and transparency among different institutions.

Blockchain and smart contracts are not magic—there are several issues, such as security or the risk of bugs in smart contracts' code, which need to be considered. However, they do offer some features that can enable antitrust agencies to be more efficient and be equipped with the same tools and resources that markets are increasingly using. The goal of this Article is not to show that blockchain technologies are the perfect solution to tackle the

and predictability that these decisions provided patent holders and others subject to our jurisdiction.”); Warren S. Grimes, *Transparency in Federal Antitrust Enforcement*, 51 *BUFF. L. REV.* 937, 940, 964 (2003) (illustrating that federal antitrust enforcement lacks transparency).

present antitrust enforcement problem. This Article explores why these technologies could be interesting in the context of antitrust and suggest the development of a blockchain and smart contracts proof of concept in the context of antitrust remedies to make the antitrust enforcement action more efficient.

In four parts this Article explores how a blockchain architecture can be used in the FTC consent procedure to increase transparency and coordination in the definition of antitrust remedies by increasing information and participation among different enforcers in the early stage of the negotiation process. It proceeds by providing some examples of conduct remedies typically adopted to close an antitrust investigation through consent. It shows how smart contracts and blockchain-based smart contracts can be adopted to increase standardization and the effectiveness of behavioral remedies by making the enforcement of these remedies more efficient. The last part examines the trade-offs of using blockchain, smart contracts and blockchain-based smart contracts in the context of antitrust by assessing advantages and disadvantages in general and in the antitrust enforcement action.

II. BLOCKCHAIN AND THE ANTITRUST CONSENT PROCEDURE

The fact that, in the United States, the adoption of consent decisions relates almost entirely to antitrust enforcement action, implies that companies under antitrust investigation commonly offer pro-competitive remedies to settle antitrust cases. Antitrust remedies defined through a consent solution are fascinating because they can provide a tailored, fast and flexible form of regulation,⁸ without requiring all market participants to bear the burden of regulation.⁹ The company usually offers pro-competitive behavioral remedies to close an antitrust investigation without finding an antitrust violation. These remedies are regulatory in nature because they require leaders of markets to change their behavior affecting the dynamics

8. See, e.g., Deborah L. Feinstein, Dir., Bureau of Competition, Fed. Trade Comm'n, *The Significance of Consent Orders in the Federal Trade Commission's Competition Enforcement Efforts*, Remarks at GCR Live 4 (Sept. 7, 2013), https://www.ftc.gov/sites/default/files/documents/public_statements/significance-consent-orders-federal-trade-commission%E2%80%99s-competition-enforcement-efforts-gcr-live/130917gcrspeech.pdf [<https://perma.cc/XU8F-4AN9>] (stressing that consent resolution is a better antitrust remedy).

9. See Núcleo de Direito Setorial e Regulatório, *Prof. Robert Baldwin Lecture on Positive Regulation*, YOUTUBE (Oct. 15, 2021), <https://youtu.be/C1wLdG9WhPM> [<https://perma.cc/C2GC-DNFM>] (stating that regulators need to be “intelligent and dynamic in discharging the tasks of regulation”).

of markets.¹⁰ They can impose from interoperability, data sharing to the license of a patent or line of business restrictions.

The consent antitrust solution is particularly compelling because one of the main challenges in enforcing antitrust principles is the asymmetry of information that exists between the agency and the company subject to investigation.¹¹ Frequently, the same company under investigation has created or leads the market in which it is investigated. In other words, companies have knowledge of the functioning and dynamics of markets that an antitrust agency might ignore¹² and can be critical in defining the appropriate remedies.

Although both the FTC and the DOJ have settled approximately 90% of antitrust no-merger proceedings by means of consent decrees,¹³ this Article focuses on the FTC consent procedure and shows some possible blockchain applications in the context of the FTC enforcement action. It first explains the *status a quo* of the FTC consent proceeding in the definition of consent antitrust remedies. Then, it develops a possible blockchain architecture that the FTC could test to increase transparency and efficiency in the definition of these remedies by enhancing coordination and participation in the antitrust proceedings.

A. *The FTC Consent Procedure (de status a 'quo')*

The FTC enables any entity subject to an antitrust investigation to submit “a proposal for disposition of the matter in the form of a consent order agreement executed by the party being investigated” in case the “time, the

10. GIOVANNA MASSAROTTO, ANTITRUST SETTLEMENTS: HOW A SIMPLE AGREEMENT CAN DRIVE THE ECONOMY 8, 17, 20 (2019); Giovanna Massarotto, *The Deterrent and Enunciating Effects of Consent Decrees*, 11 J. COMPETITION L. & ECON. 493, 497 (2015).

11. See, e.g., Jean Tirole, *Market Failures and Public Policy: Prize Lecture, December 8, 2014*, in *The Nobel Prizes* 507, 513–14 (2014), <https://www.nobelprize.org/uploads/2018/06/tirole-lecture.pdf> [<https://perma.cc/7JGK-74LD>] (discussing the information asymmetry between the company and enforcement agencies); Paul L. Joskow & Roger G. Noll, *Alfred E. Kahn, 1917-2010*, 42 REV. INDUS. ORG. 107, 116 (2013) (“[T]he role of interest group politics and the implications of imperfect and asymmetric information . . . became major topics in the economics of regulation in the early 1970s . . .”); Frank H. Easterbrook, *Limits of Antitrust*, 63 TEX. L. REV. 1, 4 (1984) (“The costs of action and information are the limits of antitrust.”).

12. Frank H. Easterbrook, *Does Antitrust Have a Comparative Advantage?*, 23 HARV. J. L. & PUB. POL’Y 5, 8 (1999) (“[O]f course the more complex the conduct and the scarcer our knowledge of its consequences, the longer the case will take to conclude, and the more it is apt to cost along the way.”).

13. Joshua D. Wright & Douglas H. Ginsburg, *The Economic Analysis of Antitrust Consents*, 46 EUR. J.L. & ECON. 245, 247 (2018) (“In the United States, over the last three decades the [FTC and DOJ] have resolved nearly their entire civil enforcement docket by consent decree . . .”); see also Wright & Ginsburg, *supra* note 7.

nature of the proceeding, and the public interest permit.”¹⁴

The consent order can be altered and amended in the same way that the statutes establish for FTC order and does not become public until the FTC accepts the agreement. This is why the negotiation process in the definition of antitrust remedies is often criticized for a lack of transparency.¹⁵ The Figure below illustrates the FTC antitrust consent procedure.

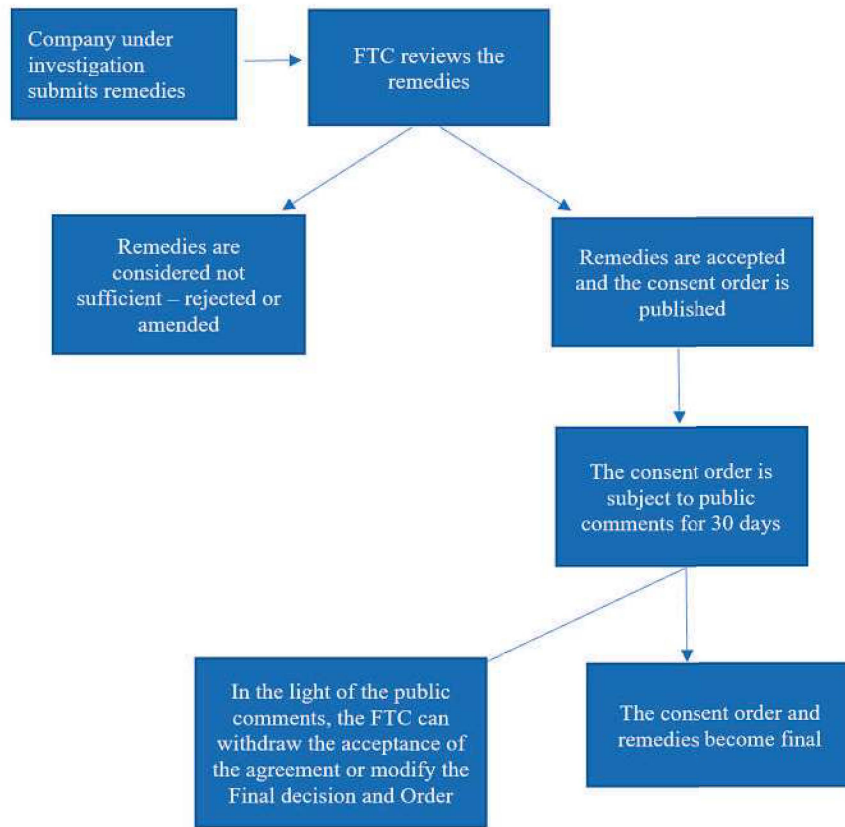


Figure 1: FTC Antitrust Consent Procedure

14. Opportunity to Submit a Proposed Consent Order, 16 C.F.R. § 2.31 (1975).

15. See Wright & Ginsburg, *supra* note 7 (illustrating the lack of transparency in the negotiation process); Ohlhausen, *supra* note 7, at 106–07 (same); Grimes, *supra* note 7, at 940, 964 (same).

B. *Blockchain Solution for the FTC Consent Procedure*

Blockchain is an immutable distributed append-only data-structure/ledger part of the distributed ledger technologies (DLT). In a blockchain system, data is verified by a network of computers rather than a single computer or authority; only when the network reaches the consensus (via a consensus mechanism) is data saved simultaneously in the distributed ledger. This is why blockchain is both distributed and decentralized.

A variety of blockchain types and infrastructures exist. Before exploring a blockchain architecture for the FTC antitrust consent procedure, the identification of what blockchain type seems to be more appropriate, and why, is an important area to discuss.

1. Blockchain for Government

Government agencies are exploring the adoption of blockchain in several contexts because blockchain enables both the sharing of the same data set view and increased data consistency and quality as data is verified by multiple nodes of computers rather than a central authority.¹⁶ Blockchain is particularly useful when you need to coordinate activities among different parties or entities.¹⁷

For example, in 2019, the U.S. Food and Drug Administration (FDA) worked on a pilot to use blockchain for better verifying and tracking of pharmaceutical products. This activity requires the coordination of several entities and data consistency; the time to collect data related to the safety of pharmaceutical products is critical. The pilot was successfully completed showing how blockchain can offer a single common record of products and enhance patient safety, because a blockchain application can trigger product alerts and increase visibility to supply chain participants in case of recall or a product investigation.¹⁸ The U.S. Postal Office (USPO) is also deepening

16. See XIWEI XU, INGO WEBER & MARK STAPLES, *ARCHITECTURE FOR BLOCKCHAIN APPLICATIONS* 13 (Springer, 2019) (“Blockchain could target improved government service delivery, and private blockchain could be used to facilitate and process coordination across agencies within the government.”).

17. *Id.* at 94 (“A blockchain is not suitable for systems that only serve individual isolated users, because a conventional database will be simpler and more efficient.”).

18. See IBM, KPMG, MERCK & WALMART, *FDA DSCSA BLOCKCHAIN INTEROPERABILITY PILOT: PROJECT REPORT* (2020), https://www.merck.com/wp-content/uploads/sites/5/2020/07/FDA_DSCSA_Interoperability_Pilot_Project-Final_Report_Feb2020.pdf [<https://perma.cc/ESY6-DMF4>] (demonstrating that blockchain can successfully “provide a common record of product movement by connecting disparate systems and organizations . . .

the study of a variety of blockchain applications for its financial services, identity services, and device management.¹⁹

In the specific context of regulatory compliance and reporting activities, Project Maison is an interesting case study to analyze. Project Maison is a pilot blockchain application developed to decrease costs of compliance and make regulatory surveillance more efficient in the context of mortgages reporting.²⁰ It was developed as a prototype application for regulatory reporting between the Financial Conduct Authority (FCA) and two major banks, with the possibility to extend the network that reaches the consensus on the validity of the loan to third-party actors, such as lawyers, tax authorities, and the Land Registry. Each party could run a node on the DLT network by performing a series of data validation in a transparent verification system.²¹ In other words, more and more government agencies are exploring the adoption of blockchain systems to do their regular work more efficiently, and antitrust agencies should not be an exception.

There are two macro categories of blockchains—permissionless and permissioned blockchains, which can be open to the public or private. Permissioned blockchain is particularly interesting for regulators because it enables the creation of a hierarchy among blockchain participants in the network by defining different types of permissions. For example, everyone can read what is saved in the ledger, while some participants can update the ledger or have the exclusive right to manage the blockchain protocol, which governs the blockchain system.

The FDA and USPO blockchain adopted Hyperledger, which is a

in a secure way” and “[i]mprove patient safety by triggering product alerts and increasing visibility to relevant supply chain partners in the event of a product investigation or recall”); *How the FDA is Piloting Blockchain for the Pharmaceutical Supply Chain*, IBM, (Mar. 4, 2020), <https://www.ibm.com/blogs/blockchain/2020/05/how-the-fda-is-piloting-blockchain-for-the-pharmaceutical-supply-chain/> [https://perma.cc/NQ6L-T3UG] (summarizing the report cited *supra*); Danny Nelson, *IBM, Merck Declare FDA-Backed Drug Tracing Blockchain a Success*, COINDESK (May 4, 2020), <https://www.coindesk.com/markets/2020/05/04/ibm-merck-declare-fda-backed-drug-tracing-blockchain-a-success/> [https://perma.cc/EPX8-CGY] (“In their final report to the FDA, [IBM, KPMG, Merck, and Walmart] . . . called [DLT] a safety-enhancing answer to the U.S. Drug Supply Chain Security Act (DSCSA), which gives the pharmaceutical industry until 2024 to implement stringent new electronic tracing requirements on drug packaging.”).

19. See OFF. OF INSPECTOR GEN., U.S. POSTAL SERV., REP. NO. RARC-WP-16-011, BLOCKCHAIN TECHNOLOGY: POSSIBILITIES FOR THE U.S. POSTAL SERVICE (2016), <https://www.uspsoig.gov/sites/default/files/reports/2023-02/rarc-wp-16-011.pdf> [https://perma.cc/BS6N-DC9K] (studying potential blockchain applications).

20. Daniel Gozman, Jonathan Liebenau & Tomaso Aste, *A Case Study of Using Blockchain Technology in Regulatory Technology*, 19 MIS Q. EXEC.19, 20 (2020).

21. *Id.* at 29.

permissioned blockchain with a modular approach²² that implies significant flexibility to the blockchain architecture design, as any component can be modified independently without affecting the entire blockchain.²³ It also enables the creation of different channels, which allow groups of participants to build separate ledgers of transactions.²⁴ In Hyperledger, nodes can be validating and non-validating nodes. Only validating nodes run the consensus mechanism and create and validate transactions by updating the ledger. Confidential transactions are only visible by transaction owners and participants.

Conversely, Project Maison adopted Corda. Several financial institutions designed Corda for adoption in financial services.²⁵ Corda architecture “is design to model and automate real-world transactions in a legally enforceable manner, and do so across an open network on which multiple applications can execute and seamlessly interoperate.”²⁶ The peculiarity of Corda is to be a DLT explicitly designed for recording and enforcing business agreements among trading partners through smart contracts and multiple different competing notary consensus pools. In Corda, transactions are never broadcasted globally to the entire network like in Bitcoin blockchain (which constitutes a ledger of all bitcoins).²⁷ Rather, information is only accessible to specific entities, such as regulators, counterparties, or other nodes that can be considered necessary, to preserve

22. Brian Behlendorf, *Meet Hyperledger: An “Umbrella” for Open Source Blockchain & Smart Contract Technologies*, HYPERLEDGER FOUND. (Sep. 13, 2016), <https://www.hyperledger.org/blog/2016/09/13/meet-hyperledger-an-umbrella-for-open-source-blockchain-smart-contract-technologies> [<https://perma.cc/Q9LT-4WT9>].

23. See HYPERLEDGER FOUND., *HYPERLEDGER ARCHITECTURE, VOLUME 1: INTRODUCTION TO HYPERLEDGER BUSINESS BLOCKCHAIN DESIGN PHILOSOPHY AND CONSENSUS 3* (2017), https://www.hyperledger.org/wp-content/uploads/2017/08/Hyperledger_Arch_WG_Paper_1_Consensus.pdf [<https://perma.cc/BQJ3-5EYH>] (describing of Hyperledger Architecture components, which include: (a) consensus layer; (b) smart contract layer; (c) communication layer; (d) data store abstraction; (e) crypto abstraction; (f) identity services; (g) policy services; (h) APIs; and (i) interoperation).

24. See XU ET AL., *supra* note 16, at 67 (“Alternative distributed ledger technologies, such as R3’s Corda or Hyperledger Fabric, natively support the creation of separate ledgers for related parties, e.g. through Fabric’s channels.”).

25. JOSH STARK, R3, *APPLICATIONS OF DISTRIBUTED LEDGER TECHNOLOGY TO REGULATORY AND COMPLIANCE PROCESSES 10* (2017), https://www.r3.com/wp-content/uploads/2017/07/apps-reg-compliance_R3.pdf [<https://perma.cc/85G2-DUBF>]; see also IMRAN BASHIR, *MASTERING BLOCKCHAIN DISTRIBUTED LEDGERS, DECENTRALIZATION AND SMART CONTRACTS EXPLAINED 61* (2017) (“Corda . . . is especially focused on [the] financial services industry.”).

26. RICHARD GENDAL BROWN, *THE CORDA PLATFORM: AN INTRODUCTION 3* (2018), <http://corda.net/content/corda-platform-whitepaper.pdf> [<https://perma.cc/J9F6-X7B5>].

27. *Id.* at 11.

privacy and confidentiality.²⁸ This implies that the consensus is achieved not across the whole network. Both Corda and Hyperledger could be interesting DLT to adopt in the context of the antitrust consent procedure.

2. FTC Blockchain Architecture

Because blockchain is a distributed ledger and transparency-oriented technology, a blockchain solution can be employed to increase coordination and transparency in the negotiation of remedies in the FTC consent procedure.²⁹ Privacy and confidentiality can be protected by giving participants in the network different types of permission, through encryption or by creating different channels. Coordination among enforcers can be enhanced by having each enforcer as part of the FTC blockchain network. As we have seen in permissioned blockchain participants can be validating or non-validating nodes and the FTC could be the only entity with the ability to change the protocol that governs an FTC blockchain system.

a. FTC DLT Design and Participants

In the construction of an antitrust blockchain solution, both Hyperledger and Corda seem to be interesting DLT that could be adopted. They are both permissioned DLT that can enable specific entities—such as regulators, counterparties, or other nodes considered necessary—access to the ledger to ensure privacy and confidentiality when required. Hyperledger and Corda offer modular design and pluggable features that permit the flexibility necessary to verify data concerning antitrust remedies in different industries and coordinate the exchange of information among different institutions. As outlined above, Corda transactions are not transmitted to the entire network but to counterparties and other necessary participants.³⁰

As described in Section II.A, the present FTC consent procedure foresees the participation of the FTC and the company subject to investigation that offers remedies. Interested parties can provide comments only when the FTC accepts such remedies within thirty days from the

28. *Why Corda*, CORDA (last visited Feb. 10, 2023), <https://www.corda.net/why-corda/> [<https://perma.cc/H7C3-PQBQ>] (“By design Corda shares data only between the counterparties of a transaction. Even the communication protocol itself is invisible to the other members on the network.”).

29. See James Rob Savin, *Tunney Act 96: Two Decades of Judicial Misapplication*, 46 EMORY L.J. 363, 367 (1997) (discussing how blockchain can be applied in the FTC’s consent procedure).

30. BROWN, *supra* note 26, at 8.

publication of the FTC order. A permissioned blockchain can be built having the FTC, and other institutions, including antitrust enforcers, such as the DOJ Antitrust Division and State Attorney Generals,³¹ as part of the network. Companies subjected to an antitrust investigation before the FTC, could share the proposed remedies with multiple antitrust enforcers simultaneously in real time and data submitted verified by such enforcers rather than the FTC only. Blockchain has the potential to provide a single and shared entity model across multiple institutions and enable point-to-point communication.

The process would be more transparent with the capability of enhancing coordination among different antitrust enforcers and industry regulators.³² In the example shown in Figure 2 below, each participant (DOJ, company, consumer association) has access to a node.

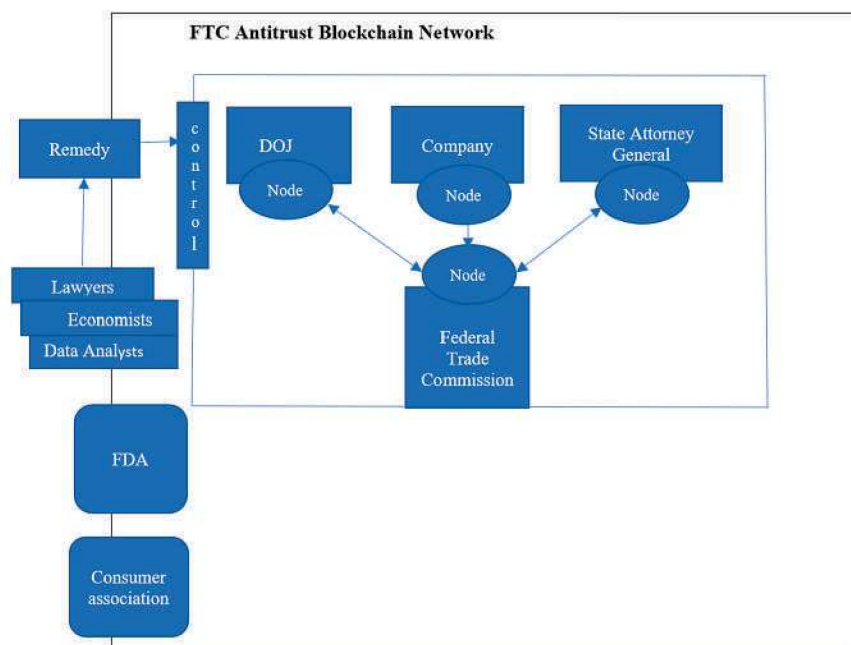


Figure 2: *FTC Antitrust Blockchain Architecture (example)*

31. In the United States, state attorneys general can bring antitrust suits “on behalf of the residents of their states” under the Hart-Scott-Rodino Antitrust Improvement Act. See Richard A. Posner, *Federalism and the Enforcement of Antitrust Laws by State Attorneys General*, 2 GEO. J.L. & PUB. POL’Y 5, 8 (2004); Robert L. Hubbard & James Yoon, *How the Antitrust Modernization Commission Should View State Antitrust Enforcement*, 17 LOY. CONSUMER L. REV. 497, 515 (2005).

32. See *supra* note 16 and accompanying text.

Figure 2, which is only for illustrative purposes, shows a possible DLT architecture. In it, the FTC, DOJ, and the State Attorney General are validating nodes; the FTC governs the FTC blockchain protocol. Lawyers, economists and data analysts are typically involved in the definition of these remedies by the company or other entity subject to investigation.

As Project Maison revealed, a similar blockchain solution can be extended to include other third-party actors that need to be coordinated to reach consensus on the validity (in that case) of a loan. In this case, it would be the consensus on data related to remedies.³³ A DLT solution can create different ledgers participated in by different institutions, such as regulators including the FDA and consumer associations. Antitrust law affects any industries and can be seen as the first arm of government regulation that can reach any markets before the Congress has time to pass a new law or establish a new regulator. Therefore, it would seem to make sense to share a blockchain network with regulators from different industries to increase coordination in sector-specific regulation and re-imagine the consent regulation process.

In the United States, the Supreme Court recognized in *Trinko* that regulation can be an alternative to antitrust and a blockchain solution can prevent overlaps by increasing coordination between antitrust agencies and regulators potentially in any regulated industry.³⁴ Data can be received through ad hoc files or reports, and regulator data validation rules designed on the ledger. Regulatory nodes would have the possibility to raise comments in real-time because it would benefit from a holistic wide picture of remedies shared with other antitrust enforcers, regulators and entities, such as consumer associations.

b. Incentives

Public bodies are incentivized to participate in the FTC antitrust blockchain network and engage in the verification process because antitrust enforcers, regulators or institutions are all interested in gathering more reliable data and being involved in antitrust cases that affect their industry or constituents. It is basically their job to participate in any discussions that affect their area of responsibility and, as outlined above, institutions can participate in a blockchain network as both validating and non-validating

33. See Gozman et al., *supra* note 20, at 29.

34. *Verizon v. Trinko*, 540 U.S. 398 (2004); see also Howard A. Shelanski, *Justice Breyer, Professor Kahn, and Antitrust Enforcement in Regulated Industries*, 100 CAL. L. REV. 487, 492 (2012); Stephen G. Breyer, *Antitrust, Deregulation, and the Newly Liberated Marketplace*, 75 CAL. L. REV. 1005, 1007 (1987).

nodes. The role of consumer associations is to protect consumers from harmful practices (e.g., antitrust practices). These associations could only benefit from participating in a blockchain architecture related to antitrust proceedings, which directly affect consumers.

In addition, data today is considered an invaluable resource;³⁵ the participation in a distributed database that provides a single source of truth about relevant markets-related data looks attractive for many. Companies and regulators might be interested in participating in an antitrust blockchain as they are typically affected by antitrust remedies and can assist in the definition of such remedies. As mentioned, antitrust remedies are regulatory in nature, because they typically require the leader of a market to change its conduct by affecting the dynamics of relevant markets. Thus, there are many entities potentially interested in overseeing the negotiation process.

c. International in Scope

Antitrust enforcers, such as the European Commission, might benefit from participating in the envisaged antitrust network as antitrust cases can affect markets globally. It could be envisaged an antitrust blockchain application built on the International Competition Network (ICN). The real benefit of adopting an antitrust blockchain solution is linked to the use of this technology by antitrust enforcers globally to provide more consistent data about their enforcement action.

Digital markets run on the Internet, which has no geographic boundaries. Many antitrust concerns are likely to be international in scope in technological markets. Therefore, a blockchain solution can be particularly useful to coordinate the antitrust enforcement action internationally by sharing a same data set view. This decentralized system has the potential to increase the quality of remedies, which are regulatory in nature and can have a great impact on multiple markets, thus consumers. In addition, blockchain can allow for future extension of the system to other products and regulatory report. Part III investigates the adoption of blockchain-based smart contracts to enforce antitrust remedies and make the monitoring of companies' compliance with such remedies more efficient by tracking antitrust remedies in real time.

35. *The World's Most Valuable Resource Is No Longer Oil, but Data*, THE ECONOMIST, (May 6, 2017), <https://www.economist.com/leaders/2017/05/06/the-worlds-most-valuable-resource-is-no-longer-oil-but-data> [<https://perma.cc/CV4Z-YQK2>].

3. Next Steps

Part II shows a possible blockchain system for the FTC in the context of sharing information about remedies since the initial stage of an antitrust proceeding and why a blockchain solution could be attractive for other antitrust enforcers. The development of an antitrust FTC blockchain pilot like those developed by other government agencies is here suggested to assess the feasibility and real benefits of employing a blockchain system. This pilot could be implemented in a present case before the FTC, in which the parties agree to settle the proceeding by adopting a blockchain participated by the FTC. A blockchain infrastructure might be particularly useful in cases concerning exchange of information among competitors by tracking exactly what information is shared among the participants of the blockchain system. Blockchain organizations, such as Hyperledger Foundation, Corda, and Chainalysis might be interested in partnership with the FTC in the construction of this blockchain pilot. Part II provides some concepts and definitions that can be useful to understand the potential benefits of using blockchain-based smart contracts discussed in Part III.

III. SMART CONTRACTS & ANTITRUST REMEDIES

Blockchain technologies can not only be considered to increase transparency and coordination in the definition of antitrust remedies, but also to make the enforcement of such remedies more efficient and effective by means of smart contracts that run on a blockchain (i.e., blockchain-based smart contracts) or simply smart contracts. This part investigates the use of smart contracts and blockchain-based smart contracts in monitoring companies' compliance with antitrust remedies. There are two main categories of antitrust remedies: (1) structural remedies, such as the divestiture of businesses or assets, and (2) behavioral regulatory remedies, which usually require modification of contract provisions, conduct and the adoption of antitrust compliance programs. While structural remedies are static because they are usually permanent or long-term remedies with questionable results in the long term,³⁶ behavioral remedies can be reviewed

36. See, e.g., Robert W. Crandall, *The AT&T Divestiture: Was it Necessary? Was it a Success?*, U.S. DEP'T OF JUST. (Mar. 28, 2007), <https://www.justice.gov/atr/att-divestiture-was-it-necessary-was-it-success> [<https://perma.cc/TWF4-2JQS>] (finding "little evidence of consumer benefit from structural remedies" in reviews of major antitrust cases). The effects of the AT&T divestiture in 1984 seem to be negative with respect to innovation if we look, for example, at the history of Bell Labs where the transistor, Unix operating system and many

over time if they become ineffective or unnecessary. Therefore, behavioral remedies have the flexibility that might be particularly useful in dynamic markets, such as digital markets, and are commonly imposed to close an FTC antitrust no merger investigation. However, they are criticized for being expensive and time consuming for the agency,³⁷ which needs to have staff dedicated to monitoring companies' compliance with these remedies in different markets. This is why the investigation of the adoption of smart contracts to automate the verification of the compliance filing concerning these remedies is compelling.

Part III first provides an overview of the most common antitrust behavioral remedies focusing on two interesting case studies: Intel and Cephalon. It then develops the idea of adopting smart contracts to enforce

other critical technologies have been invented. AT&T continued to own Bell Labs after the divestiture, but its revenue was cut off given that about eighty percent of the funds for research steamed from Bell operating companies that were sold. Furthermore, twelve years after the break-up, AT&T was again vertical integrated. Professor Robert W. Crandall, for example, reported that in the near term after the AT&T divestiture, "long distance services increased and U.S. long distance rates fell." However, AT&T break-up costed about "\$5 billion of lost productivity in 1984-85" and up to the January 8, 1982, litigation costs alone for AT&T was "360 million dollars along with an additional 15 million dollars of costs to the federal government." Robert W. Crandall, *The Failure of Structural Remedies in Sherman Act Monopolization Cases*, 80 OR. L. REV. 109, 185 (2001). Because technological change since 1984 eliminated the distinction between local exchange and interchange service, the line of business restrictions imposed on AT&T by the antitrust decision resulted in a decrease in competition. Richard S. Higgins, *The Costs and Benefits of the AT&T Antitrust Settlement: An Overview*, 16 MANAGERIAL & DECISION ECON. 275, 278 (1995); see also, Jerry A. Hausman & William E. Taylor, *Telecommunication in the US: From Regulation to Competition (Almost)*, 42 REV. INDUS. ORG. 203, 215-16 (2013) (citing Joskow & Noll, *supra* note 11, at 1060); VALENTINE KORAH, *COMPETITION LAW OF BRITAIN AND THE COMMON MARKET* 32, 33 (1975) ("[T]he experience of divestiture decrees in the United States has not been encouraging. When the Supreme Court was concerned that one of the two large markets of tins had acquired a firm making glass containers, it ordered it to dispose of the plants where the glass containers were made. The only purchase to be found for most of these was one of the largest makers of glass containers-out of the frying pan into the fire!").

37. With respect to behavior remedies, see Robert B. Bell, *Regulation by Consent Decree*, 26 ANTITRUST 73, 77 (2011) ("For many years the Division has taken the position that, with a few exceptions, regulatory remedies cost too much to administer, are easy to evade, and move the Division away from its proper mission as a law enforcement agency into a regulatory role for which it is ill suited. Recent decrees and the 2011 Remedies Guide reject that position."). See also John E. Kwoka, Jr. & Diana L. Moss, *Behavioral Merger Remedies: Evaluation and Implications for Antitrust Enforcement 2* (Nov. 14, 2011) (unpublished manuscript), <http://dx.doi.org/10.2139/ssrn.1959588>; Makan Delrahim, Assistant Att'y Gen., Antitrust Div., U.S. Dep't of Just., Remarks at the Public Roundtable Discussion Series on Regulation & Antitrust Law, Session Two: Antitrust Consent Decrees 2 (Apr. 26, 2018), <https://www.justice.gov/atr/page/file/1067496/download> [<https://perma.cc/VD7G-5G66>] ("[W]e've announced a renewed emphasis on seeking structural relief when possible as opposed to regulatory behavioral conditions.").

such remedies through some examples by emphasizing opportunities and challenges. Smart contracts can be used to increase antitrust remedies' standardization by creating Smart Contract Templates and a common language for antitrust remedies, which can facilitate and improve the enforcement of such remedies. On the other hand, coding antitrust decisions might be expensive and sometime unfeasible. The risk of bugs in the software should also be considered.

A. Antitrust Behavioral Remedies

Antitrust conduct remedies that companies usually offer, and the FTC accepts, to close an antitrust investigation are: (1) contract obligations, (2) the imposition of a specific conduct, and (3) the implementation of an antitrust compliance program and/or reporting obligations. The following paragraphs show some examples of these remedies that typically involve multiple entities and would only benefit from a distributed system. The analysis focuses on two FTC consent orders—Intel and Cephalon. The behavioral remedies enshrined in these two cases are particularly compelling because similar remedies are now consideration or in force in both U.S. and EU jurisdictions to deal with digital markets,³⁸ and are used in Section III.B to investigate how smart contracts and blockchain-based smart contracts for antitrust remedies would work in concrete terms.

1. Contract Obligations—Conduct or Code of Ethics Provisions

We find examples of remedies like contract or conduct obligations and/or the elimination or modification of some contract terms or code of

38. On June 24, 2021, the U.S. House of Representatives Judiciary Committee voted on an antitrust bill-package, which included: (a) the “American Innovation and Online Choice Act;” (b) the “State Antitrust enforcement Venue Act of 2021;” (c) the “Platform Competition and Opportunity Act;” (d) the “Ending Platform Monopolies Act;” (e) the Augmenting Compatibility and Competition by Enabling Service Switching (ACCESS) Act;” and (f) the “Merger Filing Fee Modernization Act.” Press Release, Representative David N. Cicilline, Chairman, House Antitrust Subcomm., Cicilline Statement on Big Tech Markup (June 24, 2021), <https://cicilline.house.gov/press-release/cicilline-statement-on-big-tech-markup> [<https://perma.cc/PN6W-RM99>]. Disgorgement and interoperability are antitrust remedies defined in the antitrust bill package. Similarly, the DMA includes interoperability among the foreseen antitrust remedies. *See, e.g.*, DMA, *supra* note 5, at 36 (“The gatekeeper shall allow providers of services and providers of hardware, free of charge, effective interoperability with, and access for the purposes of interoperability to, the same hardware and software features accessed or controlled via the operating system or virtual assistant listed in the designation decision pursuant to Article 3(9) as are available to services or hardware provided by the gatekeeper.”).

ethics' provisions in a variety of FTC consent orders. In the case *In re National Association of Residential Property Managers, Inc.*, the National Association of Residential Property Managers (NARPM) agreed to remove the provisions of its Code of Ethics that restricted the ability of its members to disclose truthful information and compare their products to the products of other members.³⁹ Similarly, in the case *In re National Association of Teachers of Singing, Inc.*,⁴⁰ the FTC required the association to eliminate provisions considered anticompetitive from its Code of Ethics.⁴¹

In the 2015 case *In re Professional Skaters Association, Inc.*, the FTC also required the association to eliminate potential anticompetitive provisions from its by-laws, in addition to stopping it from preventing its members from soliciting other members' students.⁴² In other words, in the context of professional and trade associations, it is quite common to find provisions in an organization's Code of Ethics or Conduct that raise antitrust concerns. The remedy to remove anticompetitive provisions typically engage the same parties in reporting activities.

In the pharmaceutical industry, the FTC often imposes contractual obligations and/or conduct requirements on the investigated company. In 2017, for example, the FTC closed an investigation against Mallinckrodt ARD Inc. (formerly known as Questcor Pharmaceuticals, Inc.) and its parent company Mallinckrodt plc, by requiring the company to grant a license to develop a drug.⁴³ The company was accused of buying the rights of the drug at hand because it "threatened its monopoly in the U.S. market."⁴⁴ In 2015, the FTC closed another investigation with a pharmaceutical company, Cardinal Health Inc., which consented to stop engaging in exclusive

39. *In re Nat'l Ass'n of Residential Prop. Managers, Inc.*, File No. 141-0031 (Fed. Trade Comm'n Oct. 10, 2014), <https://www.ftc.gov/enforcement/cases-proceedings/141-0031/national-association-residential-property-managers-inc-matter> [<https://perma.cc/M8WC-AWYS>].

40. *In re Nat'l Ass'n of Teachers of Singing, Inc.*, File No. 131-0127 (Fed. Trade Comm'n Oct. 1, 2014), <https://www.ftc.gov/legal-library/browse/cases-proceedings/131-0127-national-association-teachers-singing-inc-matter> [<https://perma.cc/MZ4X-QHJK>].

41. Press Release, Fed. Trade Comm'n, FTC Approves Final Orders Requiring Two Professional Associations to Eliminate Rules That Restrict Competition Among Their Members (Oct. 10, 2014), <https://www.ftc.gov/news-events/press-releases/2014/10/ftc-approves-final-orders-requiring-two-professional-associations> [<https://perma.cc/AR6Q-ZPUZ>].

42. *In re Pro. Skaters Ass'n, Inc.*, File No. 131-0168 (Fed. Trade Comm'n, Mar. 3, 2015), <https://www.ftc.gov/enforcement/cases-proceedings/131-0168/professional-skaters-association-inc-matter> [<https://perma.cc/F6G5-52T4>].

43. Press Release, Fed. Trade Comm'n, Mallinckrodt Will Pay \$100 Million to Settle FTC, State Charges It Illegally Maintained Its Monopoly of Specialty Drug Used to Treat Infants (Jan. 18, 2017), <https://www.ftc.gov/news-events/press-releases/2017/01/mallinckrodt-will-pay-100-million-settle-ftc-state-charges-it> [<https://perma.cc/64M9-7G69>].

44. *Id.*

agreements with producers of the radiopharmaceutical product for which it became the exclusive distributor, as well as obtaining for the same product exclusive rights.⁴⁵

In 2016, in the case *In re Victrex plc* (“Invibio”), the companies were prohibited from entering into exclusive supply contracts in the implant-grade polyetheretherketone (PEEK) market. The FTC also prevented the companies from limiting customers from employing alternative source of PEEK in new products.⁴⁶ Similarly, in the case *In re IDEXX Laboratories, Inc.*, the FTC forbade the company from entering into exclusive distribution agreements with the main distributors of its product.⁴⁷

In the telecommunication sector, in the case *In re Motorola Mobility LLC*, the FTC required Google to “abide by its commitments to license its standard-essential patents on fair, reasonable, and non-discriminatory . . . terms.”⁴⁸

2. Compliance Obligations and Programs

The adoption of antitrust compliance programs or other forms of reporting activities to oversee companies’ compliance with antitrust remedies and principles is very common in FTC antitrust proceedings. In the pharmaceutical industry, the most common antitrust practice is the “pay for delay” agreement or “reverse payment,” under which the manufacturer of a brand drug delays the entrance of its generic version into the market in exchange for money.⁴⁹ On July 11, 2017, in the case against Endo

45. Press Release, Fed. Trade Comm’n., Cardinal Health Agrees to Pay \$ 26.8 Million to Settle Charges It Monopolized 25 Markets for the Sale of Radiopharmaceuticals to Hospitals and Clinics (Apr. 20, 2015), <https://www.ftc.gov/news-events/press-releases/2015/04/cardinal-health-agrees-pay-268-million-settle-charges-it> [<https://perma.cc/LL9Z-UCA6>].

46. *In re Victrex plc*, File No. 141-0042 (Fed. Trade Comm’n Aug. 5, 2016) <https://www.ftc.gov/enforcement/cases-proceedings/141-0042/victrex-plc-et-al-matter> [<https://perma.cc/J7BM-VQY8>].

47. *In re IDEXX Labb’ys, Inc.*, File No. 101-0023 (Fed. Trade Comm’n Feb. 12, 2013) <https://www.ftc.gov/legal-library/browse/cases-proceedings/1010023-idexx-laboratories-inc-matter> [<https://perma.cc/FM4R-CMG3>].

48. Press Release, Fed. Trade Comm’n, FTC Finalizes Settlement in Google Motorola Mobility Case (July 24, 2013), <https://www.ftc.gov/news-events/press-releases/2013/07/ftc-finalizes-settlement-google-motorola-mobility-case> [<https://perma.cc/N7XZ-GD69>].

49. See FED. TRADE COMM’N, PAY-FOR-DELAY: HOW DRUG COMPANY PAY-OFFS COST CONSUMERS BILLIONS: A FEDERAL TRADE COMMISSION STAFF STUDY (2010), <https://www.ftc.gov/sites/default/files/documents/reports/pay-delay-how-drug-company-pay-offs-cost-consumers-billions-federal-trade-commission-staff-study/100112payfordelayrpt.pdf> [<https://perma.cc/R6E2-W7VV>] (discussing antitrust policy regarding pharmaceutical companies).

Pharmaceuticals Inc. (“Endo”),⁵⁰ the FTC required the appointment of a monitor to verify that defendants’ agreements were in compliance with the FTC’s order, which prevented the defendants from entering into pay for delay agreements.⁵¹

In 2015, the FTC closed a case with a consent solution where the companies, Concordia Pharmaceutical Inc. (“Concordia”) and Par Pharmaceutical, Inc. (“Par”), agreed “not to enforce the anticompetitive provisions of their agreement,”⁵² which included a provision not to compete that would prevent the entering into the market of the generic versions of the brand drug Kapvay.

The same year the FTC closed the investigation against Cardinal Health Inc. in which, as outlined above, the company was prevented from entering into exclusive distribution agreements. The pharmaceutical company also agreed to notify the FTC regarding the acquisition of any assets related to the product at hand when it was not covered by the Hart-Scott Rodino Act. The company also paid a disgorgement.⁵³

In the 2013 case *In re Bosley, Inc.*, the firms, which were investigated for exchanging competitively sensitive and nonpublic information, agreed to refrain from sharing similar information and to implement a compliance program.⁵⁴

In the context of professional and trade associations, the FTC has often required the adoption of compliance programs and obligations as well. For example, in the case *In re National Association of Animal Breeders* (NAAB), in which the FTC asked the association to remove some anti-competitive provisions from its Code of Ethics, NAAB agreed to publish and distribute

50. Press Release, Fed. Trade Comm’n, Endo Pharmaceuticals Inc. Agrees to Abandon Anticompetitive Pay-for-Delay Agreements to Settle FTC Charges (Jan. 23, 2017), <https://www.ftc.gov/news-events/press-releases/2017/01/endo-pharmaceuticals-inc-agrees-abandon-anticompetitive-pay-delay> [https://perma.cc/2THB-HK9M].

51. Press Release, Fed. Trade Comm’n, FTC Approves Appointment of Monitor in Pay-for-Delay Case Against Endo Pharmaceuticals Inc. (July 11, 2017), <https://www.ftc.gov/news-events/press-releases/2017/07/federal-trade-commission-approves-appointment-monitor-pay-delay> [https://perma.cc/T3NJ-96XX].

52. *In re Concordia Pharms. Inc.*, File No. 151-0030 (Fed. Trad Comm’n Oct. 30, 2015), <https://www.ftc.gov/legal-library/browse/cases-proceedings/151-0030-concordia-healthcare-par-pharmaceutical-matter> [https://perma.cc/K8GR-LJHR].

53. Press Release, Fed. Trade Comm’n, Cardinal Health Agrees to Pay \$26.8 Million to Settle Charges It Monopolized 25 Markets for the Sale of Radiopharmaceuticals to Hospitals and Clinics (Apr. 20, 2015), <https://www.ftc.gov/news-events/press-releases/2015/04/cardinal-health-agrees-pay-268-million-settle-charges-it> [https://perma.cc/LZ5K-XKRV].

54. Press Release, Fed. Trade Comm’n, FTC Approves Final Order Settling Charges That Bosley, Inc., Illegally Exchanged Competitively Sensitive Business Information with Hair Club (June 5, 2013), <https://www.ftc.gov/newsevents/press-releases/2013/06/ftc-approves-final-order-settling-charges-bosley-inc-illegally> [https://perma.cc/89HC-VZJK].

an announcement on the FTC consent order along with adopting an antitrust compliance program. Similarly, in the cases *In re Professional Skaters Association, Inc.*⁵⁵ and *In re American Guild of Organists*,⁵⁶ the FTC required both associations to implement an antitrust compliance program.

In other words, the parties involved and affected by antitrust decisions are many and the reporting activity intense. The FTC and the variety of entities involved would benefit from increasing automation and coordination of these activities, as well as performing a series of data validation in a transparent verification system.

3. FTC Consent Orders on the Lens

It is important to analyze two interesting FTC consent orders: Intel and Cephalon, in which the FTC agreed to close the case in exchange of a set of behavioral remedies, including interoperability and disgorgement. These case studies will be used in Section III.B to explore the potential of blockchain-based smart contracts to both automate the monitoring of companies' compliance with remedies and supervise the effects of antitrust remedies on markets.

a. Intel

In 2009, the FTC filed an antitrust complaint against Intel, accusing the Central Processing Units' (CPUs) manufacture to engage in a pattern of antitrust conduct to maintain its monopoly in the market for x86 CPUs and constitute a monopoly in the market for graphic processing units.⁵⁷ The case ended with a consent order, under which Intel agreed to:

(1) cease and desist from engaging in predatory or deceptive practices, such as entering into agreements with its customers under the condition that customers do not acquire products from Intel's competitors, and they be exclusive with Intel;

(2) "modify its intellectual property agreements with AMD, Nvidia, and Via [three of its major competitors] so that those companies have more

55. *In re Prof. Skaters Ass'n, Inc.*, File No. 131-0168 (Fed. Trade Comm'n Mar. 3, 2015) <https://www.ftc.gov/legal-library/browse/cases-proceedings/131-0168-professional-skaters-association-inc-matter> [<https://perma.cc/F6G5-52T4>].

56. *In re Am. Guild of Organists*, File No. 151-0159 (Fed. Trade Comm'n May 26, 2017), <https://www.ftc.gov/enforcement/cases-proceedings/151-0159/american-guild-organists> [<https://perma.cc/34YZ-AJQN>].

57. Complaint at ¶ 8, *In re Intel Corp.*, No. 9341 (Fed. Trade Comm'n Dec. 16, 2009), <https://www.ftc.gov/sites/default/files/documents/cases/091216intelcmpt.pdf> [<https://perma.cc/7SFM-6A27>].

freedom to consider mergers or joint ventures with other companies, without the threat of being sued by Intel for patent infringement;”

(3) “offer to extend Via’s x86 licensing agreement for five years beyond the current agreement, which expired in 2013;”

(4) “maintain a key interface (PCI Express bus) for six years in a way that would not limit the performance of graphics processing chips;”

(5) “disclose to software developers that Intel computer compilers discriminate between Intel chips and non-Intel chips, and that they may not register all the features of non-Intel chips;” and

(6) “reimburse all software vendors who wanted to recompile their software by adopting a non-Intel compiler.”⁵⁸

b. Cephalon

Cephalon is another interesting case to analyze in the context of antitrust behavioral remedies. In 2008, the FTC opened an antitrust investigation against the pharmaceutical company Cephalon for “pay for delay” conduct. According to the FTC, Cephalon, the brand name pharmaceutical company of Provigil, was paying generic drug manufactures to delay the generic version of Provigil until 2012.⁵⁹ In 2011, Teva Pharmaceutical Industries Ltd. (“Teva”) acquired Cephalon.

In 2015, the case was settled. Cephalon and its parent company Teva agreed to refrain from engaging in the suspect anticompetitive conduct and paid a disgorgement of \$1.2 billion.⁶⁰ In 2013, the retail price of a package of thirty Provigil 200 milligram tablets was \$38.46 per unit.⁶¹ In 2021, the

58. Press Release, Fed. Trade Comm’n, FTC Settles Charges of Anticompetitive Conduct Against Intel (Aug. 4, 2010), <https://www.ftc.gov/news-events/press-releases/2010/08/ftc-settles-charges-anticompetitive-conduct-against-intel> [https://perma.cc/AVU4-CEA2].

59. Press Release, Fed. Trade Comm’n, FTC Sues Cephalon, Inc. for Unlawfully Blocking Sale of Lower-Cost Generic Versions of Branded Drug Until 2012 (Feb. 13, 2008), <https://www.ftc.gov/news-events/press-releases/2008/02/ftc-sues-cephalon-inc-unlawfully-blocking-sale-lower-cost-generic> [https://perma.cc/BUA2-D5EG]; see also STEPHEN W. SCHONDELMEYER & LEIGH PURIS, AARP PUB. POL’Y INST., TRENDS IN RETAIL PRICES OF SPECIALTY PRESCRIPTION DRUGS WIDELY USED BY OLDER AMERICANS, 2006 TO 2013, at 13 (2015), <https://www.aarp.org/content/dam/aarp/ppi/2015/rx-price-watch-specialty-prescription-drug-prices-continue-to-climb-final.pdf> [https://perma.cc/84GP-FACT] (“Provigil 200 mg tablets had a price increase of 476.6 percent over the 8-year study period ending in 2013.”).

60. Press Release, Fed. Trade Comm’n, FTC Settlement of Cephalon Pay for Delay Case Ensures \$1.2 Billion in Ill-Gotten Gains Relinquished; Refunds Will Go to Purchasers Affected by Anticompetitive Tactics (May 28, 2015), <https://www.ftc.gov/news-events/press-releases/2015/05/ftc-settlement-cephalon-pay-delay-case-ensures-12-billion-ill> [https://perma.cc/R2UA-RU4Y].

61. SCHONDELMEYER & PURIS, *supra* note 59, at 17.

price of the same package was around \$68.48 per unit, and \$2,054.49 per package.

Provigil is a prescribed drug and, in 2017, the AARP Public Policy Institute analyzed trends in retail prices of prescription drugs by identifying a consistent increase in price of prescription drugs, which could not be justified by general inflation.⁶² Therefore, it is important to ensure the effectiveness of these remedies over the years for antitrust to succeed in protecting competition and consumer welfare.

B. Smart Contracts & Remedies

Smart contracts have the potential to play a critical role in the context of antitrust remedies, because modification of contract terms, the adoption of antitrust compliance programs and intense reporting activities can be difficult to monitor, costly and time consuming for the agency,⁶³ which typically needs to dedicate staff and resources. In addition, as we have seen in the case of Cephalon, the remedy can become ineffective and would benefit from the coordination of other regulators (e.g., the FDA) or institutions affected by regulatory antitrust remedies.

1. The FTC Compliance Process

FTC orders typically require companies to submit “periodic reports on their efforts to comply with the order” to enable the FTC to monitor the effective enforcement of such orders.⁶⁴ Compliance reports are critical in antitrust enforcement action, and the FTC has clarified that:

Each compliance report shall contain sufficient information and documentation to enable the Commission to determine independently whether Respondents are in compliance with the Order. Conclusory statements that Respondents have complied with their obligations under the Order are insufficient. Respondents shall include in their reports, among other

62. STEPHEN W. SCHONDELMAYER & LEIGH PURIS, AARP PUB. POL’Y INST., TRENDS IN RETAIL PRICES OF PRESCRIPTION DRUGS WIDELY USED BY OLDER AMERICANS: 2006 TO 2015, at 16 (2017), <https://www.aarp.org/content/dam/aarp/ppi/2017/11/trends-in-retail-prices-of-prescription-drugs-widely-used-by-older-americans-december.pdf> [<https://perma.cc/4FLR-LSCX>].

63. *See supra* note 37 and accompanying text.

64. Roberta Baruch & Bruce Hoffman, Compliance Reports: Reinforcing a Commitment to Effective Orders, FED. TRADE COMM’N (Mar. 11, 2019), <https://www.ftc.gov/news-events/blogs/competition-matters/2019/03/compliance-reports-reinforcing-commitment-effective> [<https://perma.cc/U7MT-D4HU>].

information or documentation that may be necessary to demonstrate compliance, a full description of the measures.⁶⁵

Failing to submit or submitting an incomplete, misleading or a very deficient report can represent not only an independent order violation, but also constitute evidence of bad faith and bring to civil penalties or other remedies.⁶⁶

Again, the reporting activity is intense and requires the submission of any relevant documentation that the FTC staff will review to assess companies' compliance with the remedies enshrined in the FTC order.

2. Smart Contracts and Blockchain-based Smart Contracts

Smart contracts are self-executable computer code because they execute themselves if certain conditions are met to produce the output. Smart contracts need to be written in computer language to be executed by computers; errors and misrepresentations can occur during the conversion from human-readable code to executable computer code.⁶⁷ Most of the time a smart contract requires the semantics of some details and aspects of the agreement that are not present in the written contract.

There is no room for interpretation in smart contracts. However, the language of antitrust orders and decisions is usually straightforward. In developing smart contracts to auto-enforce antitrust remedies enshrined in an antitrust order, it might be necessary to provide higher levels of details and the anticipations of some aspects and conditions that are not specified in the antitrust order. Moreover, it should be considered that some antitrust remedies might not be able to be auto enforced by means of a smart contract or they still require human intervention or activities.

Smart contracts often need to retrieve information from the external world. Oracles are usually used to this end. If data must be retrieved from a website you can use Chainlink, an oracle service widely adopted to connect smart contracts to the real world.⁶⁸ There are different types of oracles,

65. *Id.*

66. *Id.*

67. See Christopher D. Clack, Languages for Smart and Computable Contracts 4 (Apr. 8, 2021) (unpublished manuscript), <https://arxiv.org/abs/2104.03764v1> (“Errors and misinterpretations can occur during the process of conversion down the layers of the language stack to the final bits that control the computer. . .”).

68. See Lawrence Wintermeyer, *Oracles: The Invisible Backbone of DeFi and Applied Blockchain Apps*, FORBES (Oct. 14, 2021, 5:15 PM), <https://www.forbes.com/sites/lawrencewintermeyer/2021/10/14/cryptohacks-oraclesthe-invisible-backbone-of-defi-and-applied-blockchain-apps/> [<https://perma.cc/4VNQ-HBXW>] (observing that “[o]racles enable formerly

including software oracles (e.g., Chainlink, Provable), hardware oracles (e.g., RFID sensors) and human oracles (meaning people that provide real-world data to smart contracts acting as a kind of oracle).

Oracles are not perfect; they can also be subject to attacks as they typically work “off-chain.” For example, there have been recent attacks on oracles on DeFi protocols, costing hundreds of millions of dollars.⁶⁹ However, oracle attacks seem to be an issue with centralized oracles. Decentralized oracles, by ensuring that there is no single point of failure, look much more secure.⁷⁰ Decentralization should exist at both the data source and the node levels to ensure that a smart contract does not rely on one single node or source of truth. In addition, it has been suggested that the development of independent reputation mechanisms for oracles will increase their reliability.⁷¹

Smart contracts that run on a blockchain (blockchain-based smart contracts) are relevant because they allow you to manage basically everything of value that is stored in a blockchain. Both Corda and Hyperledger use smart contracts,⁷² which are also called Chaincode in the

enclosed networks to consume reliable external information and interact with legacy systems, resulting in smart contracts that can react to real-world events and integrate with established business processes”); CHAINLINK, <https://chain.link/> [<https://perma.cc/7TRQ-LQ5>] (last visited Feb. 11, 2023).

69. See, e.g., Nick Chong, *Seeming Oracle Attack Causes \$100m in Ethereum DeFi Liquidations*, CRYPTOSLATE (Nov. 26, 2020, 2:31 PM), <https://cryptoslate.com/seeming-oracle-attack-causes-100m-in-ethereum-defi-liquidations/> [<https://perma.cc/J6ST-AW9J>] (explaining that “approximately \$100 million worth of loans were liquidated” as the result of a purported “oracle manipulation attack”).

70. Adelyn Zhou, *Flash Loans Aren’t the Problem, Centralized Price Oracles Are*, COINDESK (Sept. 14, 2021, 6:29 AM), <https://www.coindesk.com/tech/2020/11/11/flash-loans-arent-the-problem-centralized-price-oracles-are/> [<https://perma.cc/G6VB-3VEV>].

71. *What Is a Blockchain Oracle?*, CHAINLINK (Sept. 14, 2021), <https://chain.link/education/blockchain-oracles> [<https://perma.cc/N9SD-WS6A>] (“Reputation frameworks provide transparency into the accuracy and reliability of each oracle network and individual oracle node operator.”).

72. Corda supports smart contracts as they are defined by Clack, Bakshi, and Briane, and can be written in any Java Virtual Machine (JVM) compatible language. See Christopher D. Clack, Vikram A. Bakshi & Lee Braine, *Smart Contract Templates: Foundations, Design Landscape and Research Directions 2* (Aug. 4, 2016) (unpublished manuscript), <https://arxiv.org/abs/1608.00771v2> (defining smart contracts). In Corda, smart contract is meant as “an agreement whose execution is both *automatable* by computer code working with human input and control, and whose rights and obligations, as expressed in legal prose, are legally *enforceable*.” BROWN, *supra* note 26, at 7. This definition includes both “smart legal contracts” in which there is a legal agreement capable of automatic execution by means of a software, and “smart contract code.” Clack et al., *supra*, at 2. The latter must be performed automatically and are not necessarily associated to a formal legal agreement. *Id.* Clack,

Hyperledger ecosystem and benefit from a decentralized infrastructure. Thanks to cryptographic protocols combined with decentralization of both nodes and data source through blockchain “the inputs and outputs of a digital agreement can become as tamper-resistant as the smart contract itself.”⁷³

3. Antitrust Smart Contracts in Practice

Yet, the monitoring of companies’ compliance with remedies might not be entirely automated by means of smart contracts. In situations when the remedy includes “modification of contract terms,” the company would need to file information about the amended contract, and the smart contract verifies whether the modification complies with the FTC order. As outlined above, a smart contract often needs more details than a written contract to perform activities defined in the contract/order. This does not imply that the semantics must be pre-defined for all possible future circumstances. However, for future events that the parties have predefined, semantics need to be known in advance.⁷⁴ In the example of “modification of contract terms,” the smart contract should specify what modified terms mean to enable the smart contract to detect possible non-compliance with the remedy.

Again, there is no room for interpretation in smart contracts. This is why the FTC and the companies subject to the remedy need to specify exactly what they mean for “modification of contract terms” in advance, along with the condition parameters to execute the order. The parties could establish that the smart contract performs a remedy in case of non-compliance (e.g., the imposition of a penalty).

Coding these remedies can be expensive and demanding. This is why the adoption of smart contracts makes sense if we can define remedies that are typically imposed to close antitrust proceedings and define a common language to code the terms of consent decrees. This seems feasible as there are common remedies enforced by the FTC, albeit in different contexts. Some broad terms like “public interest,” “good faith,” or “unduly” should be avoided by identifying remedies with precise terms that are not subject to interpretation. This would benefit both the agency and the company because

Bakshi, and Briane’s definition is interesting because it considers a smart contract as “automatable” instead of considering a smart contract as “automatically executed” given that in practice there might be parts of a legal agreement that require human input and control, which cannot be automatic. *Id.* at 3.

73. WORLD ECON. F., BRIDGING THE GOVERNANCE GAP: INTEROPERABILITY FOR BLOCKCHAIN AND LEGACY SYSTEMS 18 (2020), https://www3.weforum.org/docs/WEF_Interoperability_C4IR_Smart_Contracts_Project_2020.pdf [<https://perma.cc/KC3A-6CV6>].

74. Clack, *supra* note 67, at 4.

it would increase the certainty of remedies.

Let us examine a concrete example. In the antitrust consent decree of 1995, Microsoft was forbidden “from entering into per processor licenses, licenses with a term exceeding one year . . . , licenses containing a minimum commitment, and unduly restrictive nondisclosure agreements.”⁷⁵ In this case Microsoft would have to provide the text of the contracts and a smart contract could then be instructed to detect the forbidden provisions. Again, the parties should avoid the use of the term “unduly” and exactly define what “restrictive nondisclosure agreements” mean. Often FTC decisions start with the definition of terms used in the FTC order. For example, the definitions provided in the October 10, 2010, Intel FTC consent order include:

C. “AMD Patent Agreement” means the Patent Cross License Agreement between Advanced Micro Devices, Inc. and Intel Corporation dated November 11, 2009.

D. “Benefit” means any price or non-price benefit including without limitation price discounts, marketing funds, supply, and marketing or engineering support; provided, however, that initiating or forbearance from initiating litigation (including without limitation any activity related to lawfully enforcing its intellectual property rights) shall not be a Benefit.⁷⁶

This activity seems particularly useful for the programmer of the smart contract and can be used to create a common lexicon for antitrust remedies translatable into computer code. The language of remedies would need to become more straightforward and designed to be translated into code. The smart contract could enable companies that deal with Microsoft to access the information filed or file information acting as oracles. These companies have incentives to participate in the compliance process as they are usually the ones that benefit the most from such remedies. The adoption of smart contracts would enable the agency to reduce the need for staff dedicated to monitoring companies’ compliance with the remedies.⁷⁷

75. *United States v. Microsoft Corp.*, 56 F.3d 1448, 1452 (D.C. Cir. 1995).

76. *In re Intel Corp.*, No. 9341, at 2 (Fed. Trade Comm’n Oct. 29, 2010) (Decision and Order), <https://www.ftc.gov/sites/default/files/documents/cases/101102inteldo.pdf> [<https://perma.cc/C4WU-GW2N>].

77. Under 16 C.F.R. § 2.41:

The Commission has delegated to the Director, the Deputy Directors, and the Assistant Director for Compliance of the Bureau of Competition, and to the Director, the Deputy Directors, and the Associate Director for Enforcement of the Bureau of Consumer Protection the authority to monitor compliance reports and to open and close compliance investigations. With respect to any compliance matter which has received previous Commission consideration as to compliance

Most of the time antitrust cases concern companies that are leaders of a market and deal with thousands of clients, suppliers, or distributors. The automation of verifying the antitrust compliance filings can significantly reduce the administrative costs and time that an agency usually bears. It also makes the verification of companies' filings more effective and reduces the incidence of human error.⁷⁸ The names of the parties or sensitive information in the documents filed can be omitted or different ledgers can be created to preserve privacy if necessary. Let us take the example of the price or market share. If the antitrust agency wants to know from the company sensitive information that cannot be shared publicly, but it is useful to record such information in an immutable distributed ledger shared with other regulators to keep track of the remedies, the smart contract can limit the access to that information. The consensus can be reached with only selected parties, or data can be encrypted.

In cases that concern professional and trade associations, remedies that impose those associations to change its Code of Ethics or Conduct Provisions,⁷⁹ can easily be verified by a computer program. The smart contract can gather the necessary information by having a software oracle connected to the Internet where codes of ethics are usually available.⁸⁰ Again, oracles are often used to connect smart contracts to the real world. For example, it is used to inform smart contracts about the price of a good.⁸¹

or in which the Commission or any Commissioner has expressed an interest, any matter proposed to be closed by reason of expense of investigation or testing, or any matter involving substantial questions as to the public interest, Commission policy or statutory construction, the Bureaus shall submit an analysis to the Commission regarding their intended actions.

General Compliance Obligations and Specific Obligations Regarding Acquisitions and Divestitures, 16 C.F.R. § 2.41(b) (1967).

78. Carry Coglianese, *Robot Regulators Could Eliminate Human Error*, THE REGUL. REV. (May 16, 2016), <https://www.theregreview.org/2016/05/16/coglianese-robot-regulators-eliminate-error/> [<https://perma.cc/4UMV-MAHN>].

79. See, e.g., Press Release, Fed. Trade Comm'n, FTC Approves Final Orders Requiring Two Professional Associations to Eliminate Rules That Restrict Competition Among Their Members (Oct. 10, 2014), <https://www.ftc.gov/news-events/press-releases/2014/10/ftc-approves-final-orders-requiring-two-professional-associations> [<https://perma.cc/Q54Q-47FD>] (ordering the NARPM to "stop restraining members from soliciting competitors' clients or engaging in comparative advertising that is not false or deceptive" and, in another order, prohibiting the National Association of Teachers of Singing from stopping "its members from soliciting students from other members"); see also *supra* notes 39 and 40.

80. See, e.g., *Code of Ethics*, NAT'L ASS'N OF RESIDENTIAL PROP. MANAGERS (last visited Feb. 11, 2023), <https://www.narpm.org/about/ethics/> [<https://perma.cc/B4TF-KE6A>] (explaining NAPRM's code of ethics).

81. See STARK, *supra* note 25, at 4, for the case in which an oracle is used to provide the price of gold required for a future contract to resolve.

As mentioned, oracles typically operate as separate networks not integrated into the base layer of a blockchain. They usually perform “off-chain”⁸² and have been subject to attacks.⁸³ A competitor might be incentivized to attack the oracle run by the same agency or a centralized third-party entity. Therefore, it is important to ensure that oracles are reliable and secure. Chainlink, one of the main oracle services providers, for example, has developed decentralized oracle networks (DONs) in which each DON adopts a combination of several security techniques necessary to perform specific use cases. In other words, Chainlink has tackled the issue of oracle’s security by building a distributed pool of oracles, which enable smart contracts to enhance their reliability. It was also suggested to build a reputation-based mechanism for oracles.⁸⁴ Ensuring the adoption of secure and reliable oracles in the antitrust enforcement action is fundamental.

The advantage of running these smart contracts on a blockchain is having results about compliance and non-compliance with the remedies saved simultaneously in multiple computers, which share the same data view and increase data consistency. The decentralized blockchain network enables data to be verified by a network of computers rather than a single authority and reduce the risk of data corruption. In other words, thanks to a blockchain I would not need to trust a central authority and have a single point of failure,⁸⁵ but I would benefit from a peer-to-peer network.

To further understand the potential of adopting smart contracts in enforcing antitrust behavioral remedies, Intel and Cephalon case studies are good examples to analyze.

a. Intel Smart Contract

Intel agreed to close the antitrust investigation in exchange for the remedies listed in Section III.A.3.a of this Article, which FTC officers had

82. See *What Is the Blockchain Oracle Problem?*, CHAINLINK (Aug. 27, 2020), <https://blog.chainlink.com/what-is-the-blockchain-oracle-problem/> [<https://perma.cc/T7RT-CFCD>] (explaining the off-chain characteristics of oracles).

83. See, e.g., Elizabeth Licorish, *Protecting the \$50 Billion DeFi Industry from Flash Loan Attacks with Chainlink*, CHAINLINK TODAY (Apr. 13, 2021), <https://chainlinktoday.com/protecting-the-50-billion-defi-industry-from-flash-loan-attacks-with-chainlink/> [<https://perma.cc/T9YR-6KYE>] (noting an incident where hackers withdrew “\$7.7 million from the Warp Finance protocol by manipulating a faulty price oracle—a third-party service that connects blockchain to verified off-chain data”).

84. See *infra* Section III.B.2.

85. Joseph E. Stiglitz, *Incentives, Information, and Organizational Design*, 16 *EMPIRICA* 3, 21 (1989) (“[T]here is a mistaken belief in the efficacy of centralized control—there is perhaps a false sense of security in such times from knowing that someone is in control . . .” (footnote omitted)).

to monitor.⁸⁶ This is an interesting example where a smart contract can be used to monitor Intel's compliance with remedies. In case of non-compliance, the smart contract can be instructed to inform the FTC as well as to automatically punish the company if the parties agreed on the remedy for non-compliance in advance.

The Intel remedy to “extend Via’s x86 licensing agreement for five years” is a good example to explore.⁸⁷ Intel or Via would need to provide input to the smart contract. In other words, Intel or Via would act as a human oracle by sharing information about the licensing agreement, and Intel and Via could access the submitted information. The smart contract should be instructed to detect that the license agreement meets the terms defined in the consent order.

Blockchain does not ensure data veracity, but it does make clear who inserts what data and when in the ledger⁸⁸ by tracking everything in real time because all operations are tied to one another. If smart contracts are deployed in a blockchain and Intel or Via gives false information, the antitrust agency would have the permanent proof of the author of the false statement.

The smart contract can control which institutions have access to the submitted information. Each node would then receive through consensus the information about compliance or non-compliance of the licensing agreement with the terms of the consent order. Once the information is validated, it is added to the distributed ledger and all ledgers that are part of blockchain are updated.

Similarly, a smart contract could be instructed to monitor the compliance of other remedies imposed on Intel, such as “maintain[ing] a key interface, known as the PCI Express Bus, for at least six years in a way that will not limit the performance of graphics processing chips.”⁸⁹ This remedy preserves interoperability as Intel was accused of modifying its library software and compiler to lower the operation of competing CPUs despite having no technical reasons.⁹⁰

In this case, a software oracle can inform the smart contract about possible changes in the Intel Key Interface by checking the software repository for presence of the specified PCI Express Bus interface.

86. *See supra* Section III.A.3.a.

87. Press Release, Fed. Trade Comm’n, FTC Settles Charges of Anticompetitive Conduct Against Intel (Aug. 4, 2010), <https://www.ftc.gov/news-events/news/press-releases/2010/08/ftc-settles-charges-anticompetitive-conduct-against-intel> [<https://perma.cc/QM6E-66SJ>]

88. IBM BLOCKCHAIN, THE FOUNDER’S HANDBOOK: AN INTRODUCTION TO BUILDING A BLOCKCHAIN SOLUTION, THIRD EDITION 9 (2020), <https://www.ibm.com/downloads/cas/GZP-PMWM5> [<https://perma.cc/FZT2-YA4V>].

89. Press Release, Fed. Trade Comm’n, *supra* note 58.

90. Intel Complaint, *supra* note 57.

Alternatively, the smart contract could be instructed to monitor the Intel Key Interface for six years by giving Intel Key Interface users access to the information submitted by Intel. The smart contract could only detect and inform the FTC about compliance or non-compliance, as well as auto-enforce a remedy (e.g., a penalty) in case of non-compliance.⁹¹

As outlined above, it is important to consider that the monitoring of similar remedies does not (at least initially) scale as it might scale other reporting activities. But the adoption of smart contracts can scale in the context of antitrust remedies if the agency and the companies define a common language for remedies typically enforced in similar proceedings. The development of Smart Contract Templates⁹² is critical in making the adoption of smart contract in the context of antitrust effective.

Smart contracts do not necessarily need a blockchain. However, the adoption of a distributed ledger can be valuable because as we have seen it increases transparency and makes the antitrust enforcement action theoretically more efficient by tracking the remedy over the time with multiple entities as part of the companies' compliance process.

In summary, remedies like those submitted by Intel can be monitored and auto enforced by means of smart contracts by giving access to the information submitted or asking the same entities affected by the remedy to submit information. This part would not be automated as it still requires human inputs to gather information from the external world by means of an oracle. The outputs, however, can be recorded in the distributed ledger permanently, which can be accessible to other entities.

Someone might observe that an ordinary web software could verify the terms of Intel's consent decree with an ordinary web script that checks Intel's website or software repository every five minutes without the necessity of building a blockchain network. However, web applications typically do not store data on the application itself, rather they use a web server to control

91. See General Compliance Obligations and Specific Obligations Regarding Acquisitions and Divestitures, 16 C.F.R. § 2.41 (1967) ("Any person, partnership or corporation against which an order to cease and desist has been issued who is not in full compliance with such order on and after the date provided in these statutes for the order to become final is in violation of such order and is subject to an immediate action for civil penalties.").

92. See Clack, *supra* note 67, at 24 ("The use of a markup language to provide templates for Smart Contracts is a pragmatic approach to co-ordinating the requirements and activities of (i) drafting legal contracts; (ii) integrating those contracts with computerised business processes; and (iii) managing smart contract code for the automation of (some aspects of) those contracts."); Christopher D. Clack & Ciarán McGonagle, *Smart Derivates Contracts: The ISDA Master Agreement and the Automation of Payments and Deliveries* 3 (2019), <https://arxiv.org/abs/1904.01461v1>.

client's requests having a centralized database to store information. The benefit of building an antitrust blockchain stems from leveraging a decentralized infrastructure in which data is distributed across all nodes of the blockchain network with multiple regulators and antitrust enforcers part of the architecture. Blockchain is not only distributed but is also a decentralized system. A peer-to-peer blockchain network has extreme fault tolerance because of its built-in redundancy (multiple nodes processes all transactions), typically not present in web software that use centralized database.⁹³ External users can send their data to any node part of the chain (or multiple nodes together) and data would be recorded in all node parts of the blockchain network.

Intel was investigated in other jurisdictions, such as Europe, for similar conduct.⁹⁴ The adoption of a blockchain system would help antitrust agencies from different jurisdictions to make not only the reporting compliance activities more efficient and increase data quality, but potentially also to increase consistency in the definition of antitrust remedies to tackle antitrust concerns in similar cases. This is particularly important for markets that are international in scope and deal with companies that raise the same antitrust concerns in different jurisdictions. Antitrust agencies could benefit from a shared network and ledger to record information about the enforcement of antitrust remedies in markets that are international in scope.

In the Intel case, for example, a distributed ledger participated in by both the FTC and the European Commission could have helped the agencies validate case information and enhance data consistency. Again, Intel is a useful example as the company was investigated in both the United States and Europe for similar antitrust practices.⁹⁵

In summary, the adoption of smart contracts to verify companies' compliance with remedies could represent an interesting application by increasing standardization and efficiency in the antitrust enforcement action. Blockchain-based smart contracts have the potential to increase coordination

93. Gideon Greenspan, *Blockchains vs Centralized Databases: Four Key Differences Between Blockchains and Regular Databases*, MULTICHAIN (Mar. 17, 2016), <https://www.multichain.com/blog/2016/03/blockchains-vs-centralized-databases/> [<https://perma.cc/R3Z8-4DTG>].

94. European Commission Memo MEMO/07/314, Competition: Commission Confirms Sending of Statement of Objections to Intel (July 27, 2007), https://ec.europa.eu/commission/presscorner/detail/en/MEMO_07_314 [<https://perma.cc/W583-FZC6>]; European Commission Press Release IP/09/745, Antitrust: Commission Imposes Fine of €1.06 BN on Intel for Abuse of Dominant Position; Orders Intel to Cease Illegal Practices (May 13, 2009), https://ec.europa.eu/commission/presscorner/detail/en/IP_09_745 [<https://perma.cc/93PW-FASQ>].

95. See Massarotto, *The Deterrent and Enunciating Effects of Consent Decrees*, *supra* note 10.

and transparency in the enforcement of remedies by means of a peer-to-peer network and a distributed ledger.

b. Cephalon

As outlined in Section III.A.3.b of this Article, in the Cephalon case, the price of the affected drug increased after the antitrust decisions which, in addition to conduct remedies, imposed a disgorgement of \$1.2 billion.⁹⁶ A smart contract can be created to detect changes in the price of the drug at stake and inform the agency to act and ensure the effectiveness of remedies.

This case is particularly useful to show the potential of smart contracts in assessing the efficiency of antitrust remedies over the years as the price of the drug seems to have significantly increased. Smart contracts can detect and provide valuable information to the agency and enable the agency to better evaluate the quality of its enforcement action in basically real time. Like the blockchain solution adopted by the FDA to trigger product alerts and increase visibility in case of a recall or product investigation, a blockchain-based smart contract can be instructed to trigger price alerts or significant changes in companies' market shares and market concentration. Incorporating this data poses little challenge as the information about the price of drugs and market shares are typically available on the Internet and specific data platforms.⁹⁷

Cephalon competes in the pharmaceutical industry, which in the United States is regulated by the FDA. Again, the FDA is already testing blockchain to track drugs and would only benefit from the adoption of a blockchain by other regulators, such as the FTC, to make a critical industry like the pharmaceutical industry more efficient. Behavioral remedies agreed to by the company under investigation can be the key to enforce antitrust principles if we are able to efficiently monitor their effects on markets and consumers; smart contracts can assist the agencies with that.

Also in this case, a web script could check the price of the drug on thousands of pharmacies or insurance companies every hour instead of having a blockchain network. However, a blockchain architecture would enable both the FTC and the FDA to benefit from the same data view and increase their coordination in the regulation of the pharmaceutical industry, which today is increasingly critical by including other important participants over the time. Both agencies could engage in the verification process,

96. See *supra* Section III.A.3.b.

97. See, e.g., STATISTA (last visited Feb. 22, 2023), <https://www.statista.com/> [<https://perma.cc/FE6H-VCRA>].

effectively increasing data quality and consistency.⁹⁸

4. FTC Officers v. Smart Contracts

Today, FTC staff including lawyers and economists, are performing the monitoring of companies' compliance with the antitrust remedies enshrined in FTC orders. Smart contracts do not entirely replace human activities. Companies likely still need to provide the documentation and information necessary to verify the antitrust compliance filing. However, smart contracts can prevent human errors in monitoring companies' compliance with remedies if the parties (the FTC and the company subject to the FTC order) provide enough details for smart contracts to properly function. This means that the FTC and the investigated parties need to define in advance specific situations and related remedies. This seems feasible in the analyzed remedies and in the long term the benefits of having smart contracts are not only to reduce human errors and automate a variety of activities that now are manually performed, but also to facilitate the creation of a common language to code smart contracts and smart contract templates, which promotes the standardization of antitrust remedies.

Advantages in adopting blockchain-based smart contracts in the antitrust remedies' procedure exist. A company that provides misleading and false information in its compliance reports is usually prosecuted for a separate violation, in addition to showing its bad faith. A blockchain solution would track exactly who has given the false information by providing tamper-proof evidence of the conduct.

In summary, the antitrust reporting activities within the FTC are intense and would only benefit from automation by increasing the deterrent effect of penalties for non-compliance or false statements/information. Because a blockchain creates a single shared database with multiple antitrust agencies and regulators, the adoption of a blockchain infrastructure to run smart contracts would enhance coordination and likely lead to similar remedies to regulate markets that share the same competition concerns (e.g., professional associations or the computer industry). Antitrust agencies could learn from

98. In addition, some studies have revealed that:

Hyperledger is consistently better than SQL. We found that the maximum data volume in one transaction on the Hyperledger network is around ten (10) times of MySQL. Also, the time spent processing one transaction on the blockchain network is 80-200 times faster than MySQL . . . This result implies that the blockchain may be more suitable for data-intensive applications/systems.

Onno W. Purbo et al., *Benchmark and Comparison Between Hyperledger and MySQL*, 18 TELKOMNIKA 705, 714 (2019), <http://doi.org/10.12928/telkomnika.v18i2.13743>.

their enforcement action which would be tracked in a blockchain infrastructure in near real-time. As the Nobel Prize Joseph Stiglitz noted:

[T]o pretend that any institution is infallible, or that there is perfect confidence in the actions being undertaken, is to fly in the face of reality Admission of fallibility and demonstration that one can learn from one's mistakes should enhance public confidence in an institution, at least by demonstrating that the institution has enough confidence in itself and in democratic processes to engage in open discussions.⁹⁹

IV. POTENTIAL & LIMITATIONS

To sum up, in the context of antitrust, a blockchain system and smart contracts are compelling for four main reasons:

(1) Blockchain can increase transparency and quality in the definition of antitrust remedies by having multiple antitrust enforcers validating data related to such remedies since the early stage of the negotiation process (*antitrust regulation*).

(2) Smart contracts can be used to monitor companies' compliance with antitrust behavioral remedies and the effectiveness of remedies over the time (*antitrust compliance*).

(3) Blockchain as a distributed ledger can be employed to track antitrust remedies and cases over the years and share the same data set view among different antitrust enforcers and regulators, as well as consumers or trade associations (*antitrust compliance and enforcement*).

(4) Government adoption of decentralized technologies can promote the culture of data decentralization (peer-to-peer networks) and tackle data concentration and monopolization conduct in data-driven markets more effectively than that by means of new rules by endorsing innovation.

On the other side, we need to consider technical and legal limitations that exist in adopting antitrust blockchain solutions. This Part examines both advantages and limitations in the proposed antitrust blockchain and smart contracts solutions and concludes by assessing the trade-offs.

Table 1 below summarizes the common advantages and disadvantages identified in the adoption of blockchain and smart contracts in general.

99. Joseph E. Stiglitz, *On Liberty, the Right to Know, and Public Discourse: The Role of Transparency in Public Life* 23 (World Bank Grp., Working Paper No. 133342, Jan. 27, 1999), <https://documents1.worldbank.org/curated/en/436941546609601734/pdf/WP-Stiglitz-right-to-know-OUO-9.pdf> [<https://perma.cc/N74U-5ZXJ>].

Table 1: Advantages and disadvantages of blockchain and smart contracts

| DLT Architecture | Advantages | Disadvantages |
|----------------------------|--|---|
| Distributed System | <ul style="list-style-type: none"> • Data consistency • Improve Transparency • Enhance coordination among different institutions • Promote data decentralization | <ul style="list-style-type: none"> • Issue of scalability • Increased supervision |
| Tamper Proof | <ul style="list-style-type: none"> • Data integrity • Enhance data quality | <ul style="list-style-type: none"> • If data is false it is distributed in the system |
| Consensus Mechanism | <ul style="list-style-type: none"> • No intermediaries • Improve governance and accountability • Stimulate and increase participation | <ul style="list-style-type: none"> • Need to trust the technology/the system |
| Smart contracts | <ul style="list-style-type: none"> • Automatable • Increase standardization/a common language | <ul style="list-style-type: none"> • Risk of bugs • No room for interpretation |

Table 2 below sums up advantages and disadvantages in the adoption of a blockchain solution and smart contracts in the context of antitrust.

Table 2: Advantages and disadvantages of antitrust blockchain and smart contracts applications

| DLT Architecture | Advantages | Disadvantages |
|----------------------------|---|---|
| Distributed Ledger | <ul style="list-style-type: none"> • Increase transparency • Data consistency • Data integrity among different law enforcers • Keep track of antitrust remedies in different industries and enhance coordination in the regulatory intervention • Increase <i>trust</i> in the antitrust enforcement action • Stimulate data decentralization | <ul style="list-style-type: none"> • Wrong data permanently saved |
| Consensus Mechanism | <p>Increase:</p> <ul style="list-style-type: none"> • Cooperation • quality of remedies • participation in the antitrust discussion • the antitrust culture • harmonization • “consensus” on the enforcement action | <ul style="list-style-type: none"> • Make sense with many participants. Is that possible in the context of antitrust? |
| Smart Contracts | <ul style="list-style-type: none"> • Auto-enforce remedies and increase standardization of remedies/language • Reduce costs of monitoring companies’ compliance with remedy • Can be used to monitor the effectiveness of remedies | <ul style="list-style-type: none"> • Risk of bugs • Need to specify more details about remedies • No room for interpretation |

A. Advantages

1. Same Data Set View—“Single Source of Truth”

First, the blockchain-distributed ledger enables institutions to share the same data set view, while maintaining the capacity for the data set to be updated by individual parties. This seems particularly helpful for antitrust cases that are international in scope, or effect regulated industries such as the pharmaceutical industry.

Again, blockchain does not ensure data veracity, but it clarifies who provided what data and when in the ledger, by tracking everything in real time. Second, a DLT architecture can increase transparency without compromising privacy and confidentiality given that data can be transmitted privately across the network. Third, because recorded data cannot be modified, the ledger shared with the network represents a single trusted source of information for all participants,¹⁰⁰ and this can be particularly valuable for government agencies. It is true that a non-blockchain database can create a transparent public interface and APIs where anyone can see what is recorded there. However, the whole point of using blockchain in the context of antitrust is not limited to increasing transparency and trust in the system. It means increasing data decentralization, promoting a decentralized control system and the culture of a form of consent regulation by increasing transparency and access to data.

2. Automation of Remedies

Smart contracts have the potential to automate and make more effective the enforcement of antitrust remedies by enabling the agency to oversee the effectiveness of remedies in near real time. Costs saved by automating remedies might not be very high as antitrust remedies are quite unique and tailored to each proceeding, thus antitrust remedies do not typically scale. However, smart contracts enable to make more efficient the enforcement of remedies by reducing human errors. Furthermore, the adoption of smart contracts can lead to the creation of smart contract templates for antitrust remedies and a common lexicon in coding such remedies in different proceedings. In this scenario, antitrust remedies would also become scalable.

100. IBM BLOCKCHAIN, *supra* note 88 (explaining that the network shared ledger in a blockchain becomes the trusted source of information for all parties).

3. Consensus on Remedies

Sharing the same data set view can facilitate the consensus on antitrust regulation by increasing transparency and coordination from the negotiation process of antitrust remedies. Although legal barriers can make the adoption of a decentralized antitrust system unfeasible, in the near future blockchain consensus mechanism used to verify data before saving it in the distributed ledger, has the potential to become critical in handling antitrust cases that are international in scope.¹⁰¹ The European Digital Markets Act (DMA) and the U.S. antitrust bills package show the clear intention of the two main antitrust jurisdictions to provide uniform solutions to deal with antitrust concerns in digital markets. Blockchain systems can assist in the harmonization of the antitrust enforcement mechanism among different jurisdictions more effectively and in a more organic way than regulation.

The idea of having an international antitrust code with an International Court of Antitrust has been around for decades,¹⁰² and stems from the shared thought that “[d]isharmonies in law are costly.”¹⁰³ If translated into reality, the international antitrust body might adopt/be constituted of a blockchain infrastructure that fully exploits the potential of a consensus mechanism and a decentralized database among different agencies worldwide.

In Europe, a blockchain system can turn out to be particularly valuable for National Competition Authorities (NCAs) to decide cases that affect multiple Member States and need to be decided uniformly.¹⁰⁴ In 2003, Regulation 1/2003 decentralized the enforcement of EU competition law.¹⁰⁵ Since then, NCAs enforce articles 101 and 102 of the Treaty on the

101. See, e.g., VALUE TECH. FOUND., POTENTIAL USES OF BLOCKCHAIN BY U.S. DEPARTMENT OF DEFENSE 8 (2020), <https://www.crowell.com/files/Potential-Uses-of-Blockchain-Technology-In-DoD.pdf> [<https://perma.cc/AU6Y-YSET>] (“Blockchain becomes even more powerful when it is built out and deployed amongst allies and strategic participants around the world.”).

102. AM. BAR ASSOC., SPECIAL COMMITTEE ON INTERNATIONAL ANTITRUST REPORT 278, 290 (1991); Eleanor M. Fox, *Toward World Antitrust and Market Access*, 91 AM. J. INT’L L. 1 (1997); Christina A. Varney, Former Comm’r, Fed. Trade Comm’n, Cooperation Between Enforcement Agencies: Building Upon the Past, Speech at the APEC Committee on Trade and Investment, Conference on Competition Policy and Law (July 25, 1995) <https://www.ftc.gov/es/public-statements/1995/07/cooperation-between-enforcement-agencies-building-up-on-past> [<https://perma.cc/YG4P-DRML>]; Daniel J. Gifford, The Draft International Antitrust Code Proposed at Munich: Good Intentions Gone Awry, 6 MINN. J. GLOB. TRADE 1 (1996).

103. AM. BAR ASSOC., *supra* note 102, at 278.

104. Giovanna Massarotto, *Can Antitrust Trust Blockchain?*, in ALGORITHMIC ANTITRUST 121, 136 (Aurelien Portuese ed., 2022).

105. See, e.g., KIRAN KLAUS PATEL & HEIKE SCHWEITZER, THE HISTORICAL FOUNDATIONS OF EU COMPETITION LAW 215 (2013) (introducing how Regulation 1/2003’s anti-cartels regulations became problematic in enforcement).

Functioning of the European Union (TFEU).¹⁰⁶ European antitrust agencies can only benefit from the adoption of a blockchain architecture, which is decentralized by design. In other words, blockchain can be the tool that *de facto* facilitates the decentralization of EU competition law enforcement among NCAs and the Directorate-General for Competition of the EU Commission. In addition, we should consider that the adoption of blockchain might improve the culture of antitrust law by increasing transparency among different market players and increase trust in the antitrust agencies' activity.¹⁰⁷ There is often a lack of information between regulators and markets, which the agencies aim to protect. Reducing this asymmetry of information between the agencies and market players, including consumers through the adoption of distributed systems can be critical for public institutions to gain markets' trust.

4. DLT to Create Antitrust Common Language for AI

The opportunity of using DLT to create standards in the context of antitrust is compelling; especially if we envisage future artificial intelligence (AI) applications. AI systems make predictions by learning from past data and can be used to make the antitrust enforcement action faster. Of course, an AI system cannot be precise as each antitrust case is quite unique, but it can still provide the agency useful information based on its experience and detecting patterns to aid in preliminary screening, analysis of cases and identification of antitrust remedies. In other words, AI systems can become valuable antitrust tools to assist antitrust agencies, and these systems rely on data.

As Professor Gozman, Liebenau and Aste observed, centralized systems raise issues on data consistency and data granularity,¹⁰⁸ and decentralized blockchain systems can be critical in increasing data integrity and consistency. Consequently, blockchain can enhance AI systems' performance in the context of antitrust.

5. DLT as an Antitrust Remedy

Finally, blockchain can be considered as an antitrust remedy. One of

106. See PIER L. PARCU, GIORGIO MONTI & MARCO BOTTA, ABUSE OF DOMINANCE IN EU COMPETITION LAW: EMERGING TRENDS 8, 34 (2017) (assessing the role of intent in conducts under Article 102 TEFU).

107. KEVIN WERBACH, THE BLOCKCHAIN AND THE NEW ARCHITECTURE OF TRUST 4–7 (2018).

108. Gozman et al., *supra* note 20, at 30.

the main antitrust issues of the moment concerns large, centralized Internet platforms and the fact that these platforms control users' data—today's most valuable resource.¹⁰⁹ Blockchain technologies offer platforms in competition with "Big Tech" digital platforms, which could also present the opportunity for the antitrust agency to impose a blockchain to track companies' exploitation of certain data. Everything is constantly tracked in a blockchain, and the antitrust agency could become a peer in this blockchain to oversee companies' behavior and detect possible anticompetitive practices in the context of data. Of course, the remedy is invasive and is likely not to be feasible if we plan to track every single data element. What is suggested here is to explore the adoption of blockchain to track only certain data (a sample) that can help the antitrust agency understand how large digital platforms exploit data and detect possible anticompetitive conduct, in a tested environment.

Blockchain would enable the agency not only to understand companies' exploitation of data by tracking suspected anticompetitive conduct in real time, but also better predict possible markets trend. The idea is to increase the scrutiny in those situations that raise antitrust concerns rather than the burner of regulation for all market players. The decentralization that characterizes a blockchain solution would enable both the agencies and potentially consumers to increase awareness on companies' exploitation of their data. Access to information is recognized as one of the most effective tools of democracy.¹¹⁰

B. Limitations

Although blockchain and smart contracts have a lot of potential, these emerging technologies are not the antidote for all diseases. Several technical and legal limitations in the adoption of these technologies in the context of antitrust exist. Chief among them are security issues in smart contracts (e.g., bugs in the code), scalability, blockchain immutability and insecurity, costs and the lack of incentives to adopt a new system for participants that have the most to lose in decentralized solutions. In addition, to date the FTC procedure establishes that remedies become public only when the FTC has accepted such remedies. Amendments to the existing law would be necessary

109. *The World's Most Valuable Resource Is No Longer Oil, but Data*, *supra* note 35.

110. See, e.g., Jimmy Carter, *Foreword* to ACCESS TO INFORMATION: A KEY TO DEMOCRACY 3, 3 (Laura Neuman ed., 2002), <https://www.cartercenter.org/documents/1272.pdf> [<https://perma.cc/TSC7-4SL3>]. ("Access to information is a crucial element in the effort to reduce corruption, increase accountability, and deepen trust among citizens and their governments.").

if the agency wants to adopt a blockchain solution that requires companies to transmit data about remedies to a blockchain network and/or smart contracts to monitor companies' compliance with remedies. The issue of preserving confidentiality and privacy through encryption or by creating different channels should be considered.

1. Limits of Smart Contracts

It is important to remember that every brilliant concept will encounter implementation issues and opposition. Smart contracts provide only a source of interpretation, which may be difficult to implement at this early stage.

This should not be the case with FTC orders as the process seems more straightforward. However, the FTC and the companies subject to investigations should go into much more detail with respect to the imposed remedies to close the investigation if they want to have them performed/monitored by means of smart contracts. There is *de facto* a concern regarding smart contracts relating to human error in writing the code and the risk of bugs in the code that needs to be contemplated.¹¹¹

2. Blockchain Immutability and Insecurity

Since data stored in a blockchain is immutable it ensures data integrity, but also implies that wrong data or data entered in error would be permanently incorrect. The security guru Bruce Schneir noted that if someone puts illegal material in the blockchain, not only does the blockchain security fail, but everyone would get a copy of it.¹¹² First, there is often “a mistaken belief in the efficiency of centralized control” and a false sense of security from knowing that someone is in control of a system.¹¹³ The fact that blockchain is distributed with multiple participants enables more people to verify whether data is wrong or illegal, detect and track it. Today, there is

111. See Adam J. Kolber, *Not-So-Smart Blockchain Contracts and Artificial Responsibility*, 21 STAN. TECH. L. REV. 198, 231 (2018). The DAO was the first decentralized autonomous organization governed by smart contracts. A bug in a smart contract enabled a hacker to drain about \$60 million of ether (ETH). See *What Was the DAO?*, CRYPTOEDIA (Mar. 16, 2022), <https://www.gemini.com/en-US/criptopedia/the-dao-hack-makerdao> [<https://perma.cc/F89X-K8JJ>]; see also Shaanan Cohnney & David A. Hoffman, *Transactional Scripts in Contract Stacks*, 105 MINN. L. REV. 319, 320 (2020) (“Smart contracts are software. Even carefully audited, well tested software will (almost always) contain bugs.”).

112. Bruce Schneir, *Bitcoin's Greatest Feature Is Also Its Existential Threat*, WIRED (Mar. 9, 2021, 12:34 PM), <https://www.wired.com/story/opinion-bitcoins-greatest-feature-is-also-its-existential-threat/> [<https://perma.cc/77JZ-56SY>].

113. See Stiglitz, *supra* note 85, at 21 (1989).

data in public records that is likely false or wrong and might be difficult to detect or track. Increasing transparency and participation in government activities appears particularly useful to find this out.

In addition, if we look back to the Internet, security was not its hallmark either. Initially the way to secure the Internet was by limiting its access, not dissimilar to permissioned blockchains.¹¹⁴ This is why the adoption of permissioned blockchains in the context of antitrust is suggested here.

Today the Internet is still quite unsecure,¹¹⁵ however people continue to use it, and it is constantly growing. This does not mean we should not consider and address the security issues on blockchain. However, they should not be the reason why we fail to investigate their adoption starting from permissioned blockchain in which security is preserved through limiting and controlling the access to the blockchain network.

In summary, there are many lessons to be learned from the history of the Internet that can help us in understanding how a blockchain network can evolve and determine the main issues that need to be addressed before blockchain becomes mainstream in the context of antitrust.

3. Scalability

Scalability, which is usually one of the main technical issues with blockchain,¹¹⁶ does not appear to be a relevant challenge for an antitrust

114. Private permissioned blockchains are more secure than public blockchains because participation in private permissioned blockchains is by invitation only. See *What is Blockchain Security?*, IBM, <https://www.ibm.com/topics/blockchain-security> [<https://perma.cc/LT7B-YM36>] (last visited Mar. 14, 2023) (“Private blockchains are not vulnerable to 51% attacks.”).

115. See, e.g., NANCY J. YEAGER & ROBERT E. MCGRATH, *WEB SERVER TECHNOLOGY* 285 (1996) (“The Internet began as a limited facility linking only a few universities and government research laboratory The Internet protocols, like IP, TCP, UDP, and SLIP, and the routing protocols, like DNS, were not designed to incorporate a wide range of security services As the Internet grows and reaches more and more people, it is apparent that its security infrastructure has not kept pace with its rapid growth.”); see also BRUCE SCHNEIR, *CLICK HERE TO KILL EVERYBODY: SECURITY AND SURVIVAL IN A HYPER-CONNECTED WORLD* (2018).

116. Scalability is likely the main technical issue that concerns bitcoin and other cryptocurrency blockchain. While Visa executes about 24,000 transactions per second, bitcoin blockchain performs 4.6 transactions per second. SANJIV K. BHATIA ET AL., *ADVANCES IN COMPUTER, COMMUNICATION AND COMPUTATIONAL SCIENCES* 867–68 (2021); See also, e.g., Stephen O’Neal, *Who Scales It Best? Inside Blockchains’ Ongoing Transactions-Per-Second Race*, COINTELEGRAPH (Jan. 22, 2019), <https://cointelegraph.com/news/who-scales-it-best-inside-blockchains-ongoing-transactions-per-second-race> [<https://perma.cc/MXW6-5E9P>] (raising the limitations of current blockchain’s technical ability to support a large number of transactions).

blockchain solution as antitrust typically focuses on a small number of entities. In contrast to payment transactions (Visa for example can perform around 24,000 transactions per second),¹¹⁷ antitrust remedies are limited in number.

C. Tradeoffs

In contrast to Europe, the United States' wide adoption of antitrust consent solutions (antitrust settlements) created a real culture of antitrust consent and an antitrust action that is regulatory in nature. Antitrust settlements typically enshrine remedies that require leaders of a market to change their behavior in a pro-competitive way by affecting the dynamics of markets without the need to impose new laws in fast-moving technological markets. Law is typically neither dynamic nor flexible. These remedies are often common although implemented in different contexts and markets, and the adoption of smart contracts can promote standardization of remedies and more certainty for companies and markets in general.

Historically, antitrust benefits from a case-by-case analysis; as we have seen in the example of Intel antitrust remedies are specific in scope and tailored to the circumstances. The use of blockchain and smart contracts can encourage standardization of remedies and make faster the process without imposing rigid rules of law. This would enable antitrust to maintain its key component (a case-by-case analysis) and not punish companies by-default as new legislations suggest, by promoting multi-party communication and reconciliation incentivizing standardization. In summary, what this Article suggests is to focus on making the present system more transparent and efficient by exploring the adoption of the same tools that companies and markets are using to be competitive.

Blockchain and smart contracts are not the solution for all antitrust problems, but the tradeoff of testing these technologies starting with the automation of the enforcement of antitrust remedies by means of smart contracts seems attractive and deserves consideration. In testing, a blockchain system's technical issues, such as security, can be handled initially by using permissioned blockchains like the Internet did in its early stage.

The construction of an antitrust blockchain prototype like those built by the FDA and FCA seems to be the best way to concretely assess costs and advantages of a blockchain solution for a specific situation This Article

117. *Visa Acceptance for Retailers*, VISA, <https://usa.visa.com/run-your-business/small-business-tools/retail.html> [<https://perma.cc/L3PR-SK7K>] (last visited Feb. 22, 2023).

suggests the further exploration of the use of blockchain technologies in the antitrust enforcement actions. Alternatively, antitrust agencies could start coding remedies and test the functioning of smart contracts and then build a blockchain prototype to test the tradeoff of running smart contracts on a blockchain infrastructure. In the context of antitrust, a blockchain solution should be designed with the same antitrust enforcers that aim to use it to be effective. Once a blockchain solution is tested, blockchain can be explored for other antitrust applications.

In other words, it is important that regulators start with testing the implementation of blockchain solutions and smart contracts gradually to clearly define in a tested environment the potential and limitations of such technologies in specific situations. The most promising and easy application seems to be the adoption of smart contracts to automate the verification of companies' compliance with certain remedies. Having codified compliance activities related to some specific antitrust remedies and tested their functioning, the antitrust agency could build a blockchain pilot to evaluate the trade-off of running smart contracts in a blockchain.

V. CONCLUSION

Blockchain and smart contracts are not magic—but they do provide interesting tools that can be explored to make the antitrust enforcement of tailored antitrust remedies more efficient by offering a more organic solution than rigid forms of ex-ante legislation in tackling antitrust issues in today's fast-moving markets.

Blockchain architecture that benefits from having a single source of information shared with national antitrust enforcers and organizations could become a valuable tool now and even more so in the future with the prospect of increasing globalization of antitrust law. Smart contracts offer multiple benefits to antitrust agencies, especially in overseeing companies' compliance with behavioral remedies. Further exploration into the potential of blockchain solutions can be achieved by building a prototype at the FTC or any antitrust agency that would find this idea appealing. Government adoption of emerging technologies, such as blockchain and smart contracts, would at least help the government deepen its understanding in the same technologies that companies are increasingly using. The truth is that antitrust agencies could not think of being effective and moving fast enough in this new technological environment without adequate resources and tools.¹¹⁸

With that in mind, antitrust enforcers could begin the exploration and

118. Posner, *supra* note 1.

test the implementation of smart contracts and a blockchain system. This is not merely an option; it seems essential to maintain relevance. Otherwise, the communication and interpretation of what is going on in markets would be difficult, if not impossible and antitrust enforcement ineffective.