COMMENT

SMART CONTRACT DISPUTE RESOLUTION: THE INESCAPABLE FLAWS OF BLOCKCHAIN-BASED ARBITRATION

MICHAEL BUCHWALD†

† Senior Editor, *University of Pennsylvania Law Review*, Volume 168; J.D., 2020, University of Pennsylvania Law School; B.S., 2015, Cornell University. My thanks to Professor David Hoffman for his valuable insights. I would also like to thank David Wishnick, John Summers, Adam Zuckerman, Ben Schwartz, and Debbie Buchwald for their helpful feedback. Lastly, I greatly appreciate the tireless work of Molly Wolfe, Jacob Abrahamson, and the editors of the *University of Pennsylvania Law Review*.

INTRODUCTION

Over two hundred and fifty million transactions occurred on the Ethereum blockchain in 2018.[1] This staggering level of digital commerce was powered almost entirely by "smart contracts," or self-executing chunks of computer code that immutably transfer assets between users.[2]

1 *Ethereum Transaction History*, ETHERSCAN, https://etherscan.io/chart/tx [https://perma.cc/SW7Z-KQZP] (last visited February 21, 2019).

2 *Ethereum by the Numbers*, CONSENSYS (Dec. 6, 2018), https://media.consensys.net/ethereum-by-the-numbers-3520f4456529 [https://perma.cc/ KB8K-ANC4] ("Since late 2017, the number of successful calls to smart contracts has remained consistent at 1.2 million per day."); Pramod Chandersekhar, *Ethereum Smart-Contracts: Most of Them Are Rarely Used!*, HACKER NOON (May 16, 2018), https://hackernoon.com/ethereum-smart-contracts-most-of-them-are-rarely-used-

Proponents of blockchain technology see these automated, irreversible agreements as one of Ethereum's greatest innovations, offering a virtually costless contractual enforcement mechanism.[3] Some early adopters have even claimed that electronic asset-transference has rendered traditional contract law entirely obsolete.[4]

Despite such assertions, pre-coded agreements are riddled with a host of practical and governance-based complications. As Ethereum users have repeatedly discovered, simply because an agreement is self-executing does not mean that it will deliver an intended result.[5] This routine divergence of outcomes and intentions have naturally left some unsatisfied parties reaching for legal recourse.[6]

Unfortunately, smart contracts possess certain inherent characteristics that make ex-post legal enforceability a dubious proposition. In addition to

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f45749730d3e [https://perma.cc/7UPL-F36J] (stating that roughly forty percent of Ethereum transactions utilize smart contracts).

3 *See* Reggie O'Shields, *Smart Contracts: Legal Agreements for the Blockchain*, 21 N.C. BANKING INST. 177, 183 (2017) ("The perceived benefits of smart contracts include increased speed and accuracy of business transactions, more efficient business operations, and better, quicker, and cheaper enforcement of contracts.").

4 James Rogers, Harriet Jones-Fenleigh & Adam Sanitt, *Arbitrating Smart Contract Disputes*, INT'L ARB. REP., Oct. 2017, at 21, 22 ("Many technologists believe that Smart Contracts replace contract law and courts and tribunals with code.").

5 *See, e.g.*, Ivica Nikolić, Aashish Kolluri, Ilya Sergey, Prateek Saxena & Aquinas Hobor, *Finding The Greedy, Prodigal, and Suicidal Contracts at Scale, in* PROCEEDINGS OF THE 34TH ANNUAL COMPUTER SECURITY APPLICATIONS CONFERENCE 653, 659-660 (2018) (flagging "1,504 candidates contracts (438 distinct) which may leak Ether to an arbitrary Ethereum address[;] . . . 1,495 contracts (403 distinct), including the ParityWalletLibrary contract, as found susceptible to being killed by an arbitrary address[;] . . . 31,201 greedy candidates (1,524 distinct), which amounts to around 3.2% of the contracts present on the blockchain[;] . . . [and] 294 contracts [that] have received Ether after they became dead"); Charlotte R. Young, Note, *A Lawyer's Divorce: Will Decentralized Ledgers and Smart Contracts Succeed in Cutting Out The Middleman?*, 96 WASH. U. L. REV. 649, 661 (2018) ("In June 2016, a hacker attacked a DAO, utilizing a blockchain based smart contract, and stole in excess of $70 million USD."); Elaine Ou, *Smart Contracts Are Still Way Too Dumb*, BLOOMBERG (Nov. 16, 2017, 2:00 AM), https://www.bloomberg.com/opinion/articles/2017-11-16/smart-contracts-are-still-way-too-dumb [https://perma.cc/6EE2-62MX] ("Last week, more than $150 million worth of ether, the platform's currency, ended up stuck in the wallets—forever . . . . [A] few months earlier, a bug . . . allowed hackers to run off with $32 million. Shortly before that, a Canadian exchange accidentally trapped $13 million in its own broken smart contract.").

6 *See supra* note 5 and accompanying text; *see also* Nikhilesh De, *QuadrigaCX Owes Customers $190 Million, Court Filing Shows*, COINDESK (Feb. 1, 2019, 9:28 PM), https://www.coindesk.com/quadriga-creditor-protection-filing (stating that "[i]n a sworn affidavit filed Jan. 31 with the Nova Scotia Supreme Court, Jennifer Robertson . . . said the exchange owes its customers roughly $250 million CAD ($190 million)"); *Statewide Civil Caseload Composition in 26 States, 2016*, CT. STATISTICS PROJECT, http://www.courtstatistics.org/~/media/Microsites/Files/CSP/Civil/PDFs/EWSC-2016-CIVIL-Page-3-Comp-Bars.ashx [https://perma.cc/F5TJ-Y9E8] (last visited Nov. 1, 2019) (indicating that in many states, contract disputes account for the majority of civil claims).

doctrinal woes concerning contract formation and term definitiveness, practical hurdles—namely smart contract self-execution and pseudonymous counterparties—present seemingly insurmountable barriers to obtaining one's day in court. Even if one assumes such a day in court is possible, blockchain proponents may not wish to subject their pseudonymous transactions to traditional forms of adjudication. In many ways, reliance on a centralized third party greatly undermines the theoretical and philosophical bedrock of blockchain technology. Placing oneself at the mercy of a government to amend on-chain mistakes negates the core purposes of a public blockchain: decentralization,[7] consumer autonomy,[8] and complete transactional privacy.[9]

Thus, the practical and ideological disconnects between crypto-commerce and legal proceedings suggest that smart contract adjudication is not long for traditional tribunals. While certain states have enacted legislation aiming to legitimate these disputes and introduce them into their courtrooms,[10] these attempts are sorely misguided in light of Ethereum's pseudonymous nature.[11]

Given that traditional tribunals do not present a viable method for smart contract adjudication, the salience and importance of alternative recourse options will only continue to increase. The ever-growing volume, size, and complexity of transactions on Ethereum[12] will shine an increasingly brighter

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7 Vitalik Buterin, *The Meaning of Decentralization*, MEDIUM (Feb. 6, 2017), https://medium.com/@VitalikButerin/the-meaning-of-decentralization-a0c92b76a274 [https://perma.cc/545E-6RNE] ("'Decentralization' is one of the words that is used in the cryptoeconomics space the most frequently, and is often even viewed as a blockchain's entire raison d'être . . . .").

8 PRIMAVERA DE FILIPPI & AARON WRIGHT, BLOCKCHAIN AND THE LAW 43 (2018) ("Perhaps most profoundly, blockchains are characterized by their ability to facilitate the deployment of autonomous software that is not under the control of any one party.").

9 Jordan Clifford, *Privacy on the Blockchain*, HACKER NOON (Oct. 5, 2017), https://hackernoon.com/privacy-on-the-blockchain-7549b50160ec [https://perma.cc/D2ZA-6MZW] ("Financial privacy means being able to transact without revealing or leaking identifying information. The goal is to make it as difficult as possible for others to profile your crypto use. Privacy puts the user in charge of their data.").

10 *See* SMART CONTRACTS ALLIANCE, CHAMBER OF DIG. COMMERCE, SMART CONTRACTS: IS THE LAW READY? 23 (2018) ("Various U.S. state legislatures (*e.g.*, Arizona and Tennessee) have enacted or are planning to enact specific legislation attempting to authorize the use of smart contracts in electronic records and signatures, so that they are fully enforceable by a court of law.").

11 *See* Mike Orcutt, *States That Are Passing Laws to Govern "Smart Contracts" Have No Idea What They're Doing*, MIT TECH. REV. (March 29, 2018), https://www.technologyreview.com/s/610718/states-that-are-passing-laws-to-govern-smart-contracts-have-no-idea-what-theyre-doing/ [https://perma.cc/DT8Y-QK8S] (suggesting that a lack of coordination between states, the difficulty of identifying smart contracts, and increased complexity may undermine the efficacy of state laws adequately regulating smart contracts).

12 *Ethereum Average Block Size Chart*, ETHERSCAN, https://etherscan.io/chart/blocksize [https://perma.cc/5SRD-BLSN] (last visited Feb. 21, 2019); *Ethereum Total Daily Gas Used Chart*,

light on immutably unsatisfactory smart contracts.[13] In turn, current and potential Ethereum users may become fearful of "on-chain"[14] contractual obligations, ultimately deterring widespread blockchain adoption and slowing the once-potent decentralization movement to a definitive stop.

In an attempt to cure crypto-commerce of this inherent technological shortcoming, Ethereum application developers have begun to introduce on-chain dispute resolution systems. Despite the infancy of these platforms, supporters are quick to claim that they will usher in "a new era of low cost and universally accessible justice[.]"[15] While each currently available application differs from its peers in certain key respects,[16] every application flows from the same basic premise: arbitration that incorporates a blockchain is the most effective method for resolving disputes that arise on a blockchain. In practice, this means that emerging Ethereum platforms such as Kleros,[17] JUR,[18] Aragon Network Jurisdiction,[19] and OpenCourt[20] enable contracting parties to precode an option for ex-post, fully decentralized arbitration.

As a succinct elevator pitch, blockchain-based arbitration seems like a promising and practical solution to suboptimal self-executing smart contracts. If blockchain technology is truly an anchor for the next phase of electronic commerce, then a digitized and decentralized dispute resolution process will be necessary for its success.[21] As the argument goes, on-chain

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ETHERSCAN, https://etherscan.io/chart/gasused [https://perma.cc/WTS7-K3T7] (last visited Feb. 21, 2019); *Ethereum Network Utilization*, ETHERSCAN, https://etherscan.io/chart/networkutilization [https://perma.cc/Y4TE-GWC9] (last visited Feb. 21, 2019).

13 Evidence of growing concern can be found in Section I.C, which details the small but increasing academic interest in smart contract dispute resolution.

14 "On-chain transactions refer to those cryptocurrency transactions which occur on the blockchain—that is, on the records of the blockchain—and remain dependent on the state of the blockchain for their validity." Jake Frankenfield, *On Chain Transactions (Cryptocurrency)*, INVESTOPEDIA (April 5, 2018), https://www.investopedia.com/terms/c/chain-transactions-cryptocurrency.asp [https://perma.cc/M6BX-T92R].

15 OpenLaw, *OpenCourt: Legally Enforceable Blockchain-Based Arbitration*, CONSENSYS **(Oct. 18, 2018)**, https://media.consensys.net/opencourt-legally-enforceable-blockchain-based-arbitration-3d7147dbb56f [https://perma.cc/C3MU-SP5L] [hereinafter *OpenCourt*].

16 These differences will be explored in Part II.

17 KLEROS, https://kleros.io/ [https://perma.cc/MP92-AKN7] (last visited March 13, 2019).

18 JUR, https://jur.io/ [https://perma.cc/L2CJ-TQWQ] (last visited March 13, 2019).

19 ARAGON, https://aragon.org/network/ [https://perma.cc/2579-MWRY] (last visited March 13, 2019).

20 *See OpenCourt*, *supra* note 15 ("That is why the era of decentralized dispute resolution procedures is beginning.").

21 Blockchain proponents specifically cite it as integral to the completion of Web 3.0, a term used to describe the next phase of the Internet in which the initial mass migration to social networking sites and online shopping is optimized and perfected. *See e.g.,* Anthony J. Biller & David M. Chambers, *Distributed Ledger Trademark Registry? A Proposal for One Ledger to Rule Them All!*, J. INTERNET L., Nov. 2018, at 12, 14 ("As we move to an AI Web 3.0, a trademark ledger could in theory implement a smart algorithm to calculate the rate of geographic expansion within market segments . . . .").

arbitration offers the best of both worlds, allowing disputants and jurors to remain pseudonymous without sacrificing the right to expedient, cheap, and satisfactory adjudication.

But blind deference and acceptance of such tools, based on perceived convenience, has troubling justiciability implications. It would be foolish and dangerous for lawmakers, programmers, and platform users to simply assume the efficacy of these mysterious computer programs. As soon as one pushes past the veneer of alleged superiority, a multitude of problems quickly begin to arise. Thus, before reliance on blockchain-based dispute resolution systems expands any further, two vital policy questions must be answered: (1) Does blockchain-based dispute resolution suffer from inherent technological flaws that inhibit adequate adjudication? And (2) if so, are any of these on-chain options still somehow equivalent or superior to off-chain alternatives?

This Comment will attempt to answer both questions. Part I will first offer a brief overview of both blockchain technological processes and existing academic literature concerning smart contract dispute resolution. Part II will elucidate the realm of current and forthcoming blockchain-based arbitration applications. Part III, the heart of this Comment, will then identify the inescapable shortcomings associated with these applications. Specifically, it explores three gaping issues inherent in blockchain technology: (1) those associated with the discovery process; (2) those associated with juror voting incentives; and (3) those associated with platform scalability. Part IV will finally consider whether these dispute resolution platforms, despite their distinctive flaws, are an improvement upon off-chain adjudication options available to Ethereum users. Ultimately, this Comment concludes that it is impossible for on-chain dispute resolution to successfully emulate any off-chain alternative without sacrificing the guiding principles of blockchain. Users will not be able to remain pseudonymous, nor will decentralized decision-making ever be able to efficaciously resolve disputes at scale. No literature currently exists which comprehensively examines the feasibility of such on-chain decision making systems. Thus, this Comment will serve as a useful guidepost to policymakers, businesses, and developers as application adoption expands.

I. Overview of Technology and Existing Literature

A. *Blockchain Technology*

Many blockchain-focused articles begin with an in-depth explanation of the technology itself. While these comprehensive descriptions are useful and

informative, they are also plentiful[22] and laborious.[23] Lengthy discussions of key blockchain concepts such as decentralization, hashing, mining, and immutability tend to be exhausting, confusing, and occasionally downright maddening.[24] Luckily, such discussions are unnecessary for present purposes. This Comment is far more concerned with what these technological processes enable and far less with how the technology works. Thus, before exploring on-chain dispute resolution application feasibility, this Comment need only provide an extremely brief overview of key blockchain concepts. Specifically, it touches upon the general structure of a public blockchain, as well as those technological features that may restrain the functionality of on-chain dispute resolution systems. Importantly, readers familiar with the technological concepts surrounding public blockchains can skip the following background section. These readers may resume at Section I.C, Existing Literature.

1. Blockchains Generally

At the highest level, a public blockchain is a decentralized and immutable digital ledger of transactions.[25] The latter half of this definition—a digital ledger of transactions—is readily understandable, familiar, and hardly disruptive. For example, any Venmo user who has ever examined her history has interacted with a simple digital ledger.[26] It is instead these first two definitional components—decentralization and immutability—that excite "cypherpunks"[27] and confuse casual observers. As will become clear, these two fundamental mechanisms of crypto-commerce are the very same structural deficiencies that obfuscate successful on-chain and off-chain legal recourse.

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22 *See, e.g.*, Nathan Fulmer, *Exploring the Legal Issues of Blockchain Applications*, 52 AKRON L. REV. 161, 166-71 (2018); Wulf A. Kaal & Craig Calcaterra, *Crypto Transaction Dispute Resolution*, 73 BUS. LAW. 109, 114-25 (2017); Jesse Marks, *Distributed Ledger Technologies and Corruption: the Killer App?*, 20 COLUM. SCI. & TECH. L. REV. 42, 45-58 (2018).

23 *See supra* note 22.

24 *See What is Blockchain?*, LISK ACADEMY, https://lisk.io/what-is-blockchain [https://perma.cc/XJ6J-JE9T] (last visited December 20, 2019).

25 *See* Kevin Werbach & Nicolas Cornell, *Contracts* Ex Machina, 67 DUKE L.J. 313, 327 (2017) ("In theory, no one can alter an existing transaction, because every block is linked in an immutable sequence."); *id*. ("The blockchain is not stored in one central location. Instead, computer nodes running the Bitcoin software connect in a peer-to-peer (P2P) network, where each maintains a complete copy of the blockchain."); *see also* Buterin, *supra* note 7 ("Blockchains are politically decentralized . . . and architecturally decentralized . . . .").

26 *Transaction History*, VENMO, https://help.venmo.com/hc/en-us/articles/360016096974-Transaction-History [https://perma.cc/URB6-DRRV] (last visited March 13, 2019) ("To view your complete transaction history or statement, you can log into your Venmo profile from a computer's browser.").

27 Declan McCullagh, *Technology as Security*, 25 HARV. J.L. & PUB. POL'Y 129, 130 (2001) (referring to "[a] loosely organized group of essayists, activists, and programmers . . . [who have] been . . . fierce champion[s] of a technology-over-law approach").

2. Decentralization

Decentralization refers to the fact that no singular authority figure validates or mediates individual transactions on a blockchain.[28] Instead, a digital copy of the blockchain ledger is continuously and completely available for storage and monitoring by any user with an internet compatible device.[29] These devices, known as "nodes,"[30] are the backbone of decentralization's success. A public blockchain relies on a subset of nodes—referred to as "miners"[31]—to verify and validate every transaction that appears on the chain.[32] Without miner consensus, a given transaction will not post to the blockchain ledger.[33] This supposedly enables a global commercial ecosystem that requires zero oversight from centralized governments or large institutions. These dispersed, anonymous miners replace such regulatory entities.[34]

Venmo again offers a useful lens for understanding the practical difference between centralized and decentralized transactions. When Venmo User A sends money to Venmo User B, the money simply shifts between two Venmo-

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28 Jeremy M. Sklaroff, Comment, *Smart Contracts and the Cost of Inflexibility*, 166 U. PA. L. REV. 263, 267 (2017) ("Broadly labeled 'decentralized ledger technology' (DLT), the term spans a group of cryptographic tools and protocols to exchange, verify, and secure data without the need for centralized intermediaries.").

29 Jimi S., *Blockchain: What Are Nodes and Masternodes?*, MEDIUM (Sept. 5, 2018), https://medium.com/coinmonks/blockchain-what-is-a-node-or-masternode-and-what-does-it-do-4d9a4200938f [https://perma.cc/SNV5-LPYS] ("Nodes can be any kind of device (mostly computers, laptops or even bigger servers). Nodes . . . [C]onstantly exchange the latest blockchain data with each other so all nodes stay up to date. They store, spread and preserve the blockchain data, so theoretically a blockchain exists **on** nodes.").

30 *Id.*; *see also* Sklaroff, *supra* note 28, at 267-68 n.12 (defining nodes as "computers in a decentralized ledger system which participate in recording and verifying transactions").

31 CoinGeo Exchange, *Blockchain Nodes Explained*, XCELLAB MAG. (Nov. 15, 2019), https://medium.com/xcellab-magazine/blockchain-nodes-explained-ac278e2ff56a [https://perma.cc/Y6P4-5Z29] ("As the owners of nodes willingly contribute their computing resources to store and validate transactions, they have the chance to collect the transaction fees and earn a reward in the underlying cryptocurrency for doing so. This is known as mining or forging.").

32 Sabih Rehman, *What Is Blockchain?*, XCELLAB MAG. (Sept. 12, 2018), https://medium.com/@sabih811/when-and-where-blockchain-comes-9a2ffe59edea [https://perma.cc/VW86-NUW8] ("Rather than relying on a central authority to securely transact with other users, blockchain utilizes innovative consensus protocols across a network of nodes, to validate transactions and record data in a manner that is incorruptible.").

33 DE FILIPPI & WRIGHT, *supra* note 8, at 36 ("If a majority of nodes supporting the network do not agree on a change, a blockchain will remain the same.").

34 Importantly, miners are rewarded for their transaction-validation efforts through small payments of localized, blockchain-specific digital currency (i.e. crypto-currency). Ethereum miners, for example, receive ether, whereas Bitcoin miners receive bitcoin. *See id.* at 40 ("By using block rewards and transaction fees, blockchains incorporate payoff structures designed to reward parties that maintain a blockchain-based network."); Ameer Rosic, *Ethereum Mining 101: Your Complete Guide*, HUFFPOST (Mar. 1, 2017, 10:20 AM), https://www.huffingtonpost.com/entry/ethereum-mining-101-your-complete-guide_us_58b6e1eee4b02f3f81e44e9f [https://perma.cc/J4UQ-65PH] (describing the mining process and its necessity).

controlled accounts.[35] The entirety of the digitized currency remains on the Venmo platform and is subject to Venmo's control. Until the digitized cash leaves the platform, the only update is to each user's "Venmo History" ledger and corresponding on-application account balance.[36] Venmo, as the centralized authority figure, still has the unilateral capability to reverse and restrict transactions.[37] Conversely, on a public blockchain like Ethereum, there is no centralized overseer.[38] If Ethereum User A sends ether[39] to Ethereum User B and a disaggregated majority of miners verifies that transaction, alteration or reversion becomes virtually impossible.[40] The specifics of the transaction are beyond the reach of miners, unsavory hackers, and even the users themselves. Such decentralization supposedly deters oppressive governmental and corporate overreach.[41]

3. Immutability

The second core component of blockchain technology—immutability—flows from its decentralization. Specifically, the miner verification process renders ledger alteration virtually impossible. The ledger is protected by a "Merkle tree" structure of encryption, in which each new encrypted block of transactions incorporates a string of characters that represents and encapsulates the previous block of transactions.[42] If a single nefarious user

35 *See Venmo Balance*, VENMO, https://help.venmo.com/hc/en-us/articles/217042588 [https://perma.cc/8E5L-D7QZ] (last visited March 13, 2019). ("[I]f you have access to a balance and it covers the entire payment, it will be pulled from your balance.").

36 *Transaction History*, VENMO, https://help.venmo.com/hc/en-us/articles/360016096974-Transaction-History [https://perma.cc/URB6-DRRV] (last visited Mar. 13, 2019).

37 Erik Kuebler, *Op Ed: Venmo Offers the Ultimate Cryptocurrency Experience*, BITCOIN MAG. (June 7, 2018), https://bitcoinmagazine.com/articles/op-ed-venmo-ultimate-cryptocurrency-experience/ [https://perma.cc/J4BA-5SWN] ("The Venmo network is owned by PayPal. Transactions can be reversed and/or monitored for scams via Venmo customer support. There are also limitations placed on transactions . . . .").

38 *Cf. id.* ("The Bitcoin network has no intermediaries and cannot be censored/modified unless there is a significant attack . . . .").

39 *Haseeb Qureshi*, *A Hacker Stole $31M of Ether—How it Happened, and What it Means for Ethereum*, FREECODECAMP (July 20, 2017), https://medium.freecodecamp.org/a-hacker-stole-31m-of-ether-how-it-happened-and-what-it-means-for-ethereum-9e5dc29e33ce [https://perma.cc/9GCK-3XAM] ("Ethereum's corresponding digital currency, ether, is essentially a side effect of powering this massive computer.").

40 *See* DE FILLIPI & WRIGHT, *supra* note 8, at 25.

41 *See generally* Buterin, *supra* note 7 (describing the mechanisms and benefits of blockchain decentralization).

42 A "Merkle tree" is broadly defined as

> a way of hashing a large number of "chunks" of data together which relies on splitting the chunks into buckets, where each bucket contains only a few chunks, then taking the hash of each bucket and repeating the same process, continuing to do so until the total number of hashes remaining becomes only one: the root hash.

attempts to alter a posted transaction, such a change reverberates through the entire system; theoretically modifying every transaction on the chain.[43] All other nodes quickly become aware of that attempt and refuse to approve it.[44] For this reason, a blockchain is said to be immutable.[45]

This memorialization process is technical and confusing, but it is not overly important that one understand its inner workings. For present purposes, it is only important to recognize that a public blockchain is in fact immutable, and that smart contracts are subject to this rigidity.

4. Pseudonymity

Before turning directly to smart contracts, it is pivotal to note that blockchain-based transactions are performed pseudonymously, unless the user chooses to self-identify. Public blockchain users have the ability to hide behind a string of characters while utilizing "asymmetric cryptography" to securely and privately send services and goods to one another.[46] Specifically, Ethereum users possess both a public and a private key.[47] The former is a unique string of characters personalized to a specific user, but which may be viewed by all other Ethereum users.[48] When a transaction is posted to a blockchain, it displays the public key of each transacting party.[49] The private key, as the name suggests, is not for public viewership.[50] It is maintained by a single user and should never intentionally be posted on the ledger. In a

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Vitalik Buterin, *Merkling in Ethereum*, ETHEREUM BLOG (Nov. 15, 2015), https://blog.ethereum.org/2015/11/15/merkling-in-ethereum/ [https://perma.cc/JL2H-GRLE].

43 DE FILLIPPI & WRIGHT, *supra* note 8, at 25 (stating that "[b]ecause the header of each block incorporates a hash of the preceding block's header, anyone trying to modify the content stored in a block will inevitably break the chain." Thus, "[e]ven a small alteration . . . will necessarily trigger a change to the hashes of all subsequent blocks," which means that "[a]nyone willing to modify . . . would have to go through the computationally expensive task of generating new hashes for every subsequent block . . . . The more transactions that occur on the network . . . the harder it becomes to retroactively modify previously recorded transactions.").

44 *Id*.

45 *See* Werbach & Cornell, *supra* note 25, at 327 ("In theory, no one can alter an existing transaction, because every block is linked in an immutable sequence.").

46 *See* Toshendra Kumar Sharma, *How Does Blockchain Use Public Key Cryptography?*, BLOCKCHAIN COUNCIL (Jan. 27, 2018), https://www.blockchain-council.org/blockchain/how-does-blockchain-use-public-key-cryptography/ [https://perma.cc/Z849-Z2TT] ("Asymmetric cryptography or public cryptography is an essential component of cryptocurrencies like Bitcoin and Ethereum.").

47 DE FILIPPI & WRIGHT, *supra* note 8, at 14-15 ("Public-private key cryptography solved this problem by enabling the sending of encrypted messages without the need for a shared key. Under Diffie and Hellman's model, both parties would agree on a shared pub[l]ic key and each party would generate a unique private key.").

48 *Id*. at 15 ("The private key acted as a secret password, which parties did not need to share, whereas the public key served as a reference point that could be freely communicated.").

49 *Id*.

50 *Id*.

sense, it is a password to access files and information encrypted with a user's matching public key.[51]

Concretely, if Party *A* wishes to send a confidential document to Party *B*, Party *A* encrypts that document with Party *B*'s public key. When Party *A* sends the document to Party *B*, the transmission is recorded on the blockchain, but its contents are hidden from all other users. Only the private key of Party *B* can decrypt the message and view the content.

Importantly, while it is technically possible to identify the user behind a public key, it is extremely costly and impracticable.[52] By and large, most transactions on Ethereum occur between parties that are effectively locationless, nameless, and unidentifiable.[53] This pseudonymity creates major jurisdictional complications with regard to transaction dispute resolution[54] and greatly limits the opportunity for off-chain alternatives.

B. *Smart Contracts and Oracles*

Thus far, this Comment has used the amorphous term "transaction" to explain the basic workings and goals of a blockchain. While it is true that all blockchains aim to facilitate secure, trusted, and pseudonymized transactions, the scope and complexity of possible transactions differ tremendously depending on a user's blockchain of choice. The first-ever Bitcoin blockchain, for example, was specifically designed for the trading of cryptocurrency.[55]

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51 *Id.*

52 *See* DE FILIPPI & WRIGHT, *supra* note 8 at 29 ("The open and decentralized nature of Ethereum allows smart contracts to be deployed pseudonymously and to operate in a largely autonomous manner."). *But see* Clifford, *supra* note 9 (describing first the methods that exist for linking one's identity with a set of transactions, and then describing the many blockchain-based efforts to negate this ability for the average, unsophisticated user); Will Price, *Clustering Ethereum Addresses*, TOWARDS DATA SCI. (Dec. 6, 2018), https://towardsdatascience.com/clustering-ethereum-addresses-18aeca61919d?gi=625b0a0828e5 [https://perma.cc/2FKD-9J46] (stating that "[e]thereum users may be anonymous, but their addresses are unique identifiers that leave a trail publicly visible on the blockchain").

53 DE FILIPPI & WRIGHT, *supra* note 8, at 29.

54 *See, e.g.*, Kaal & Calcaterra, *supra* note 22, at 134 ("Traditional jurisdictional means have limited applicability in the context of blockchain technology. Jurisdiction over the public blockchain does not exist within the present doctrinal infrastructure for jurisdiction. In practice, the blockchain itself cannot be regulated or governed because it is decentralized and autonomous."). Such issues are only further complicated by additional technological updates that aim to push pseudonymity into the realm of anonymity by enabling individual users to dissociate public keys from a specific history of transactions. Thus, any attempt to use the historical list of transactions for a single public key may soon be futile, making off-chain dispute resolution even less likely. *See, e.g.*, Clifford, *supra* note 9 ("Many schemes have been devised to erase a bitcoin's history — restoring privacy and preserving fungibility.").

55 DE FILIPPI & WRIGHT, *supra* note 8, at 27 ("However, the more people who considered Bitcoin, the more its limitations became apparent. Bitcoin excelled as a platform to facilitate the

Bitcoin does have the technical capabilities to execute slightly more complex transactions, but this decade-old platform almost exclusively handles the straightforward transference of digital moneys.[56]

Given the inherent limitations of Bitcoin, newer blockchains like Ethereum and EOS have emerged to offer users a "richer functionality"[57] through the advent of smart contracts.[58] This term, "smart contract," is often derided as a misnomer and deserves further consideration.[59]

As noted above, a smart contract is a "self-executing digital transaction[] using decentralized cryptographic mechanisms for enforcement."[60] In other words, it is a method of transferring assets that relies on a series of "if-then" logic statements which cannot be halted once executed.[61] Many academics do not consider every manifestation of this self-executing code to be a fully

exchange of digital currency, but without updating the underlying protocol, it could not be used for much more.").

56 *Cf. Yes, Bitcoin Can Do Smart Contracts and Particl Demonstrates How*, BITCOIN MAG. (Oct. 13, 2017), https://bitcoinmagazine.com/articles/yes-bitcoin-can-do-smart-contracts-and-particl-demonstrates-how/ [https://perma.cc/89JA-BSZB] ("Ethereum might be a strong foundation for writing very complex smart contracts, or ones in which security and privacy are not priorities, but Bitcoin provides a simpler and more reliable scripting framework for the private escrows that Particl requires.").

57 DE FILIPPI & WRIGHT, *supra* note 8, at 27.

58 *Id.* at 27-28 (stating that "[t]he first blockchain to enable the creation and deployment of sophisticated smart contracts was the Ethereum blockchain" and "unlike Bitcoin, Ethereum is faster and has a greater range of capabilities when it comes to smart contracts"). It should be noted that each of these platforms has its own native currency. Ethereum miners strive to amass "Ether" in the same way that Bitcoin miners strives for Bitcoins. Further, Ethereum enables users and applications to issue their own coins, in what is known as an Initial Coin Offering (ICO). Users may offer their individualized token to investors in exchange for ether or fiat currency. This ICO funds the development of blockchain application that often requires ether or the individualized token to use. If the application is successful, those who participated in the ICO will see a rise in the value of the individualized token. However, the creation of coins on a given blockchain creates certain cross-platform trading difficulties, the scope of which is beyond this Comment. *See generally*, Shaahan Cohney, David Hoffman, Jeremy Sklaroff & David Wishnick, *Coin-Operated Capitalism*, 119 COLUM. L. REV. 591 (2019) (discussing the potential value of regulating ICOs).

59 *See, e.g.*, James Grimmelmann, *All Smart Contracts Are Ambiguous*, 2 J.L. INNOVATION 1, 2 (2019) ("'Smart contracts' are neither smart nor contracts, but the name has stuck.").

60 Werbach & Cornell, *supra* note 25, at 313.

61 *See* Sklaroff, *supra* note 28, at 291 ("Computer code must be precisely and completely defined, because at root it is a series of if-then instructions that must all be resolvable by a computer."). As a technical matter, smart contracts exist as individual Ethereum accounts wholly separate from that of the contracting parties. DE FILIPPI & WRIGHT, *supra* note 8, at 28. Users send "messages" to the contract account, enclosing all necessary information within the message for a smart contract to self-execute. *Id.* At a minimum, these messages contain the address of the sender, the desired destination, and the amount of ether (Ethereum's base cryptocurrency) associated with a transaction. *Id.* This message executes the smart contract, resulting in the transfer of some digital asset, performance of some digital service, or potentially the calling upon another smart contract to perform some additional function. *Id.* at 29.

formed, legally enforceable contract.[62] However, this code is often connected to a semantic, natural-language e-document that resembles a traditional contract. Parties read this semantic component and sign it with a pseudonymous blockchain address.[63] In actuality, signing the natural language contract may be an entirely separate action from initiating the code-based smart contract. Further, the corresponding code may or may not perform in accordance with what the semantic document conveys, leading to suboptimal results.

Despite the occurrence of such suboptimal results, smart contracts enable a range of interesting use cases. Ethereum users can, for example, engage freelance website developers, exchange ether for live-video streams, purchase physical commodities, and place sports bets; all via the Ethereum blockchain.[64] Many of these use cases rely on "oracles," or technological blockchain add-ins that enable a smart contract to access information external to the ledger.[65] Oracles are a major catalyst for blockchain-based disputes, as they allow for real-world human error to penetrate the immutable code-based ledger. Further, each individual use-case may vary greatly in complexity, as transacting parties have the option to pre-code an infinite number of terms and conditions into the code-based agreement.

As alluded to above, once a smart contract is initiated, its execution is inevitable. No user can stop the triggering of conditions and the resulting flow of assets as prescribed by the code. This finality is cemented by the structural rigidity and immutability of blockchain technology. Simply put, Ethereum purposely removes any ex-post mechanism to amend the results. Once the transaction is complete, the transfer of digital assets is forever transcribed on the Ethereum blockchain. Thus, without taking certain precautions, smart contracts are stricken by the same permanence as all other forms of crypto-asset transference.

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62 *See* Grimmelmann, *supra* note 59, at 3; Werbach & Cornell, *supra* note 25, at 367-68 ("Contract law developed over centuries to account for situations that arise in the execution of agreements. Through the inductive process of the common law, courts evolved solutions to novel problems. Upon closer examination, many of these rules are in tension with smart contracts' mechanism of automatic, irrevocable enforcement.").

63 *See* Aaron Wright, *OpenCourt: Legally Enforceable Blockchain-Based Arbitration*, YOUTUBE (Oct. 18, 2018), https://www.youtube.com/watch?v=oVfjy43YgnY&feature=youtu.be [https://perma.cc/FKG7-TJ5Q] [hereinafter *OpenCourt Tutorial*] (describing the process by which parties sign the semantic contract component).

64 Bernard Marr, *30+ Real Examples of Blockchain Technology in Practice*, FORBES (May 14, 2018, 1:38 AM), https://www.forbes.com/sites/bernardmarr/2018/05/14/30-real-examples-of-blockchain-technology-in-practice/#6b9eff4774od [https://perma.cc/65ET-YB5W].

65 In the classic example, a smart contract for a farmer's insurance could include an oracle that performs a daily check of the temperature in a farmer's geographic location by accessing a weathering website. If the oracle reports an excessively hot temperature for a successive number of days, the insurance contract would issue a payout to the farmer. *See* Werbach & Cornell, *supra* note 25, at 331.

Unfortunately, the range of possible ex-ante precautions is sparse. The parties may attempt to code for every permutation, but such upfront programming is costly and undesirable.[66] Alternatively, as this Comment addresses, parties may pre-code an ex-post quality control check. This pre-code is the foundational element of on-chain smart contract dispute resolution.[67] In such a situation, the code of a smart contract enables a dissatisfied purchaser to initiate on-chain dispute proceedings prior to contract completion.

C. *Existing Literature*

This Comment now turns to literature specifically surrounding on-chain dispute resolution. While legal academia has produced a wide array of interesting and important blockchain literature in recent years, there are surprisingly few articles that substantively and exclusively examine the developing phenomenon of on-chain arbitration. Those articles that do exist lay an excellent foundation for discussion but do not fully articulate the limitations of these new platforms.

In *Crypto Transaction Dispute Resolution*, perhaps the most direct and comprehensive legal examination of on-chain dispute resolution, Professors Wulf A. Kaal and Craig Calcaterra advocate for "an open-source platform ecosystem of smart contracting dispute resolution that allows users to opt in to conflict resolution mechanisms . . . ."[68] The article thoroughly examines the physical jurisdictional issues associated with in-court blockchain resolution,[69] but does not consider shortcomings with the authors' proposed theoretical crypto-arbitration solution. Indeed, in Part III, this Comment will briefly evaluate Kaal and Calcaterra's proposed upgrade to the Aragon and OpenBazaar on-chain dispute resolutions systems.[70]

Similarly, in *Contracts Ex Machina*, Kevin Werbach and Nicolas Cornell explore when and how ex-post smart contract enforcement poses novel and

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66 Sklaroff, *supra* note 28, at 297-98 ("Tapscott and Tapscott observe that lower costs of 'monitoring [and] enforcing' a smart contract are offset by higher 'up front' costs of 'determining agreement terms.'").

67 "Ex-post" may not be the wholly correct term to use, as the option to affirm satisfaction with a transaction springs to life immediately prior to smart contract finalization.

68 Kaal & Calcaterra, *supra* note 22, at 148.

69 *See id.* at 133-139 (highlighting the anonymity of blockchain transactions, enforceability of smart contracts, and limited regulatory oversight as the primary reason that smart contracts fall beyond traditional tribunal reach).

70 *See id.* at 144-148 (describing the flaws in both the Open Bazaar and Aragon dispute resolution system, and then suggesting "an open-source platform ecosystem of smart contracting dispute resolution that allows users to opt in to conflict resolution mechanisms that simultaneously could enable more nuanced crypto solutions and produce greater (legal) certainty").

challenging questions to traditional contract dispute doctrines.[71] The authors ultimately conclude that smart contract adoption will cause the posture of claims to shift, but that "[l]itigation—like nature—will find a way."[72] However, they do not address the feasibility of traditional litigation when both parties are pseudonymous. Further, the authors only briefly acknowledge on-chain resolution options, noting that "giving authority to human oracles who decide whether the factual basis for performance has been met, or employing arbitrators who resolve disputes through a multisig arrangements, may avoid some of the draconian implications of fully self-enforcing agreements."[73]

Jeremy Sklaroff offers additional important insights into the "inflexibility in smart contracts,"[74] providing an in-depth comparison of self-executing agreements and traditional malleable off-chain contracts.[75] Sklaroff focuses on the benefits of contractual flexibility and the need for traditional intra-party mechanisms to interpret subjective contractual terms, such as "good faith" and "best effort" clauses.[76] However, he also briefly explores the feasibility of on-chain dispute resolution systems, surmising that "blockchain-based dispute resolution is radically uncertain without offering any advantage over traditional contract litigation."[77]

While Sklaroff does indeed identify several of the same issues explored here, his quick analysis of on-chain juror incentivization schemes,[78] practical scalability, and choice-of-law selection[79] does not directly or completely address the inherent, inescapable flaws of on-chain dispute resolution.[80] In some sense, Sklaroff asks whether current iterations of on-chain dispute resolution offer any

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71 *See* Werbach & Cornell, *supra* note 25, at 318 ("Contract law is a remedial institution. Its aim is not to ensure performance ex ante, but to adjudicate the grievances that may arise ex post. Smart contracts bring this core function of contract law into sharper relief, [by eliminating] the act of remediation by admitting no possibility of breach.").

72 *Id.* at 376.

73 *Id.* at 375.

74 *See* Sklaroff, *supra* note 28, at 291-96 (arguing that smart contracts are flawed because they "must be written in precise, fully defined computer code; they are unmodifiable once executed; and they favor anonymous and one-off transactions.").

75 *See id.* at 292 (noting that if parties wanted to modify their original agreement, "[t]his flexibility would not have been an option if the agreement were a smart contract.").

76 *See id.* at 281 n.74 ("Other examples of contractual standards include best effort clauses, fiduciary duties of agents to principals, and the performance of obligations in good faith.").

77 *Id.* at 300 (capitalization altered).

78 *See id.* at 301 ("In these decentralized resolution systems, parties cannot know how to craft their arguments to maximize success or minimize risk.").

79 See *id.* ("But each moderator is free to decide her cases based on whatever substantive principles she prefers, which may or may not be evident from her listing.").

80 See *id.* at 302 ("As a result, decentralized adjudication will grow more resource-intensive over time as parties attempt, and inevitably fail, to define every contingency ex ante with the exacting rigor of computer code.").

advantages over traditional adjudication, whereas this Comment will explore whether on-chain resolution is perpetually bound to inferiority.

Finally, it is worth noting that there exists a slew of literature concerning off-chain online arbitration ("OArb"[81]). While not specifically addressing blockchain technology, much of this past writing helps to comparatively inform this Comment's discussion of flaws associated with on-chain arbitration. Existing OArb-related articles identify arbitral seat determination,[82] choice-of-law selection,[83] and the impracticalities of discovery and testimony[84] as particularly problematic in the OArb context. Importantly, some of the proposed and implemented fixes for traditional and online arbitration flaws become increasingly complicated when applied to on-chain dispute resolution.[85]

II. ON-CHAIN DISPUTE RESOLUTION PLATFORMS EXPLAINED

With a review of smart contract technology and related academic literature in hand, this Comment may now turn to the specifics of blockchain-based dispute resolution. While the market for on-chain applications is not overly saturated, a handful of successful dispute protocols do currently exist.[86]

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81 *See* Amy J. Schmitz, *"Drive-Thru" Arbitration in the Digital Age: Empowering Consumers Through Binding ODR*, 62 BAYLOR L. REV. 178, 183 (2010) ("This has left binding online arbitration (I will refer to it as 'OArb' for ease of reference and to distinguish it from non-binding [Online Dispute Resolution] methods) largely overlooked.").

82 *See id.* at 211 ("[I]t is difficult to define the 'seat of the arbitration' for OArb, as is often required to determine the law applicable for enforcement of any arbitration agreements and awards as well as the law the arbitrators will use in deciding the parties' claims.").

83 *See id.* ("Choice of law questions nonetheless create additional concerns for OArb agreements and proceedings because many countries refuse or are reluctant to enforce pre-dispute arbitration agreements in consumer and electronic contracts."); *see also* Nicolas de Witt, *Online International Arbitration: Nine Issues Crucial to its Success*, 12 AM. REV. INT'L ARB. 441, 452 (2001) ("Online international arbitration cannot bear the costs of protracted argument on the issue of applicable law, allowing practices such as 'dépeçage' or any other complex doctrine of private international law.").

84 *See* de Witt, *supra* note 83, at 457 ("Evidentiary rules in international online arbitration will drastically differ from those of traditional arbitration . . . .").

85 For example, Claudia T. Salomon and Sandra Freidrich discuss the use of "telephone or video conferencing technology" in the online arbitration context, which allows "hearing participants to 'virtually appear' before the tribunal" and thus ease the costs of discovery and advocacy. This may seem like a promising solution for all forms of web-based arbitration, but the calculus changes when parties are entitled to and desire transactional anonymity. This line of literature highlights an eventual key takeaway. The well-documented problems associated with traditional OArb are not only present with on-chain resolution application, but also are often exacerbated due to blockchain's inherent structure. Claudia T. Salomon & Sandra Friedrich, *Obtaining and Submitting Evidence in International Arbitration in the United States*, 24 AM. REV. INT'L ARB. 549, 583 (2013).

86 No clear market leader has yet emerged from this list of competitors, but Kleros seems to have amassed an early lead. As of January 2020, Kleros boasts a market cap of $3.1 million and a "Kleros Court Dapp" that has already "resolved over 150 cases" worth hundreds of thousands of

Platforms such as Kleros, JUR, Aragon Network Jurisdiction, OpenCourt, and OpenBazaar[87] offer products that supposedly perfect the smart-contracting process. These applications are similar in many key respects, but each one attempts to differentiate itself from its peers by trumpeting unique juror-incentivization strategies, different levels of legal enforceability, and specialized tribunals. This Part will outline the adjudication processes and procedures of these on-chain applications, highlighting key differences among them. The application overview proceeds sequentially, attempting to guide the reader through an on-chain dispute resolution as it occurs in real time.[88]

A. *Agreement Formation*

On-chain applications require the implementation of an escrow-like system to facilitate agreement formation.[89] At the start of a transaction, a purchaser deposits a sufficient level of funds into a smart contract.[90] This crypto-payment will remain in escrow on the blockchain until (1) the

dollars in the aggregate. KLEROS BLOCKFYRE REPORT, BLOCKFYRE 2 (2020), https://drive.google.com/file/d/1AjdFJTikOfIf5nws01Gi9WkyvuHehzIp/view [https://perma.cc/XR2G-4ZU7]; *see also* KLEROS ONE PAGER, KLEROS 1 (2019), https://kleros.io/onepager_en.pdf [https://perma.cc/Q93Q-QT79] ("$400k passed through the TCR . . . . More than 50 Jurors have ruled on cases . . . . Over 100 cases [have been] ruled on . . . . Over $15K [has been] paid in fees to jurors"); *Kleros (PNK)*, COINGECKO, https://www.coingecko.com/en/coins/kleros [https://perma.cc/C3XF-4M4N] (last visited Jan. 15, 2020).

87 *See supra* notes 17–20 and accompanying text. OpenBazaar will not be explained in more detail, as it largely duplicative of other dispute resolution systems. For an overview, see Austin Williams, *Escrow Smart Contract Specification in OpenBazaar*, OPENBAZAAR (Oct. 24, 2018), https://openbazaar.org/blog/Escrow-Smart-Contract-Specification-in-OpenBazaar/ [https://perma.cc/5WMA-Y8BU].

88 For a comprehensive explanation of each individualized platform, see ALEXANDER SHEVTSOV, JURY.ONLINE, RESPONSIBLE ICO 4 (2019), https://icosbull.com/whitepapers/110/Jury.Online_whitepaper.pdf [https://perma.cc/F26T-FY6J]; JUR, WHITE PAPER V.0.3, at 33-34 (2018) [hereinafter JUR WHITE PAPER], https://icosbull.com/whitepapers/4088/JUR_whitepaper.pdf [https://perma.cc/95UC-L28U]; Clément Lesaege & Federico Ast, Kleros Short Paper v1.0.6, at 3 (Nov. 2018) [hereinafter Kleros White Paper] (unpublished manuscript), https://www.researchgate.net/publication/318877800_Kleroterion_a_decentralized_court_for_the_Internet [https://perma.cc/J9CC-JKKP]; *Aragon Network*, GITHUB (Aug. 28, 2018) [hereinafter *Aragon White Paper*], https://github.com/jiangbubai/aragon-whitepaper [https://perma.cc/HVN9-CHPN]; Tatu Kárki, *Aragon Network Jurisdiction Part 1: Decentralized Court*, ARAGON (July 18, 2017), https://blog.aragon.org/aragon-network-jurisdiction-part-1-decentralized-court-c8ab2a675e82/ [https://perma.cc/68TF-ASSU]; *OpenCourt Tutorial*, *supra* note 63.

89 *See* DE FILIPPI & WRIGHT, *supra* note 8, at 76 ("Interested buyers can send money to a virtual escrow account implemented via a smart contract . . . . [I]f a dispute arises over the quality of the good . . . a human-based oracle steps in to analyze the facts of the case and determine who should receive the escrowed funds.").

90 This smart contract will pre-code the basic components of the transaction.

purchaser confirms satisfaction with seller performance, or (2) any initiated dispute has been resolved.[91] Importantly, purchaser manifestation of approval may only occur if the smart contract has designated a dispute resolution application—such as JUR or Kleros—ex ante.[92] This code-based designation allows the purchaser to freeze the smart contract one step short of finalization and call upon the application to resolve a dispute.[93] Depending on the platform, certain procedural elements of the dispute must also be specified ex ante. Kleros, for instance, requires users to select the number of jurors, a specialized "subcourt,"[94] and a list of possible future remedies prior to contract formation.[95]

Most of these dispute resolution applications also offer users an opportunity to create a natural language agreement to accompany the code-based smart contract. The level of contractual clarity and comprehensiveness varies by platform, with certain applications going to great lengths to achieve traditional legal enforceability.[96] OpenCourt, for example, offers templates for drafting a natural language contract to supplement the Solidity[97] code-based agreement.[98] The application interface allows Ethereum users to

91 DE FILIPPI & WRIGHT, *supra* note 8, at 76.

92 *See, e.g.*, Kleros White Paper, *supra* note 88 (manuscript at 3) ("Smart contracts have to designate Kleros as their arbitrator.").

93 *See id.* at 12 ("In case of dispute, Kleros can be used to have the smart contract either reimburse the buyer or pay the earlier."). To reiterate, unless the parties pre-code for this option, no such quality control exists. The purchaser's cryptocurrency is automatically delivered to the seller presuming the conditions of the contract are met. For instance, consider a smart contract in which a user pays a merchant to provide her with a link to a live concert stream. The user executes the contract and receives a link to a live concert stream, but the link is broken. If payment is simply contingent on the user receiving the link, that user has no recourse. The same is not true if the smart contract contains an option for on-chain resolution.

94 Kleros currently offers a variety of sub-courts such as "International Deliveries" Court—a sub-court of "E-Commerce" Court (itself a sub-court of "General Court")—intending to produce arbitrators with expertise particularized to given smart contract. *See* Kleros White Paper, *supra* note 88 (manuscript at 11).

95 FEDERICO AST ET AL., KLEROS, DISPUTE REVOLUTION: THE KLEROS HANDBOOK OF DECENTRALIZED JUSTICE 31 (2019) [hereinafter KLEROS HANDBOOK], https://ipfs.kleros.io/ipfs/QmZeV32S2VoyUnqJsRRCh75F1fP2AeomVq2Ury2fTt9V4z/Dispute-Resolution-Kleros.pdf [https://perma.cc/DA9N-ZL7R] ("Contracts between parties will specify the subcourt where a dispute will be adjudicated, including the number of jurors that will be drawn for the first instance decision."); *see also* E-mail from Stuart Jackson, Commc'ns Lead, Kleros, to Michael Buchwald (Feb. 18, 2019, 06:46 EST) [hereinafter Jackson E-mail] (on file with author) ("Yes, answers are precoded (there is a fixed set of answers).").

96 The practical value of achieving traditional legal enforceability when both parties are pseudonymous is questionable. This proposition is explored below.

97 *See Solidity*, SOLIDITY, https://solidity.readthedocs.io/en/v0.5.3/ [https://perma.cc/XP6B-R7LZ] (last visited March 14, 2019) ("Solidity is an object-oriented, high-level language for implementing smart contracts.").

98 *OpenCourt*, *supra* note 15 ("Unlike other bills of sale, our bill of sale is structured using our markup language and incorporates the OpenCourt arbitration system, comprised of a series of

populate templates with pseudonymous Ethereum addresses, ether values, and boilerplate arbitration clauses.[99] This enables the parties to "generate a legally compliant bill of sale that is managed and digitally signed via a blockchain."[100] Importantly, any "bill of sale" is wholly distinct from the smart contract itself. Simply because a natural language term exists does not mean that the code will truly carry out that function. Indeed, many smart contract disputes arise because party intentions and code manifestations diverge.

These two components, a pre-coded smart contract and its natural language counterpart, are the tools by which parties enter and initiate an agreement when opting into on-chain resolution.

B. *Dispute Resolution Initiation*

Given the escrow-like system of each available platform, there is little variation among applications for initiating a dispute. In all cases, the dissatisfied purchaser may use the application to trigger dispute resolution prior to code-completion. Sellers generally do not have this capability, as they have not posted a payment to the smart contract.[101] If a seller feels that she is justified in non-performance, the validity of such a position will theoretically come to fruition via the adjudication process.

There are, however, slight differences among platforms with respect to the responsibilities entrusted to the dispute initiating purchaser. On JUR, for instance, the party initiating the dispute must propose a particularized remedy upon initiation.[102] The defending party then has twenty-four hours to counter with an alternative solution.[103] This supposedly builds in the flexibility for narrowly tailored outcomes, unlike the pre-coded relief options utilized by Kleros.[104]

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smart contracts."); *see also* JUR WHITE PAPER, *supra* note 88, at 33 ("Agrello is another player offering an interactive graphical interface that allows ordinary users to create legally binding smart contracts using natural legal language, which is later converted to a smart contract.").

99 *OpenCourt*, *supra* note 15 ("[P]roviding contracting parties with an agreement containing a dispute resolution provision (approved by the well-known arbitration association JAMS) to ensure the enforceability of the arbitrator's decision in the real world.").

100 *Id.* Compare this system to Kleros, which actively avoids automatic incorporation of a natural language contract into the dispute. *See* KLEROS HANDBOOK, *supra* note 95, at 104 ("When there is no written agreement, the plaintiff can present communication with the defendant prior to the agreement to prove that the defendant did not meet the requirements agreed upon.").

101 JUR seems to be an exception to this statement. *See* JUR WHITE PAPER, *supra* note 88, at 19 ("In the absence of agreement, *one of the two* parties opens a dispute . . . .")(emphasis added).

102 *See id.* ("In the absence of agreement, one of the two parties opens a dispute by proposing a resolution and staking a minimum percentage of the value of the contract. The other party has 24 hours to propose an alternative solution.").

103 *Id.*

104 *See* KLEROS HANDBOOK, *supra* note 95, at 164 ("Smart contracts are immutable, meaning that the code by default cannot be changed.").

C. *Evidence and Arguments*

Regardless of platform, discovery processes and ensuing opportunities for advocacy are sparse. As a general rule, discovery is entirely optional and self-imposed. Kleros, JUR, and Aragon all indicate that the discovery process consists solely of parties unilaterally uploading any evidence that they see fit to best support an argument.[105] Common examples of such evidence include links to uncompleted websites, images with relevant text, and on-chain party correspondence.[106] Jurors have no mechanism to compel further discovery, and counterparties have minimal opportunity to request further relevant documents from the opposition. The discovery process is that of a singular, un-vetted data-dump.

Similarly, disputants have minimal opportunity to elucidate the nature of a grievance. While the formatting differs by platform, each application calls for both parties to upload some version of a "statement of facts."[107] In what essentially amounts to a textbox, each party explains why they believe that they are entitled to relief.[108] On many platforms, no ongoing dialogue exists between jurors and disputants. Parties often cannot rebut counterclaims or offer clarifications about their own past statements in the event that a juror becomes confused.[109] There is simply this single textbox.

To further diminish the little argumentative opportunity that advocates possess, on-chain platforms offer virtually no basis for grounding an argument. At best, platforms provide general guidelines for jurors to utilize when rendering a verdict.[110] These guidelines, however, do not cover the

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105 *See* Jackson E-mail, *supra* note 95 ("[J]urors are provided with evidence from both parties as to where and what has gone wrong in the contract . . . . Parties can upload any evidence they see fit as to better explain their side. It could be a link to an uncompleted website, or an image with relevant text info.").

106 *Id.*

107 *See* Kaal & Calcattera, *supra* note 22, at 144 ("Whenever users wish to dispute the execution of a contract in the Aragon Network, they post . . . a brief of their argument."); Kleros White Paper, *supra* note 88 (manuscript at 3) ("Alice taps a button that says "Send to Kleros" and fills a simple form explaining her claim."); *OpenCourt*, *supra* note 15 ("Using this interface, each party can notify OpenCourt that they wish to dispute the smart contract, [and] provide a statement of facts . . . .").

108 *OpenCourt Tutorial*, *supra* note 63; *see also Token Curated Registry of Tokens (T2CR)*, KLEROS, https://tokens.kleros.io/tokens [https://perma.cc/QVR2-ZZTG] (last visited Apr. 26, 2020) (providing link to PDFs stating grievances).

109 A partial explanation for this absence may be that application designers fear parties will bribe jurors as a result of this dialogue. *See e.g.*, Kleros White Paper, *supra* note 88 (manuscript at 10); *But see* E-mail from Federico Ast, CEO, Kleros, to David A. Hoffman, Professor of Law, Univ. of Pa. Carey Law Sch. (Apr. 1, 2019, 11:23 AM EST) (on file with author) (providing instructions on how to see the "thorough . . . back and forth between submitter and challengers").

110 *See* KLEROS HANDBOOK, *supra* note 95, at 105 ("This policy guides jurors through the disputes arbitrated in the subcourt, from their very creation to the rendering of a verdict. Let's go through it step by step."); Justin Goro, *Ulex Applications: Ethereum (Part 3)*, MEDIUM (Sept. 11, 2018), https://medium.com/@startsocieties/bootstrapping-ulex-to-run-on-the-ethereum-blockchain-

entire lexicon of possible disputes, often simply instructing jurors to make a decision based on what they believe to be "fair."[111]

D. *Juror Selection*

Among those platforms that strive for pure decentralization and anonymity, juror selection relies on the core functionality of blockchain disaggregation, employing incentive-based crowd sourcing akin to miner consensus validation. Unlike involuntary juror selection in the United States,[112] on-chain anonymous juror-candidates actively volunteer. A candidate submits a cryptocurrency deposit in the amount of her choosing with the hopes of being selected as a juror.[113]

Depending on the platform, the juror-candidate will have the option to post this deposit to a specialized subcourt. For instance, JUR offers "Hub" virtual tribunals, in which application administrators screen jurors for certain qualifications.[114] Similarly, Aragon imposes additional costs on disputants if they wish to obtain a pool of jurors that have positive "reputations." As Aragon's White Paper notes, "[w]hen a user triggers a dispute they must pay an arbitration fee proportional to the amount of reputation that will be included on the jury."[115] This supposedly incentivizes quality decision-making and weeds out non-meritorious claims.

Once a sufficiently large pool of candidates have submitted token deposits, a randomized lottery occurs to produce a set of jurors.[116] On certain platforms, probability of selection in this lottery is directly proportional to

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a48c2d5cb731 [https://perma.cc/E84M-9CYY] *(*"For instance, the following lines would get their own text file: 2.1.4. Personal Harm . . . ALI, Restatement of Torts, Third, Liability for Physical and Emotional Harm (2009–12).").

111 *See* JUR WHITE PAPER, *supra* note 88, at 53 (describing why implementation of a Schelling Point game will lead jurors to select "fair" outcomes).

112 *E.g.*, 28 U.S.C. § 1863 (2018) (mandating a plan for random juror selection in federal courts); *see also* Butler v. Perry, 240 U.S. 328, 333 (1916) ("It introduced no novel doctrine with respect of services always treated as exceptional, and certainly was not intended to interdict enforcement of those duties which individuals owe to the state, such as services in the army, militia, on the jury, etc.").

113 *See* Kleros White Paper, *supra* note 88 (manuscript at 4) ("Candidates will self-select to serve as jurors using a token called pinakion (PNK).").

114 *See* JUR WHITE PAPER, *supra* note 88, at 48 ("Application Policy: to become a member of the Hub anyone can apply following the rule established by the Hub (example, to hold a certification of engineering).").

115 *Aragon White Paper*, *supra* note 88.

116 *See* Kleros White Paper, *supra* note 88 (manuscript at 5) ("After candidates have self-selected specific courts and deposited their tokens, the final selection of jurors is done randomly."); Kárki, *supra* note 88 ("When an arbitration begins, five judges will be randomly selected from a pool of volunteers. Volunteers are individuals that have posted a bond indicating their interest in serving as a Judge.").

the size of one's deposit.[117] Application developers cite this pairing of proportionality and randomization as a method of deterring malicious parties who seek to create a large number of Ethereum addresses and thus control the entire voting system.[118]

One major exception to this volunteer lottery is the process utilized by OpenCourt. OpenCourt instead requires each disputant to input a pseudonymous Ethereum address of a mutually agreed upon third-party arbitrator.[119] This mutual appointment resembles the selection processes utilized by off-chain arbitration tribunals but presents its own set of criticism when employed on-chain.

E. *Juror Decision-making and Financial Incentivization*

Two key attributes of fully decentralized, on-chain juror systems separate them from every other adjudicatory process on the planet. First, as just mentioned, jurors remain wholly pseudonymous throughout the arbitration proceedings. Second, on-chain applications employ a financially incentivized majority-voting scheme.[120] Those jurors who fail to vote with the majority will lose some or all of this initial deposit.[121] In many instances, jurors are similarly penalized for revealing their vote before a mutually agreed upon time.[122] The likes of Kleros and JUR point to Thomas Schellling's "focal point theory" to justify these majority-based schemes.[123] As JUR's white paper states, "the best strategy to win the reward is to sincerely predict what other people think is fair."[124] The hope is that forcing jurors to take a financial stake in the outcomes will eliminate incoherent and arbitrary voting.[125]

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117 Kleros White Paper, *supra* note 88 (manuscript at 4) ("The probability of being drawn as a juror for a specific dispute is proportional to the amount of tokens a juror deposits.").

118 *See id.* ("If jurors were simply drawn randomly, a malicious party could create a high number of addresses to be drawn a high number of times in each dispute. By being drawn more times than all honest jurors, the malicious party would control the system.").

119 *OpenCourt Tutorial*, *supra* note 65, at 4:15.

120 *See* JUR WHITE PAPER, *supra* note 88, at 44 ("Tokens voted for the minority proposition are forfeit. Tokens voted for the majority side are matched with forfeit tokens until the forfeit tokens run out."); Kleros White Paper, *supra* note 88, at 2 ("Parties who voted as the majority are rewarded with 10% of their coins. Parties who voted differently from the majority lose 10% of their coins.").

121 *See supra* note 120.

122 Kleros White Paper, *supra* note 88 (manuscript at 7) ("We let any party able to show the commitment of a juror to Kleros before the vote is closed steal the pinakions of this juror and invalidate the vote of this juror.").

123 *See id.* at 2 ("Thomas Schelling described focal point(s) for each person's expectation of what the other expects him to expect to be expected to do. The Schelling Coin uses this principle to provide incentives to a number of agents who do not know or trust each other to tell the truth.") (internal quotation marks omitted); *see also* JUR WHITE PAPER, *supra* note 88, at 53 ("In a Schelling Point game . . . . [t]he possible token reward provides an incentive to predict correctly.").

124 JUR WHITE PAPER, *supra* note 88, at 53.

125 *Id.*

Importantly, when actually making a decision, jurors have almost no analytical framework from which to draw. The aforementioned on-chain guidelines are far from comprehensive,[126] and jurors have access to only the disputed contract (if it exists), the statement of facts, and any evidence submitted by each party.[127] No on-chain platform currently asks jurors to rely on jurisdictional precedent, rigorous legal analysis, or even simple legal tests. The jurors, in isolation from one another, simply cast a vote and offer a "justification" for voting as they did.[128] As will be explored below, pairing this lack of structure with financial incentives renders the system deeply flawed.

F. *On-Chain Appeals Process*

After the initial ruling, most fully decentralized platforms offer a dissatisfied party the opportunity to appeal, with the exact format and cost differing by platform.[129] On Kleros, for instance, each successive appeal doubles the number of jurors and thus the up-front arbitration fee.[130] This system of cost doubling aims to disincentivize excessive appellate proceedings. Similarly but distinctly, Aragon disputants may choose to appeal the decision of an initial five-juror panel.[131] Appellate proceedings require a doubling of the reputational weight of the jury, and thus a doubling of the arbitration fee for the appellant.[132] In this secondary round of review, dubbed a "Prediction Market," all jurors on the Aragon Network are invited to post a bond and rule on the merits of the dispute.[133] This costly mass review is intended to improve decisional accuracy through an increased sample size, as well as deter parties from engaging in frivolous appeals. If a party is still unhappy with the results of a prediction market resolution, that party may finally appeal to Aragon's "Supreme Court."[134] This court consists of nine pseudonymous jurors who wield the highest reputational ranking on the

126 *Id.* at 55.

127 *See* KLEROS HANDBOOK, *supra* note 95, at 34 ("Users that are drawn as jurors will have access to the evidence for analysis and will vote a decision.").

128 *See id.* at 35 ("They are also required to provide a justification for their decision.").

129 *See id.* ("Decisions can be appealed several times.").

130 *See id.* ("In each round, a new jury will be formed with twice as many jurors than the previous instance plus one. The appealing party will be required to make a new deposit in order to pay for arbitration fees.").

131 *See* Kárki, *supra* note 88 ("If the applicant is unsatisfied with the ruling of the Decentralized Court, they have the option to elevate the issue to the next realm. This is done by posting an even larger bond than before.").

132 *Id.*

133 *See id.* ("For this round of court, we will use a prediction market where all the Judges of the Network can take part — providing the applicant with a much larger audience.").

134 *See id.* ("In Supreme Court, the judges will be composed of the top 9 judges by ANJ payout. In other words, these are the individuals with the highest ranking in resolving Aragon Network Jurisdiction cases.").

platform.[135] These nine arbitrators offer a ruling that will finalize and conclude the dispute.[136] Interestingly, the financial compensation for jurors in previous rounds may retroactively be reversed in accordance with the rulings of the Supreme Court.[137]

These two mechanisms for appeal are representative of on-chain possibilities. They also represent the conclusion of a dispute and the end of a user's opportunity for recourse. Upon final determination, the smart contract unfreezes and distributes assets accordingly.

G. *Types of Disputes*

Apart from the actual procedures associated with adjudication, it is important to note the types of disputes that on-chain applications attempt to resolve. To do so, it is useful to imagine the universe of possible disputes as a two-by-two matrix, segmented by dispute origin and forum for resolution. Intuitively, the forum for dispute will either be on-chain or off-chain. The dispute type, which also consists of an on-chain or off-chain possibility, is slightly more nuanced. On-chain disputes are those specific to blockchain transactions. Bugs in the code[138] and phantom transactions[139] generate disputes derived entirely from smart contract malfunction. Conversely, a freelance designer who fails to timely deliver a customer's website epitomizes a dispute with an off-chain origin. The dispute arises solely due to human error in attempting to carry out the contract. There is nothing specific to blockchain about the origin of the grievance.

While on-chain resolution is theoretically capable of handling both types of issues,[140] current platforms are marketed as tools for resolving the latter: human error associated with a smart contract. For instance, early Kleros promotional materials highlighted the following four applications:

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135 *Id.*

136 *Id.*

137 *Id.*

138 *See, e.g.*, Kai Sedgwick, *25% of All Smart Contracts Contain Critical Bugs*, BITCOIN.COM (Aug. 29, 2018), https://news.bitcoin.com/25-of-all-smart-contracts-contain-critical-bugs/ [https://perma.cc/4L3K-NNS9] ("Ethereum, the ICO economy's go-to launchpad, has been the worst affected, with stories abounding of exploitable code that's led to hundreds of millions of dollars e[i]ther being stolen or locked up.").

139 *See, e.g.*, Morgan E. Peck, *What You Need to Know About Mt. Gox and the Bitcoin Software Flaw*, IEEE SPECTRUM (Feb. 13, 2014, 3:58 PM), https://spectrum.ieee.org/tech-talk/computing/networks/what-you-need-to-know-about-mt-gox-and-the-bitcoin-software-flaw?fbclid=IwARouHakOjNJiAbm9TdpTbXrwUSo6IW59h4EaCcoDp_jVKFRld7OlEQKQ524 [https://perma.cc/Q6KS-YL97].

140 Blockchain dispute resolution platforms are not geared toward handling off-chain disputes with off-chain origins, the final quadrant in the matrix.

> ESCROW: Kleros can be used to have the smart contract either reimburse the buyer or pay the seller.
>
> INSURANCE AND FINANCE: When an insured event happens, the insurer can validate it and compensate the insuree through Kleros.
>
> FREELANCING: Kleros can be used to solve disputes between freelancers and clients.
>
> CONTENT MODERATION: Kleros can be used to mediate disputes on whether a comment violates some community guidelines or whether some piece of content violates someone's rights.[141]

Indeed, if relegated only to code-based disputes, on-chain resolution platforms would have very few practical use cases. The supposedly disruptive contribution of these new applications is that they can reduce the harm from off-chain bad actors (i.e., malfeasance or nonfeasance). With the advent of on-chain resolution, there is allegedly no longer the worry that users will be left without recourse in the event that an oracle-driven blockchain transaction goes awry. If businesses are ever to transact on-chain and at scale, there must be some mechanism to govern the humans behind the transaction and thus limit a firm's liability. Kleros, JUR, and the like claim to be that mechanism. Further, they claim to fill this void without sacrificing the core benefits of blockchain technology. However appealing this sales pitch may be, it is far from the truth.

III. DISTINCTIVE FLAWS OF ON-CHAIN, DECENTRALIZED ARBITRATION SYSTEMS

With the inner workings of on-chain resolution applications now elucidated, it is possible to begin compiling and analyzing the set of adjudicatory flaws that are distinctive to blockchain technology. To do so, it will be useful to employ a four-step framework.

1. Determine the shortcomings that exist with current on-chain applications. If no flaws exist, the analysis will simply end.
2. If a flaw exists, consider whether it flows from (1) platform infancy or (2) the nature of blockchain technology itself. This Comment is less concerned with the former, as flaws flowing from platform infancy may be corrected via application updates.
3. If a flaw is indeed inherent, examine whether it renders on-chain resolution inferior to that of its off-chain counterparts. Such an

141 KLEROS BLOCKFYRE REPORT, *supra* note 86, at 6.

examination will require an exploration of current practices among various off-chain dispute resolution systems, including traditional courts, arbitration tribunals, and off-chain online arbitration (OArb) systems.[142]

4. If the first three questions are answered in the affirmative, the framework will finally ask: what is the optimal path forward?[143] Answering this question requires a holistic balancing of all inherent flaws as compared to the flaws of other adjudicatory systems. Embedded within this balancing is a consideration of whether possible application updates would sacrifice the alleged benefits of a blockchain. This fourth and final question will therefore only be taken up in Section IV once all inherent flaws have been discussed.

The hope is that this analytical framework will first reveal distinctive shortcomings of on-chain resolution and then describe how best to proceed in light of these flaws. The author has attempted to isolate the core adjudication areas in which inherent flaws are most likely to exist. Again, those areas specifically include (1) discovery compulsion processes, (2) juror incentivization and decision-making schemes, and (3) platform scalability. Thus, an exhaustive review of every component of the adjudication process is unnecessary.

A. *Flaw 1: Inability to Compel Discovery*

1. Current Flaws with On-Chain Discovery

Despite noticeable variation among current on-chain application functionality, not one of these platforms enables a juror to compel discovery.[144] As described above, on-chain resolution mechanisms rely

142 If on-chain and off-chain resolution systems suffer from an identical flaw, it would be illogical to assume on-chain resolution inferiority. If, however, technological limitations present a flaw beyond those present in off-chain alternatives, one must then consider the practical value of using such a system in the future.

143 Regardless of the flaw, the answer to this final question splinters into three possibilities. First, the flaw and resulting harm might be so egregious that they negate any possibility of viable on-chain arbitration. In other words, the flaw requires us to abandon all hope. Second, the flaw might inherently differentiate, but not beyond the point of salvation. An imperfect system may still be the penultimate system. The optimal path forward might be to encourage application designers to push on-chain arbitration towards its technological optimum without compromising basic blockchain tenets. This would, however, first require a determination that the benefits of a "perfected" model outweigh the inherent shortcomings. Third, there may be some scenario in which it makes sense to sacrifice blockchain pseudonymity and decentralization to achieve the efficacy of traditional dispute resolution mechanisms. For instance, one proposition this Section will explore is a move away from anonymous jurors. However, this final suggestion raises further questions as to why one would use blockchain at all if its main advantages have disappeared.

144 Nor is there an option for a counterparty to request discovery documents.

exclusively on self-imposed production.[145] Further, these platforms offer little guidance as to what should be included.[146] Applications generally prompt each party to upload an optional "statement" in which the party articulates a grievance, as well as any evidence that may further its claim.[147] These two streams of production establish the entire universe of documents available for juror review.

Given this self-imposed discovery, two distinct types of information will come to dominate on-chain disputes: (1) materials which reflect positively on the party who submitted the evidence and (2) materials which damage or discredit the claims of the opposition. While this set of documents is important and useful, it is ultimately insufficient for proper adjudication. Self-imposed discovery specifically omits all documents that inflict self-harm. On-chain, this third source of information falls into oblivion. Even in the simplest of disputes, the proverbial "smoking gun" disappears behind a wall of blockchain pseudonymity, presenting major opportunities for deceitful—but not impermissible—omissions.[148]

Consider a smart contract in which a purchaser engages the service of a freelance website designer. Assume the freelancer produces a half-hearted product, and for some inexplicable reason, decides to e-mail (or message via a decentralized chat app like EtherChat[149]) a friend about her lack of effort on the project. As just indicated, jurors possess no mechanism to compel the discovery of that all-important email. The total absence of discovery compulsion mechanisms is therefore the first great flaw of on-chain arbitration, and it is thus necessary to determine whether such a flaw exists for other resolution tribunals.

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145 *See* Jackson E-mail, *supra* note 95 ("[J]urors are provided with evidence from both parties as to where and what has gone wrong in the contract . . . . Parties can upload any evidence they see fit as to better explain their side. It could be a link to an uncompleted website, or an image with relevant text info.").

146 *See* KLEROS HANDBOOK, *supra* note 95, at 32 (providing few rules or guidelines governing the form and content of written submisssions on Kleros).

147 *See* JUR WHITE PAPER, *supra* note 88, at 52 (describing the role of the jurors as analyzing "the proofs made by the parties and *their explanation of facts*." (emphasis added)); *OpenCourt Tutorial*, *supra* note 65, at 3:43; Kleros White Paper, *supra* note 88 (manuscript at 3) ("Alice taps a button that says 'Send to Kleros' and fills a simple form explaining her claim."); *Aragon Whitepaper*, *supra* note 88, § 3.2 (stating that there is a period of "Evidence Submission . . . [in which] parties of an agreement can submit statements and evidence to the jury") (emphasis removed).

148 The term deceitful is used loosely, given that if a system does not compel discovery, it would not technically be fraudulent to withhold incriminating information.

149 *See* Minh Nguyen, *EtherChat: Decentralized Messaging Application on Ethereum Platform*, MEDIUM (Apr. 1, 2018), https://medium.com/@leonardnguyen/etherchat-decentralized-messaging-application-on-ethereum-network-part-1-253e5078770b [https://perma.cc/GRP6-9PYP] ("EtherChat is a[] decentralized app running on Ethereum platform that allows you to send encrypted messages via a smart contract. Only you and the recipient of a message can decrypt it.").

2. Methods for Compelling Discovery Off-Chain

Unfortunately for on-chain platforms, discovery compulsion is widespread and expansive among off-chain alternatives. While an obvious gradation exists off chain, it is clear that on-chain dispute resolution stands alone in its current holistic inability to compel.

a. *Traditional Tribunals*

Traditional civil procedure most clearly juxtaposes current on-chain resolution capabilities, with the U.S. Federal Rules of Civil Procedure presenting perhaps the greatest divergence.[150] As Salomon and Friedrich explain:

> U.S. litigation is particularly known for its full-blown discovery, in which courts routinely grant the parties expansive disclosure requests[,] . . . . provid[ing] for a myriad of discovery mechanisms, including document disclosures, oral and written depositions, interrogatories and requests for admission. Under Rule 26, the permissible scope of discovery is extremely broad, allowing parties to "obtain discovery regarding any nonprivileged matter that is relevant to any party's claim or defense." . . . . Similar rules can be found at the state level.[151]

Importantly, a failure to comply with valid discovery requests results in punishment. Under Rule 37 of the Federal Rules of Civil Procedure, "[i]f a party fails to make a disclosure required by Rule 26(a), any other party may move to compel disclosure and for appropriate sanctions."[152] While Rule 45 does lay out geographical limitations for subpoenaing a witness or compelling an appearance, it also offers litigants the opportunity to obtain vital information by reducing the burden and costs for the producing party.[153]

Such an ability to compel evidence does not stop at the United States' geographic borders. 28 U.S.C. § 1783 stipulates that "[a] court of the United

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150 Salomon & Friedrich, *supra* note 85, at 551.

151 *Id.* at 551-52. While a 2015 amendment the Federal Rules introduced a proportionality limitation, it remains to be seen how much this limitation will scale back discovery requirements in practice. *See, e.g.,* Matthew T. Ciulla, Note, *A Disproportionate Response? The 2015 Proportionality Amendments to Federal Rule of Civil Procedure 26(b)*, 92 NOTRE DAME L. REV. 1395, 1396 (2017) ("Among the most significant and contentious of these changes is the Rules' renewed focus on the concept of proportionality in the scope of discovery, added in an effort to curb perceived over-discovery.").

152 FED. R. CIV. P. 37(a)(3)(A).

153 FED. R. CIV. P. 45(c)(1)–(2)(stating that "[a] subpoena may command a person to attend a trial, hearing, or deposition . . . within 100 miles of where the person resides, is employed, or regularly transacts business in person" but that "[a] subpoena may command . . . production of documents, electronically stored information, or tangible things at a place within 100 miles of where the person resides, is employed, or regularly transacts business in person").

States may order the issuance of a subpoena . . . of a national or resident of the United States who is in a foreign country, or requiring the production of a specified document or other thing by him . . . ."[154] Similarly, for a purely foreign and tangential witness, the Hague Convention offers U.S. courts and international counterparts an opportunity (albeit more limited) to compel discovery from nonparties.[155]

b. *Arbitration Tribunals*

The same overwhelming level of production compulsion is rarely present within an arbitration tribunal.[156] As opposed to traditional expansive discovery rules, arbitration proceedings are guided by the arbitration-specific laws of the relevant arbitral seat.[157] Such laws generally promote arbitrator and party autonomy,[158] establishing two sources of authority that govern the discovery process. Firstly, the parties themselves may agree to particular initial requirements for production volume and scope.[159] Secondly, the arbitrator may compel document production as she sees fit, often in spite of party pre-agreements.[160] The interaction between these two sources of authority differ by region and arbitrating body,[161] but the existence of the latter provides evidence of an arbitrator's perpetual ability to compel discovery. Indeed, the arbitrator "generally ha[s] broad implied authority to conduct the disclosure process, even where the relevant arbitral rules (and

154 28 U.S.C. § 1783(a) (2018).

155 *Cf.* Société Nationale Industrielle Aérospatiale v. U.S. Dist. Court, 482 U.S. 522, 541 (1987) ("[T]he text of the Convention draws no distinction between evidence obtained from third parties and that obtained from the litigants themselves . . . . Thus . . . the optional Convention procedures are available whenever they will facilitate the gathering of evidence by the means authorized in the Convention.").

156 *See* Salomon & Friedrich, *supra* note 85, at 553 ("As a general rule, the disclosure phase in an international arbitration tends to be much shorter and succinct."); *id.* at 553-54 ("Indeed, the limited availability of disclosure in international arbitration is a key difference between judicial and arbitral proceedings.").

157 *See id.* at 553 ("[T]he arbitral tribunal's authority to order disclosure may stem from provisions in the procedural laws at the arbitral seat.").

158 *See id.* at 552 ("Generally, parties may agree on the procedure of an international arbitration, including the disclosure process. The U.S. Supreme Court has recognized the principle of party autonomy in international arbitration.").

159 *Id.*

160 *See id.* at 553 ("[T]his flexibility to shape the arbitral process according to the specifics of each business relationship is one of the reasons parties choose arbitration over litigation.").

161 For instance, the International Arbitration Rules of the International Centre for Dispute Resolution unqualifiedly provide that that an arbitration tribunal may "order parties to produce other documents, exhibits or other evidence it deems necessary or appropriate." *Id.* at 565 (quoting INT'L CTR. DISPUTE RESOLUTION, INT'L DISPUTE RESOLUTION PROCEDURES art. 16(1) (2009)). Conversely, § 7 of the Federal Arbitration Act and subsequent U.S. Supreme Court cases indicate that traditional court-system discovery is not appropriate in an arbitrational tribunal unless the parties specifically agree to it. 9 U.S.C. § 7 (2018); Salomon & Friedrich, *supra* note 85, at 563.

domestic arbitration legislation) do not specifically address the issue."[162] This power often also extends to instances in which parties stipulate discovery limitations that the arbitrator finds to be inequitable.[163]

However, the proper authority to order document production greatly differs from an ability to actually compel it. To effectively compel discovery, an arbitrator must possess some form of credible sanction in the event that a party fails to comply.[164] Problematically, arbitrators do not wield the same subsidiary tools to ensure enforcement as executive and legislatorial-backed court systems. In one sense, the greatest threat an arbitrator may unilaterally impose is the drawing of an "adverse inference"[165] for a failure to disclose. Without the threat of enforcement by a governmental actor, penalized parties will afford little weight to arbitrator-imposed financial sanctions.[166] This is especially true when an arbitrator seeks disclosure from a geographically distant third party.

To remedy this insufficiency, most arbitration systems allow "the tribunal and the parties [to] seek judicial assistance in accordance with national laws in obtaining disclosure."[167] While enlisting court-assistance creates its own set of risks and limitations[168] (particularly in the Second[169] and Third[170] Circuits), these restrictions aim only to ensure that compulsion requests stay limited to relevant and inaccessible information.[171] Off-chain arbitration discovery is

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162 Salomon & Friedrich, *supra* note 85, at 569.

163 *See id.* at 557 ("The parties may also agree to preclude or significantly limit disclosure as long *as fundamental principles of procedural fairness and equality are respected*.") (emphasis added).

164 *See* Chris Brummer & Yesha Yadav, *Fintech and the Innovation Trilemma*, 107 GEO. L.J. 235, 245 (2019) ("[E]nforcement provides a credible threat of punishment when rules are ignored.").

165 *See* Salomon & Friedrich, *supra* note 85, at 584 ("Where a party fails to comply with the tribunal's order to produce documentary or witness evidence without reasonable excuse, the tribunal may draw adverse inferences against that party.").

166 This situation may be likened to a judge asking a bailiff to detain an unruly witness, only to find that the bailiff has indefinitely stepped out to lunch.

167 *See* Salomon & Friedrich, *supra* note 85, at 586.

168 *See* Claudia Salomon & Abhinaya Swaminathan, *Compelling Third-Party Discovery in New York Arbitration*, N.Y.L.J., Nov. 26, 2018, at 1, 1 (describing the limitations placed on compelled discovery in certain federal circuit courts).

169 *See* Life Receivables Tr. v. Syndicate 102 at Lloyd's of London, 549 F.3d 210, 218 (2d Cir. 2008) ("[A]rbitrators possess a variety of tools to compel discovery from non-parties. However, those relying on section 7 of the FAA must do so according to its plain text, which requires that documents be produced by a testifying witness.").

170 *See* Hay Grp., Inc. v. E.B.S. Acquisition Corp., 360 F.3d 404, 407 (3d Cir. 2004) ("Thus, *Section 7*'s language unambiguously restricts an arbitrator's subpoena power to situations in which the non-party has been called to appear in the physical presence of the arbitrator and to hand over the documents at that time.").

171 It should be noted, however, that in practice, instilling compulsion power primarily with the arbitrators results in a truncated discovery process. *See, e.g.*, Salomon & Friedrich, *supra* note 85. This truncation of document production is accompanied by a parallel scarcity of witness testimony, third-party documents, and non-party witnesses. Thus, much like on Kleros, parties tend to

therefore more narrow than that compelled by traditional tribunals, but it appears that a perpetual and global option for compulsion remains.

c. *Online Arbitration*

In theory, Online Arbitration discovery does not differ from discovery in physical, in-person arbitration tribunals. However, certain practical realities associated with shifting the process online have created discovery compulsion problems, again stemming from lack of a governmental back-stop. While earlier iterations of OArb struggled with this virtual migration, the compulsion process has improved dramatically over time.[172]

One remaining complication is the determination of an arbitral seat.[173] To reiterate, this seat supplements arbitrator authority by offering a credible threat of sanction in the form of traditional judicial intervention.[174] The same determination is necessary for off-line arbitration, but the tangible nature of the contracting process greatly reduces seat ambiguity. OArb systems must therefore utilize the following two safeguards to determine an arbitral seat.

First, many OArb systems allow geographically dispersed parties to contractually specify, ex-ante, a desired seat.[175] The parties opt-in to the governing arbitral rules of a certain jurisdiction.[176] While contractual seat selection might result in the cherry-picking of business-friendly jurisdictions (especially in the business-to-consumer (B2C) online commerce space), it does in fact establish a governmental backstop. This selection process has its limitations, as the chosen seat may refuse to honor the selection of the parties and opt not to adjudicate.[177] However, the second procedural safeguard remedies such instances. When global parties enter into an online contract absent seat specification (or specify a seat that is later void), the arbitrator

primarily produce evidence that favors their case, with arbitrators seldom or limitedly overriding the self-selection process. The scale and scope of the case obviously impacts the level of arbitrator interjection, but for present purposes, one may assume severe limitation in all instances. Such reduced production facially cuts against the notion of off-chain and on-chain discovery divergence, but in actuality it helps to highlight the key difference. *Id.* at 571-75.

172 *See* Karolina Mania, *Online Dispute Resolution: The Future of Justice*, 1 INT'L COMP. JURIS. 76, 77 (2015) ("Despite the problems cited, new methods of communication have improved many areas of law—including modernising processes for the out-of-court settlement of disputes, examples of which are constituted by systems for online dispute resolution.").

173 Schmitz, *supra* note 81, at 211.

174 Salomon & Friedrich, *supra* note 85, at 553.

175 *See* Schmitz, *supra* note 81, at 211 ("These jurisdiction and choice of law questions may be resolved, however, by the parties' agreement or development of a *lex mercatoria*, or delocalized 'law' incorporating general contract principles and e-commerce norms."); *see also* de Witt, *supra* note 83, at 451 ("Most sophisticated parties, who are aware of the implications of the place of arbitration, will include an adequate provision in their agreement to arbitrate.").

176 *See supra* note 175.

177 Schmitz, *supra* note 81, at 211.

herself often has the discretion to make a determination.[178] Exceptions to the rule certainly exist,[179] but those overseeing an arbitration proceeding typically have "broad powers . . . to establish the place of arbitration" based on the realities of the situation.[180] While one can imagine situations in which documents and witnesses slip through the cracks, this presence of an enforcement backstop allows online arbitrators to instill some level of fear among relevant parties.

Lastly and somewhat tangentially, it is important to note that parties are readily identifiable in the online arbitration context. OArb may preserve physical anonymity by allowing users to remain hidden behind a computer screen,[181] but the nature of typical online contracting and fiat currency payments necessitate identity revelation. As explored below, this creates a thick divide between OArb and on-chain dispute resolution compulsion.

3. On-Chain Update Infeasibiilty

In short, there exists a foundational distinction between decentralized, pseudonymous on-chain resolution and all other forms of adjudication. As just articulated, off-chain arbitration universally provides an option for arbitrators to compel production. In each instance, an order to compel is backed by a credible threat of punishment. Such a system does not currently exist with any on-chain platform. Of greater importance, such an option cannot exist while maintaining pseudonymity and decentralized resolution processes.

a. *Pseudonymity of Third Parties*

More precisely, the realities of blockchain pseudonymity negate any possibility of compelling third-party document production and testimony. Unfortunately, such evidence is vital to any system of arbitration. As noted in an article recently touted by the ABA, "[i]f arbitration is to be promoted, some discovery of non-parties is likely to be necessary in large, complex cases. . . . Cases of this size demand at least the possibility of non-party discovery."[182]

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178 de Witt, *supra* note 83, at 451; Salomon & Friedrich, *supra* note 85, at 553.

179 *See* de Witt, *supra* note 83, at 451 ("The LCIA . . . provides that, unless the parties have otherwise agreed, the place of arbitration shall be London.").

180 *Id.*

181 *See* Lin Q. Hang, Comment, *Online Dispute Resolution Systems: The Future of Cyberspace Law*, 41 SANTA CLARA L. REV. 837, 858 (2001) ("The advantage of [online dispute resolution systems] is that they may preserve anonymity and resolve the dispute at the same time.").

182 Lowell Pearson, *The Case for Non-Party Discovery Under the Federal Arbitration Act*, DISP. RESOL. J., Aug.–Oct. 2004, at 46, 50.

Yet, on Ethereum, a third party is unreachable and un-threatenable for discovery purposes. Unlike the disputants, who have already locked cryptocurrency into escrow or wasted valuable time completing services, the third party has maintained complete dominion over its own assets (i.e. its cryptocurrency). Given that Ethereum does not enable the unilateral fining of bad actors, jurors have no method for punishing a third party who fails to comply with a discovery request. There is simply a lack of access to and power over the individual and her assets. Unless a third party voluntarily subjects itself to on-chain arbitration, any necessary documents or testimony in its possession will escape juror review. Indeed, even creative compulsion mechanisms such as threatening to ban a third party's Ethereum address from the resolution platform would be of little value. In the event of an address ban, an individual could simply create a new Ethereum address or enlist the services of a competitor if she desired to use on-chain dispute resolution services at some later date.

Importantly, ex-ante on-chain determination of an arbitral seat does nothing to remedy the situation. Assuming that a traditional court wished to compel discovery in an on-chain dispute (presumably after being asked by anonymous jurors), it simply would not have the ability to exert its influence over a pseudonymous party. Unlike with OArb, where all relevant characters are geographically dispersed but readily identifiable, on-chain arbitration presents courts with nothing but a pseudonymous Ethereum address.[183] There is little value in issuing a court order to a random of string letters. If a court were to impose a fine in fiat currency on an Ethereum username for failure to comply,[184] the underlying individual would have minimal incentive to do so. This is especially true if the court is located in a jurisdiction that differs from the compelled third party.

In order for a court to credibly threaten punishment, it must therefore do the improbable: dig beneath a user's pseudonymous Ethereum address. While addresses are in fact "unique identifiers that leave a trail publicly visible on the blockchain,"[185] this trail only fractionally helps connect a user to her address. To date, there are very few instances of involuntary Ethereum user identification. Further, any publicly visible identifiers are quickly vanishing,

183 *See* DE FILIPPI & WRIGHT, *supra* note 8, at 29 ("The open and decentralized nature of Ethereum allows smart contracts to be deployed pseudonymously and to operate in a largely autonomous manner."). For an example of these pseudonymous addresses, see ETHERCHAIN—THE ETHEREUM BLOCKCHAIN EXPLORER, https://www.etherchain.org/ [https://perma.cc/X8CD-PPDF] (last visited Nov. 7, 2019).

184 Hypothetically, these fines would be imposed pursuant to Rule 37. FED. R. CIV. P. 37.

185 Price, *supra* note 52.

as applications such as Monero[186] and ZCash[187] are actively working to make true anonymity Ethereum's norm.

This Comment does concede, however, that in the unlikely event that a third party's identity is unwillingly revealed, and the governmental arbitral seat allows for compulsion, on-chain arbitration is effectively transformed into traditional OArb. In that far-fetched scenario, a court might utilize its own compulsion mechanism or the proceedings of the Hague Convention to compel discovery. But even if such identity discovery were regularly possible, it would fly directly in the face of blockchain's promise of consumer autonomy. Revealing the identity of a third party, as would be necessary for discovery compulsion and accompanying governmental enforcement, unequivocally destroys pseudonymity.[188] If pseudonymity, a core blockchain benefit, is eliminated, it may undermine the need or usage of blockchain at all.

Interestingly, these compulsion concerns do not apply to intraparty discovery. Unlike unattached third-parties, disputants have already deposited a specific level of assets into the resolution platform's smart contract. These assets are natural collateral for jurors to compel discovery. Presumably, neither contracting party is willing to forfeit the entire sum at issue to avoid a discovery request, which indicates that some lesser cryptocurrency fine would suffice to trigger compulsion.

b. *Decentralization Compromised*

In addition to compulsion shortcomings stemming from pseudonymity, any mechanism that employs the use of a governmental backstop threatens to undermine Ethereum's decentralization. Recall that blockchain exists specifically to eliminate reliance on "authoritarian" governmental power and enable pseudonymous users to transact, contract, and resolve disputes entirely autonomously. As Ethereum Founder Vitalik Buterin previously argued:

> [I]t is much harder for participants in decentralized systems to collude to act in ways that benefit them at the expense of other participants, whereas the leaderships of corporations and governments collude in ways that benefit themselves but harm less well-coordinated citizens, customers, employees and the general public all the time.[189]

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186 *About Monero*, MONERO, https://ww.getmonero.org/resources/about/ [https://perma.cc/GTW2-JYPN] (last visited Mar. 13, 2019).

187 *How it Works*, ZCASH, https://z.cash/technology/ [https://perma.cc/S768-B9ND] (last visited Mar. 13, 2019).

188 The parties to a smart contract may opt-in to self-identification, but all other parties do not opt-in by default.

189 Buterin, *supra* note 7.

Parallel principles apply in the discovery compulsion context. One might reason that external judicial oversight will lead to unintended Ethereum consumer harms. Consider, for example, the selection process of the federal bench. Political leverage and partisanship continue to exert an increasingly large influence on the judicial selection process itself.[190] Such ideologically driven appointments appear to be exactly what Buterin and fellow cypherpunks fear.

Imagine for a moment that Ethereum has become the standard mode of commerce and every household in America makes purchases via Ethereum smart contract. If jurisdictional judicial oversight is introduced to backstop on-chain resolution, it might be to the advantage of commercial entities with political influence to push for the appointment of judges with certain ideologies. Perhaps empirical data demonstrates that mandatory disclosure tends to disadvantage businesses in B2C arbitration. The likes of Procter & Gamble or Johnson & Johnson might start donating to candidates who select antidisclosure judges. In this scenario, the benefits of decentralization are diminished through the implementation of a governmental enforcement backstop. This example is obviously embellished, but the underlying message remains. Governmental creep into blockchain transactions has the potential to delevel a supposedly unbiased playing field.

It therefore appears that making third-party compulsion feasible and maintaining decentralized integrity pull in opposite directions. It is impossible to implement a viable discovery system without a governmental backstop. Yet, even if such an implementation were possible, it would diminish the purely decentralized nature of on-chain resolution. Thus there is no obvious method for document compulsion that sufficiently emulates off-chain OArb, physical arbitration, or traditional litigation. More precisely, the author cannot fathom a system that compels discovery while preserving the core structural tenets of blockchain technology.

B. *Flaw 2: Unavoidable Juror Incentivization Schemes*

As described above, most on-chain platforms implement some version of an incentive-based juror voting system. In such a system, pseudonymous Ethereum users who wish to serve as jurors begin by posting a bond to the resolution application's smart contract. In some instances, a subset of bond-

190 *See, e.g.*, *What Is the Federalist Society and How Does it Affect Supreme Court Picks?*, NPR (June 28, 2018), https://www.npr.org/2018/06/28/624416666/what-is-the-federalist-society-and-how-does-it-affect-supreme-court-picks [https://perma.cc/UM2Z-5VJ2]("Leonard Leo, who was the executive vice president of the Federal Society, took leave from the society to construct that list for President Trump.").

posters are selected as jurors.[191] In others, all bond-posters are entitled to vote on the dispute.[192] After juror selection, each juror reviews the evidence and arguments submitted by the disputants. The jurors then subsequently cast a vote for one of the predetermined possible remedies.[193] If that vote aligns with a majority of other jurors, the juror is rewarded with cryptocurrency. If the juror casts a minority vote, she is financially penalized through the loss of her deposit. Developers claim that these "game theory" dynamics help to optimize juror quality and thwart hackers who wish to rig the decision-making process.[194] While financial and reputational incentives may assist platforms in avoiding certain major pitfalls, these same incentives open the platforms up to a wide range of new criticisms. Thus, this Comment will utilize the above four-step framework to explore inherent weaknesses and the continued viability of decentralized, pseudonymous majority voting schemes.

1. Current Flaws with On-Chain Incentivized Voting

a. *Popular vs. Correct Opinions*

First and foremost, casting a majority vote is simply not equivalent to casting a vote for the correct legal result. Kaal and Calcaterra touch upon this schism in relation to the Aragon Network but do not fully explore its implications or root causes.[195] To do so, it is useful to consider the bargaining power imbalances that flow from the United States' low enforceability threshold for electronic "clickwrap" agreements.

As the Second Circuit held in *Specht v. Netscape Communications Corp.*, if a firm provides "[r]easonably conspicuous notice of the existence of contract terms" and consumers express "unambiguous manifestation of assent to those terms,"[196] a court will assume that a consumer has read those terms.[197] While the *Specht* court specifically found its defendant's notice to be inconspicuous and unreasonable,[198] many subsequent decisions have

191 *See supra* note 122 and accompanying text.

192 *See supra* note 134 and accompanying text.

193 *Aragon White Paper*, *supra* note 88.

194 *See, e.g.*, Kleros White Paper, *supra* note 88, (manuscript at at 8-9, 13) (describing how financial juror incentivization protects against incoherent voting).

195 Kaal & Calcaterra, *supra* note 22, at 147-148.

196 306 F.3d 17, 35 (2d Cir. 2002).

197 *See id.* at 30 (quoting Marin Storage & Trucking, Inc. v. Benco Contracting & Eng'g, Inc., 107 Cal. Rptr. 2d 645, 651 (Cal. Ct. App. 2001)) *("*It is true that '[a] party cannot avoid the terms of a contract on the ground that he or she failed to read it before signing.'").

198 *See id.* at 32 ("[W]here consumers are urged to download free software at the immediate click of a button, a reference to the existence of license terms on a submerged screen is not sufficient to place consumers on inquiry or constructive notice of those terms.").

upheld the enforceability of standard adhesive online contracts.[199] Such jurisprudence will appear patently unfair to common consumers, especially those who know the pain of incurring hidden contractual fees.[200] This inherent normative tug to help the downtrodden is powerful, but it often flies directly in the face of the doctrine. Such a dichotomy reveals the flaws with on-chain majority voting.

Traditional court proceedings represent the antithesis of the flaw, as they enable a juror to follow the letter of the law without fear of economic reprisal. A juror is specifically instructed by a judge as to what questions must be answered.[201] Based on this framework, a juror casts a vote that is grounded in nothing but her own beliefs about the merits of the dispute. While it is certainly possible for a traditional juror to ignore legal precedent and simply follow her own normative compass, this does not negate the fact that (1) there is no immediate external financial incentive to act upon such beliefs and (2) a jury verdict that simply does not comport with reason or law may still be subject to judicial review.[202]

On-chain, a juror is specifically incentivized to incorporate extraneous and frankly irrelevant factors. In the B2C context, the juror must ask: will a narrative built around evil corporations pull at the heartstrings of her fellow jurors? As correctly envisioned and predicted by on-chain application developers, such a consideration does in fact require game theory-like tactics.[203] However, the focus of the game incorrectly shifts to incentivize a juror to vote for an outcome that diverges from the "right" legal result. Out of economic self-interest, the juror must instead predict how co-jurors will vote—effectively replacing the disputant as the proverbial prisoner in a dilemma. This system forces the decisionmaker to care more about her own well-being than the well-being of the disputants. When such a swap occurs, a

199 *See* Hancock v. Am. Tel. & Tel. Co., 701 F.3d 1248, 1259 (10th Cir. 2012) ("We conclude that Defendants' standard practice gives U-verse customers sufficient notice of the TV/Voice and Internet terms of service, as well as an adequate opportunity to manifest assent to the terms."); Register.com, Inc. v. Verio, Inc., 356 F.3d 393, 402 (2d Cir. 2004) (distinguishing from *Specht);* Swift v. Zynga Game Network, Inc., 805 F.Supp.2d 904, 912 (N.D. Cal. 2011) ("Because Plaintiff was provided with an opportunity to review the terms of service in the form of a hyperlink immediately under the "I accept" button and she admittedly clicked "Accept," . . . a binding contract was created here.").

200 *See, e.g.,* Natasha Sarin, *Making Consumer Finance Work*, 119 COLUM. L. REV. 1519, 1562 (2019) ("This fee became a rallying cry for the Occupy Wall Street movement—protesters burned Bank of America debit cards, and an online petition against the fee garnered more than 200,000 signatures.").

201 FED. R. CIV. P. 51.

202 *See* FED. R. CIV. P. 50(a) ("If a party has been fully heard on an issue during a jury trial and the court finds that a reasonable jury would not have a legally sufficient evidentiary basis to find for the party on that issue, the court may: (A) resolve the issue against the party . . . .").

203 Kleros White Paper, supra note 88 (manuscript at 13).

juror with a perfect understanding of contract law,[204] which assumes consumer readership for good reason,[205] may veer away from a straightforward legal analysis. Kaal and Calcettera recognize this divergence, proposing a solution for future on-chain applications. They specifically envision an application development

> that would include an open review system for evaluating the reputations of arbiters. Arbiters would submit their judgments to the community for review, removing all personal information to ensure anonymity. Members of the community would independently review and rank such judgments. Arbiters could improve their reputations by submitting comments and counterjudgments in an open forum.[206]

While such a suggestion demonstrates promise, it fails to explain how community members are to be incentivized to partake in a coherent, neutral manner. Presumably, incentivization will again require financial reward. This in turn means that the community will fall prey to the exact problem these authors suggest that they have fixed. Jurors with financial incentives to write "quality" opinions must consider what other jurors and reviewers believe to be of sufficient quality. This type of review community might even exacerbate system inefficiencies, as game theory dictates that an individual will have an occasional incentive to offer an untruthful negative review of a peer juror. If pseudonymous slandering could relatively boost one's own reputational status, earning capacity, and economic wellbeing, that juror would be incentivized to partake.

b. *Lack of Legal Structure or Guidance*

Such misaligned incentives become more problematic when one considers the jurisdictional and legal ambiguity of on-chain decision-making. As currently configured, most applications do not allow disputants or jurors to utilize the laws of a specific jurisdiction.[207] The ad-hoc nature of current

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204 Assuming the laws of single specified jurisdiction applies.

205 If contracting parties were able to negate contractual obligations simply by claiming that they did not read or understand the contract, all contracts become meaningless. There are of course exceptions to the rule, such as contracts of adhesion, but the general doctrine is globally clear and aligns with the *Specht* court.

206 Kaal & Calcaterra, *supra* note 22, at 148.

207 OpenCourt is the one current exception, as it specifies that its interface inserts a stock "JAMS" arbitration provision into the semantic component of its smart contracts. *OpenCourt*, *supra* note 15. When such a framework is in place, jurors are not forced to start from scratch. If the parties choose an off-chain arbitrator or a single, third-party Ethereum user, the problem decreases in severity. However, unless an appeal process or workable reputational system exists that strips an original arbitrator of her fee, a single third-party is not incentivized to vote coherently or truly devote the proper resources to a dispute.

decision-making—i.e., a complete absence of rules and precedents—results in highly normative or highly localized judgments.[208]

Importantly, if there are no overarching contractual performance standards, the voting majority becomes somewhat arbitrary. Juror A has every right to vote for a consumer because she hates big business. Juror B might cast the same vote because the argumentative brief submission makes the consumer seem like a nice person. Neither is unjustified in their beliefs, but there is obviously no nexus between their reasoning. Volunteering as a juror essentially becomes a game of crypto-roulette, given that a juror has little basis for understanding how her anonymous counterparts are addressing the dispute at hand.[209] This ambiguity, in conjunction with the aforementioned incentivization schemes, creates two major adjudication issues.

The first is that of consistency. Similar facts may lead to wildly different outcomes depending on the normative groundings of the jurors. Ethereum users will have no idea how to structure their semantic or code-based contracts, as they will have no precedential guidance as to how such contracts will be evaluated when disputed. Such a system cannot stand. Indeed, to say that adjudicators may make decisions based on internal fairness considerations is to say that society does not require laws. As explored below, off-chain systems at least attempt to imbue the justice system with stare decisis protections.

The second problem might be described as an illusion of uniformity. Consider, for example, the specialized courts promoted by Kleros and JUR. Kleros' specialized "E-Commerce: International Deliveries Court"[210] has the potential to attract jurors with facially similar expertise but different legal anchorings. Despite narrowing the subject matter of the dispute, this court does nothing to account for the fact that laws regarding e-commerce contracts differ drastically by state and country.[211] One could very easily imagine a scenario in which the five jurors with specialized expertise in e-commerce hail from five different geographic regions. Without the need to adhere to a

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208 As Sklaroff notes, "without the tools created for traditional contracts by traditional courts, parties will have to argue every dispute from scratch, and without any idea about how such disputes will be analyzed." Sklaroff, *supra* note 28, at 302.

209 Such ambiguity extends to the disputants, who have minimal guidance on how to properly argue a case.

210 *See* Kleros White Paper, *supra* note 88 (manuscript at 11) (displaying the subcourts available to jurors within the system).

211 *See e.g.*, Luz E. Nagle, *E-Commerce in Latin America: Legal and Business Challenges for Developing Enterprise*, 50 AM. U. L. REV. 859, 928 (2001) ("What is notable about these two approaches to e-commerce is that regard for personal privacy in international data communication is not uniformly addressed."). *See generally* Samuel O. Manteaw, *Entering the Digital Marketplace: E-Commerce and Jurisdiction in Ghana*, 16 TRANSNAT'L LAW. 345 (2003) (comparing Ghanian e-commerce jurisprudence to that of the United States).

singular legal framework or an ability to communicate, the jurors may rely on their priors and arrive at five different analytically correct results. While a majority will inevitably form, certain jurors will be financially penalized despite clearly arriving at the obvious (regional) result. This is an undesirable financial result for a juror, and one that will make users wary to serve as arbitrators. If a juror's financial livelihood is tied to the normative predisposition of anonymous counterparts, that juror might be better served going to a casino. Such ambiguity will undoubtedly lessen the quality of arbitrator attracted to these applications.

In sum, the financial pull to diverge from one's own analyses renders on-chain juror voting deeply problematic. This possibility for incorrect and arbitrary voting is negatively reinforced by a current lack of legal guidance and precedent. Such systems are not sustainable in the long run, and—as will be explored—quickly deteriorate at scale.

2. Off-Chain Incentivization Schemes

While decision-making processes differ greatly across tribunal type and location, Ethereum resolution applications alone resort to majority voting incentivization schemes. No other voting system in the world directly ties juror or judge payment to the casting of a majority vote.

a. *United States Federal Court*

The United States federal court system again provides the clearest contrast to on-chain juror processes. In federal court, jurors receive a flat fee of fifty dollars per day.[212] There exists absolutely no financial incentive to vote with the majority, as both criminal and civil cases generally require a unanimous verdict.[213] If anything, such a system would incentivize a juror to withhold a majority vote in the hopes of prolonging the trial (given that employers may not deduct pay for jury leave, and jurors receive this additional fifty dollars[214]). However, purposeful delays are unlikely. In a compulsory jury system, financial compensation is a byproduct of forced participation on a jury, not a means of incentivizing participation or

212 *Juror Pay*, UNITED STATES COURTS, https://www.uscourts.gov/services-forms/jury-service/juror-pay [https://perma.cc/C5ZS-N8ZL] (last visited March 13, 2019).

213 *See* FED. R. CIV. P. 48(b) ("Unless the parties stipulate otherwise, the verdict must be unanimous and must be returned by a jury of at least 6 members."); FED. R. CRIM. P. 31(a) ("The jury must return its verdict to a judge in open court. The verdict must be unanimous.").

214 BUREAU OF LABOR STATISTICS, TABLE B-3. AVERAGE HOURLY AND WEEKLY EARNINGS OF ALL EMPLOYEES ON PRIVATE NONFARM PAYROLLS BY INDUSTRY SECTOR, SEASONALLY ADJUSTED (Nov. 1, 2019), https://www.bls.gov/news.release/empsit.t19.htm [https://perma.cc/UDL5-G2F5] (displaying that the average hourly salary amounts to far greater than fifty dollars per day).

prolonging it. Further, even if jury pay was a juror's incentive to participate and lengthen the trial, compensation is still not dependent on the juror's eventual decision.

Similarly, federal judges are not financially incentivized to rule in a certain way. The United States Constitution ensures such impartiality by providing lifetime tenure "during good Behaviour" and a specified level of income.[215] Salary and job security are not at risk, allowing a judge to decide a case purely based on the letter of the law. Thus, a federal judge, like a jury member, may safely and securely cut extraneous monetary decision-making factors from the process.

b. *State and Foreign Courts*

The same cannot be said for adjudicators in many foreign nations and a majority of U.S. states. In these regions, popular judicial elections[216] with fixed term limits[217] are the primary mechanisms for judicial appointment. States generally rely on the former, while foreign nations generally rely on the latter. In some instances, judicial elections are "partisan," in which a candidate runs on the ticket of a particular political party.[218] In others, judicial election ballots actively conceal the political affiliations of their candidates.[219]

Importantly, it is possible to find causal link between judicial decision-making and financial compensation within these systems. A state court judge held accountable to an electorate may rule in a manner that she believes her electorate wishes. Much like when an on-chain juror casts a vote based on the normative considerations of co-jurors, a judge subject to an election may rule with the ballot box in mind. There is no built-in, long-term protection for a judge to make a correct but unpopular legal decision, as has been repeatedly

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215 U.S. CONST. art. III, § 1, cl. 2.

216 *See generally Judicial Elections*, BALLOTPEDIA, https://ballotpedia.org/Judicial_elections [https://perma.cc/Q9QR-X8A9] (last visited March 13, 2019) (explaining the judicial election process for each U.S. state).

217 *See* Steven G. Calabresi & James Lindgren, *Term Limits for the Supreme Court: Life Tenure Reconsidered*, 29 HARV. J.L. & PUB. POL'Y 769, 819 (2006) ("Every major democratic nation, without exception, instead provides for some sort of limited tenure of office for its constitutional court judges.").

218 *See, e.g.*, *Alabama Judicial Elections*, BALLOTPEDIA, https://ballotpedia.org/Alabama_judicial_elections [https://perma.cc/6Z33-CXUJ] (last visited March 13, 2019) ("Candidates for judge or justice who wish to run on a party ticket must qualify to run in an open primary by obtaining the legally required number of signatures to get on the ballot.").

219 *See, e.g.*, *Montana Judicial Elections*, BALLOTPEDIA, https://ballotpedia.org/Montana_judicial_elections [https://perma.cc/8HGF-6L8J] (last visited March 13, 2019) ("In the nonpartisan primary, the two candidates who receive the greatest number of votes advance to the general election. If only two candidates file for one judicial seat, both candidates advance to the general election.").

demonstrated in federal court.[220] The re-election of a state-court judge, and thus her financial livelihood, is in part dependent on appeasing the masses.

However, it is clear that the causal link between income and decision-making is far more attenuated than with on-chain majority-voting schemes. An elected judge is theoretically evaluated on the amalgamation of her work, if not mere political affiliations. Thus, in any given dispute, the judge is less inclined than on-chain jurors to consider the financial reward or penalty for ruling in a certain manner. Presumably, the masses will seldom take such individual rulings into consideration on election day. While certain extremely high-profile cases attract the attention of the public or judicial reappointment political committees,[221] this high-level scrutiny is most likely the exception to the norm. Such attenuation between decision-making and compensation is obviously not true on-chain, where a crypto-juror's entire payment is always dependent on ruling in unison with a majority of her co-jurors.

c. *Arbitration Tribunals*

Arbitral decision-making processes—both in person and online—more closely mirror on-chain incentivization schemes. However, these processes are still clearly distinguishable from on-chain resolution in certain key respects. To understand how, one must first understand the selection and payment processes of a typical arbitration proceeding. Stephen G. Rogers offers a succinct explanation of such processes:

> Parties to arbitration agreements frequently require "tripartite" panels to resolve commercial disputes. This format typically has each party unilaterally appointing one arbitrator, and then the appointees or the parties either agreeing on the selection of the third, neutral arbitrator or requesting an

220 *See, e.g.*, Reid Kress Weisbord & David Hoffman, *Are There Really 'Plenty of Shapiros Out There'? A Comment on the Courage of Norma L. Shapiro*, *in* EDITED VOLUME OF ESSAYS ON NOTABLE AM. JUDGES (Kevin Peppers ed., forthcoming) (manuscript at 4), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2952513 ("In each case, Judge Shapiro assumed the risk of reversal and the boomerang of *public criticism* for making a unpopular decision necessary to prevent other branches of government from abusing power.") (emphasis added).

221 *See, e.g.*, Debra Cassens Weiss, *Manafort Charged in New York State as He's Sentenced to More Prison Time in Second Federal Case*, A.B.A. J. (March 13, 2019, 1:59 PM), http://www.abajournal.com/news/article/manafort-is-charged-in-new-york-state-as-he-is-sentenced-to-more-prison-time-in-second-federal-case [https://perma.cc/T64N-TVSP] (illustrating media attention to the criminal charges and sentencing of Paul Manafort, newsworthy because of his notoriety as a former campaign chairman for President Trump).

> appointment through an agreed-upon institution such as a court or private dispute resolution firm.[222]

Importantly, these party-selected arbitrators are not (facially) compensated based on the outcome of a dispute.[223] Arbitral decision makers are paid specifically for the work they perform, not the outcome at which they arrive.[224] The fees can certainly be astronomical, but the hourly rates tend to be proportional to an arbitrator's skill or expertise.[225] Such pay-per-hour schemes initially suggest that an arbitrator is not incentivized to vote for a particular outcome, given that the final payout will not be affected by the panel's ultimate decision.

But such a conclusion places the incentives of a non-neutral arbitrator under too strong of a microscope. Zooming out, it becomes clear that a non-neutral arbitrator is bound to the party that hired her.[226] Remuneration for the dispute at-hand is not subject to loss, but a failure to procure a winning vote may destroy the working relationship between the arbitrator and the disputant. Each non-neutral arbitrator is therefore financially incentivized to convince the singular neutral arbitrator of its hiring party's position.[227] A failure to do so might result in a repeat offender hiring a different non-neutral arbitrator in the future. In effect, these hired guns have a long-term financial incentive to rule in accordance with a specific party. Such an incentivization scheme might be likened to the popular election issue above, except that the repeat-disputant itself replaces the electorate. In other words, the arbitrator must appease its direct employer instead of its voters.

Importantly, the above analysis fails to fully consider the role and effect of the mutually agreed upon neutral decision maker.[228] If this third decision maker is truly neutral, the non-neutral hired guns simply become additional advocates for their parties. Because the neutral is not paid based on the outcome, she effectively becomes a singular, independent judge. In this

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222 Stephen C. Rogers, *Can Tripartite Arbitration Panels Reach Fair Results?*, DISP. RESOL. MAG., Fall 2001, at 27, 27.

223 Deborah Rothman, *Trends in Arbitrator Compensation*, DISP. RESOL. MAG., Spring 2017, at 8, 8-9.

224 *See id.* at 10 ("While arbitrators occasionally discuss the concept of providing a fixed fee for an arbitration, I am not aware of this becoming a reality in the field of commercial arbitration.").

225 *See id.* at 9 ("The rates tend to rise with experience and prominence, but retired judges do not necessarily have higher rates than attorney arbitrators, even at the high end.") (internal quotation omitted).

226 *See* Rogers, *supra* note 222 at 27 ("Absent an agreement between the parties, their selected arbitrators are assumed to be aligned with the side that appointed them and to lack the neutrality expected of the third member of the panel, who serves as the ultimate decision-maker in the dispute.").

227 *See, e.g.*, *id.* at 29 ("Assuming the neutral is willing to listen, a party arbitrator has the opportunity . . . to engage the neutral in an open discourse about the case.").

228 Assuming the above tripartite scheme.

instance, arbitration is theoretically subject to no incentivization issues, as this singular arbitrator will rule without fear of reprisal and based solely on reasoned beliefs about the merits of the case. Thus, even a singular neutral with decision-making power renders arbitration voting totally dissimilar from on-chain majority-voting schemes.

3. On-Chain Update Infeasibility

As with discovery compulsion, it is necessary to ask if juror-incentivization flaws are fixable through platform redesign or whether they suffer from flaws inherent to blockchain technology. While two procedural safeguards exist that may blunt the ills of financially incentivized jurors, there appears to be no technological alternative that completely corrects juror incentives. Thus, the below update suggestions may completely eliminate legal ambiguity but only indirectly and partially force jurors to practice purely meritorious decision-making processes.

a. *Standardized Frameworks and Precedential Decisions*

First, in order to reduce vote-casting based only on relative moral judgements (or beliefs about others' moral judgments), parties to a smart contract should ex-ante incorporate a choice-of-law provision. If the jurors are presented with laws and rules to guide the decision-making process, they can be more confident as to (1) how they go about their own decision-making process, and (2) how their co-jurors will do the same. Identifying a legal framework thus helps to remedy both misaligned incentives and unstructured on-chain decision making. Legal ambiguity and game-theory considerations will still impact the outcome, but the scope of the problem narrows. Instead of predicting the entire universe of factors that a co-juror might consider, a juror may now limit considerations to how the co-juror will interpret the law and legal standard presented.

Recall the example of a smart contract in which an Ethereum user seeks to purchase a website from a freelancer. The semantic component of the smart contract specifies a certain delivery date, but the designer reaches out via EtherChat several days before the deadline in order to ask for an extension. The purchaser agrees to the extension, but the parties do not alter the original smart contract. Well before the new deadline but after the original smart contract delivery date, the purchaser initiates a dispute.

First assume that all jurors have access to all necessary facts but are not guided by a given set of laws. One juror might reason: a deal is a deal; extra side talk is irrelevant and it is not part of a contract. Another might think: the purchaser promised to give the designer an extension and then reneged,

so the purchaser updated and then breached the contract. These are both valid thought processes, but they are not rooted in any source of authority.[229]

Now instead assume that the parties to the smart contract have agreed to adhere to the contract law jurisprudence of a jurisdiction that has strictly adopted the Second Restatement of the Law of Contracts. In this scenario, each party is forced to argue, and each juror is required to consider, the merits of a promissory estoppel claim.[230] If a party brings a promissory estoppel claim, every juror considers the exact same set of questions when casting a vote: (1) Was there a promise reasonably expected to induce action? and (2) Was that promise reasonably relied on? The jurors may certainly disagree as to whether reliance by the seller was "reasonable,"[231] but this does not negate the fact that a legal framework has narrowed the range of ambiguous considerations. In other words, whether reliance was reasonable is a much narrower inquiry than who should get what money from this particular set of facts. Thus, either requiring parties to submit a choice-of-laws provision or implementing a default system in which the jurors may choose a legal framework[232] will enable co-jurors to more confidently decide a case on the merits.

b. *Decentralization Concerns*

Utilizing choice-of-law provisions of course increases reliance on centralized-governmental institutions. Choice-of-law provisions would fold the legal systems of the world into on-chain dispute resolution, which might draw decentralization criticisms similar to those found in subsection III.A.3 regarding discovery compulsion. If the choice-of-law provision in a given smart contract implements a legal framework that favors institutional power (e.g., U.S. law concerning adhesion contracts), an on-chain resolution outcome becomes subject to the same political pressures and skews as outcomes in traditional U.S. tribunals.

Interestingly, the inverse would not be true. A ruling on Kleros would have no impact on a traditional contractual dispute because it has no precedential value. Further, judges and lawmakers would presumably not be

229 As described above, this lack of standardized authority means that individual disputes with identical facts are thus subject to wild inconsistency and the predilections of their jurors. The same is to some degree true in traditional legal systems but may be blunted by the procedural safeguards discussed above (e.g., precedent, jury instructions, and appeals).

230 *See* RESTATEMENT (SECOND) OF CONTRACTS § 90 (AM. LAW INST. 1981) (defining promissory estoppel as "[a] promise which the promisor should reasonably expect to induce action or forbearance on the part of the promisee or a third person and which does induce such action or forbearance is binding if injustice can be avoided only by enforcement of the promise").

231 Thereby reintroducing game-theory considerations into the decision-making process.

232 As with arbitration.

ruling with an eye towards the effect of an in-court precedent on on-chain disputes. Lastly, to compound the above discovery compulsions issues, such submissive adherence would not aid in providing a jurisdictional backstop to settle any unresolved issues. Simply because the anonymous jurors must apply U.S. law to a dispute does not mean that a judge has the power to entertain and adjudicate the dispute to which it is applied. On-chain dispute resolution would thus be passively subject to the laws of a given jurisdiction.

To resolve difficult choice-of-law questions of this nature and the resulting centralization concerns, applications like Ulex offer a lexicon of generalized contract doctrines in conjunction with its dispute resolution services.[233] Specifically, the platform has suggested that the ALI Restatements might be a sufficient guidepost for its jurors.[234] From such bare-bones doctrines, it might be possible for a resolution application to develop its own set of common law precedent over time. This would offer jurors a basic legal framework from which to work without the need for reliance on the laws of a particular government. The parties to the smart contract would have access to these laws before employing the application, enabling knowing consent of the adjudicatory risks.

c. *Juror Filtering*

The second safeguard flows naturally from this first suggestion to implement some sort of jurisdictional guidance. If parties do indeed specify a choice-of-law ex ante, platforms would do well to limit the juror pool to those with an expertise or background in the law of that jurisdiction. Kleros and JUR developers have entertained this idea, suggesting that the applications may one day comprehensively sort users by educational records and judicial history (all of which may be preserved on the Ethereum blockchain ledger).[235] Juror filtering, in conjunction with choice-of-law

233 *See* Goro, *supra* note 110 ("The Ulex Core smart contracts would have . . . a concept of community forum . . . where plain english rules are outlined for a given community which are then used by the Ulex Core judges to render verdicts on subjective or other rules which are not possible to codify in smart contracts.").

234 *See id*. ("For instance, the following lines would get their own text file: 2.1.4. Personal Harm . . . ALI, Restatement of Torts, Third, Liability for Physical and Emotional Harm (2009–12).").

235 *See* Ian Murphy, *Would You Use The Justice Protocol from Kleros?*, ENTERPRISE TIMES (Jan. 23, 2018), https://www.enterprisetimes.co.uk/2018/01/23/use-justice-protocol-from-kleros/ [https://perma.cc/ACL5-4P7E] ("One solution that could be implemented here is a blockchain-based skills solution . . . . It records all the educational records for individuals from school through to degree or doctorate. The system can even be integrated into corporate HR systems to record post education qualifications."); *see also* JUR WHITE PAPER, *supra* note 88, at 48 (explaining the Hub's [i.e., different subset of courts] filtering process, assigning certain jurors to certain disputes based on relevant criteria).

clauses, would create a simulated jurisdiction that existed only for the purposes of the smart contract.

d. *Remaining Incurable Incentivization*

Each of the two above suggestions—choice-of-law specification and juror filtering—may help to converge on-chain decision-making processes with that of off-chain alternatives.[236] However, it is important to remember that these improvements will be of limited value if there is no accompanying application mechanism that requires jurors to vote coherently. Thus, on-chain resolution is still subject to an incentivization problem that off-chain alternatives are not. Unless some other system of pseudonymous, coherent decision-making exists, the aforementioned harms flowing from groupthink will perpetually plague on-chain dispute resolution.[237]

Unfortunately, any shift away from incentivized participation and voting threatens to sacrifice the decentralized and non-compulsory nature of a blockchain. As mentioned above, traditional legal systems require mandatory juror service. Blockchains and smart contract technology, conversely, cannot unilaterally mandate users to serve as jurors. It is not possible to involuntarily render Ethereum its own jurisdiction and force all users to contribute to that system by serving as jurors. Although data access objects (DAOs) and virtual jurisdictions do enable this (much like Aragon), these examples are still very much opt-in systems.[238] Any such system, in which inducement is required, will also require incentives for participants to adhere to the rules and goals of the system.

An alternative possibility, as currently employed by OpenCourt, is to completely abandon an anonymous, majority-based crowd-sourcing juror system. Instead, this platform enables the disputing parties to actively agree upon a specific arbitrator (or set of arbitrators).[239] Unfortunately, this creates a different, potentially more expensive form of adjudication, as an arbitrator's credentials now become vitally important to her marketability. This negates the promise of cheap but effective adjudication, as quality arbitrators are less

236 Such suggestions are not perfect but present possible avenues for exploration. However, one can easily think of examples where there will be conflicts: for instance, consider a pseudonymous user in the United States that enters into a smart contract with a pseudonymous user in China, but the semantic contract contains a clause for arbitration subject to German law.

237 *See Aragon White Paper*, *supra* note 88 (discussing focal point decision making); *see also supra* notes 203–20 and accompanying text.

238 This would, again, require some sort of oversight that these anonymous jurors are voting coherently, similar to a federal judge's ability to offer a judgment as a matter of law or a circuit judge's ability to hold a prior finding as erroneous.

239 Opencourt, *supra* note 15 ("Using this interface, each party can . . . agree on the blockchain address of who they select as an arbitrator.")

likely to volunteer on-chain when they can command hundreds of dollars per hour off-chain.[240]

Perhaps more importantly, selecting an arbitrator without some sort of incentive to rule coherently might, again, result in random and incoherent voting. An arbitrator who has collected a fee may simply issue a ruling and walk away. While this is true of normal arbitration, that arbitration is often legally binding and may be appealed to a forum in which the adjudicator has no financial incentive to hear a case or issue a quick and incoherent ruling. [241] As already discussed, pseudonymous parties on Ethereum do not have that same capability. They may not turn to government-backed, non-incentivized judges without revealing their identity or sacrificing decentralization principles. If the parties and jurors are indeed willing to reveal identities to utilize involve traditional arbitral or legal adjudication methods, this calls into question the need for on-chain dispute resolution in the first place.

In sum, the author cannot envision a decentralized, anonymous method of juror voting that will produce consistently coherent votes while allowing jurors to vote on what they alone believe to be the optimal legal result.

C. *Flaw 3: Platform Scalability*

One final flaw, scalability infeasibility, must be examined before discussing the long-term viability of on-chain dispute resolution. Because this is a purely technological issue and many of the comparative legal systems have already been explored in depth, this discussion will only loosely adhere to the four-step framework.

1. Structured Discovery Processes at Scale

Ironically, the same systems that fail to ensure that jurors and counterparties receive pertinent information simultaneously risks its antithesis—an endless flood of useless, misleading, unorganized, or false documents. Again, the root of this problem stems from a complete lack of established procedure for synthesizing or paring back the influx of documents. To be sure, traditional corporate litigation presents the same

240 Rothman, *supra* note 223, at 8.

241 *What Happens After the Arbitrator Issues an Award*, AMERICAN ARB. ASS'N, https://www.adr.org/sites/default/files/document_repository/AAA229_After_Award_Issued.pdf [https://perma.cc/2GHN-4VX2] (last visited May 6, 2020) (stating that "if a party wins in the arbitration and the other party does not do what the award says, the winning party may go to court to 'confirm' the arbitration award" and that the "Federal Arbitration Act ("FAA") and some state laws provide the reasons why an award can be vacated (thrown out), modified (changed), or corrected," but noting that "there are only a few ways to challenge an arbitrator's award").

flood of documents.[242] But as discussed above, there are at least some limits on the proportionality of production, and law- and policymakers are taking active steps to reduce unnecessary clutter.[243] While it may and often does lead to expansive document dumps, the traditional legal system (1) adheres to a regimented process and timeline, (2) offers the option to push for document exclusion from a record, and (3) presents continuous opportunities to dialogue with a judge or arbitrator about discovery process concerns.[244] Again, no similar processes exists on-chain. Currently, there exists only a point-and-click data dump.

2. Advocacy and Fact-Finding at Scale

Unfortunately, the shortcomings associated with discovery only compound as arbitration sequentially progresses. This compounding may be articulated succinctly: opportunities for advocacy are sparse. As currently designed, each available platform calls for counterparties to submit some version of a "brief" in support of their argument. In reality, this brief is a simple textbox that enables an Ethereum user (presumably without a lawyer) to explain why they feel shortchanged.[245] There is no trial. There is no arbitration hearing. It is even unclear as to whether any of these systems maintain some sort of continuously adversarial process in which parties can respond to claims or attack the validity of self-produced evidence. In essence, on-chain resolution applications offer only appellate review of a disorganized and potentially distorted set of evidentiary findings.

Without a platform for full-fledged advocacy, the minutiae of contractual disagreement become impossible to adequately unpack. As James Grimmelmann explains, "[t]he meaning of a legal contract is a social fact. So too is the meaning of a smart contract."[246] In other words, terms in a contract and lines of computer code are regularly rife with ambiguity.[247] Thus, if a

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242 *See* Jason R. Baron, *Law in the Age of Exabytes: Some Further Thoughts on 'Information Inflation' and Current Issues in E-Discovery Search,* 17 RICH. J.L. & TECH. 1, 14-15 (2011) (citations omitted) ("[T]he plaintiff claimed that 'defendants engaged in a "massive document dump" by producing 1.8 million documents' placed on a series of disks that, in the plaintiff's view, contained ninety-nine percent irrelevant material.").

243 *See* Gregory L. Waterworth, *Proportional Discovery's Anticipated Impact and Unanticipated Obstacle*, 47 U. BALT. L. REV. 139, 141 ("The new Rule 26(b)(1) is but a shadow of its former self. In an attempt to curb the much debated growing costs, the new Rule 26(b)(1) supplanted the standards of the former rule with only two considerations—relevance and proportionality.").

244 Admittedly, off-chain arbitration is often subject to a truncated discovery and/or a hands-off approach to document regulation.

245 See *OpenCourt Tutorial*, *supra* note 63 (demonstrating in a video tutorial how to file a dispute and showing the textbox where the facts of the dispute can be inputted).

246 Grimmelmann, *supra* note 59, at 3.

247 *Id.*

contract calls for a party to perform a service "in good faith," stakeholders might have different opinions on whether that threshold has been achieved. This is a primary takeaway from Sklaroff's *Smart Contracts and the Cost of Inflexibility*,[248] and it extends to on-chain dispute resolution. While this determination is ultimately a subjective decision made by the jurors,[249] it requires the counterparties to demonstrate the processes and actions undertaken in performing a contract.

When a contract is simple and between two individuals, a single textbox might suffice. For instance, imagine that an Ethereum user enters into a smart contract with a singular freelance designer in which the designer agrees to create an advertising poster for her business. The smart contract has a semantic, natural-language component that requires the digital designer to "act in good faith." The designer works on the website for a week straight, creates several iterations, and submits one that she believes is perfect. If a dispute ensues, the designer possesses all of the relevant information, given that she herself performed all of the relevant actions.[250] That designer can confidentially, fully, and single-handedly describe the entire process in this single textbox.

When a contract increases in complexity, this completeness becomes less feasible. Consider instead a hypothetical contract between a university and food supplier, in which the food supplier promises to make a good-faith effort to continuously deliver food on time, and the university promises to make a good-faith effort to keep attendance (and thus meal plans) above a certain threshold. Even if the initial smart contract implements every single oracle possible in order to document a picture-perfect record (i.e., video cameras that track the supply chain and submit daily inspection pictures, a link to an accredited third-party website for student enrollment, etc.), the number of players involved with each company, the actions and efforts of each player, and the reasons for those actions all contribute to whether the parties acted in good faith.

The question then becomes: how do the likes of Kleros and JUR allow parties (or their lawyers) to synthesize, aggregate, verify, and present this information in a compelling, concise, and clear manner? Again, at present, the answer is a textbox. Theoretically, each party could collect and submit affidavits from all relevant actors and summarize the findings in the brief. However, without some form of in-court testimony, this system falls prey to

248 *See* Sklaroff, *supra* note 28, at 302 ("Smart contracts that fail to offer semantic and enforcement flexibility will be useful in a very limited set of circumstances.").

249 A decision made without precedent, no less. *See supra* subsection III.B.2.

250 It should be noted, however, that this ignores the value of precedential rulings as to what constitutes good faith, a topic explored below.

concerns of discovery forgery. A lack of in-person hearing opportunities may also inadvertently compound ambiguity facing jurors. Suppose, in an embellished example, the university president submits an affidavit which simply reads: "I worked really hard to bring enrollment up." Without the opportunity for further clarification via testimony, cross-examination, or a second round of affidavits—as is currently the case on most platforms—jurors must now figure out how "hard work" fits into "good faith."

Of further potential concern, the above example again assumes away pseudonymity. The human element of good faith becomes much harder to examine when information about the contracting parties is shrouded in secrecy. What if, for instance, an anonymous user represents itself as a single individual, but in actuality is an organization composed of hundreds of individuals? One individual working tirelessly might constitute a good-faith effort, while a hundred people exerting minimal effort may not, despite each entity producing the same end product.

This point is a crucial one. As touched upon above, the efficacy of OArb has increased over time due to technological communication improvements. Parties and advocates may meet via video conference and telephone calls, as well as store, share, and review large sets of documents at virtually no cost. On-chain pseudonymity directly negates this possibility. If a blockchain user is unwilling to reveal her name, she is most likely also unwilling to put her own face in front of a webcam and testify. Further, if the user is in fact willing to reveal her identify, this makes on-chain arbitration unnecessary.

Lastly, and perhaps most importantly, any technological updates to current on-chain platforms in which developers attempt to expand discovery opportunities will quickly become extremely costly. Recall that blockchain transactions cost cryptocurrency to perform.[251] Further recall that as complexity increases, a transaction becomes costlier and slower to complete. This means that the promise of cheap and expedient adjudication begins to vanish as the pile of documents, number of hearings, and filing of briefs increases. Indeed, Ethereum founder Vitalik Buterin has recognized the shortcomings of Ethereum's processing power and has continuously hinted at forthcoming yet illusive overhauls to reduce transaction cost and increase speed.[252] Until such an overhaul, large scale disputes will be

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251 *See supra* note 24.

252 *See* Cryptomaniaks, *Hey Ethereum, Any News About Casper and PoS?*, MEDIUM (Oct. 13, 2018), https://medium.com/predict/hey-ethereum-any-news-about-casper-and-pos-medium-f6319773f810 [https://perma.cc/JZ5L-T5W5] ("Both Casper (Ethereum's improved iteration of PoS) and sharding will help Ethereum scale from a financial and technical perspective.").

prohibitively costly and potentially slower to adjudicate than if heard before off-chain alternatives.

In sum, Ethereum is plagued by many of same scalability issues that originally faced traditional OArb. While OArb developers have learned to incorporate technological advances into the adjudication process, Ethereum's promise of pseudonymity and the cost of encrypting and sending information present additional concerns that detract from the possibility of large-scale, on-chain commercial litigation.

IV. OPTIMAL PATH FORWARD

Lack of third-party discovery. Skewed juror incentives. Scalability concerns for on-chain commercial disputes. These are the inherently unfixable flaws that plague blockchain-based dispute resolution. The question remains, however, whether these flaws are so detrimental to the adjudication process that they render on-chain application systems indefinitely unusable. This Comment will therefore conclude by briefly weighing in on long-term system viability. Given that any answer to this question will be a primarily subjective one, the discussion below pales in importance compared to the above elucidation of inherent flaws. This final Part does not intend to offer a definitive statement on the optimal path forward. Further debate and writing on the matter are strongly encouraged.

In short, this Comment concludes that on-chain arbitration is viable only for resolving minor disputes. It does not offer a catch-all, long-term system for complex resolution. In the event that widespread, large-scale blockchain adoption were to occur, contracting parties would do well to build in contractual mechanisms to (1) reveal party identities and (2) migrate resolution off-chain. However, such precautions negate key blockchain benefits.

A. *Small Scale Disputes*

In a minimized, peer-to-peer transacting context, the flaws associated with ledger technology do not negate on-chain resolution viability. Such a position stems from the belief that inherent flaws will seldomly impact the result of minor disputes. When monetary stakes are low, the dispute is between two single-person parties, and few documents exist, third-party compulsion shortcomings will rarely have an opportunity to manifest. Why? Because simpler disputes tend to be accompanied by fewer variables. A person-to-person dispute will not often require third-party testimony because there is less opportunity for a third party to be involved in carrying out the contract (smoking-gun communication being the exception). Similarly,

majority-voting schemes become less problematic as contractual obligations become more straightforward. The range of game-theory considerations are more limited, as simple, individualized claims are more likely to call for simple, individualized arguments, analytical tests, and voting options.

Lastly, even if all possible flaws were to manifest in a given case and negatively impact adjudication standards, such limited functionality may still bow to the expediency and convenience of the process. Effectively, one must engage in a cost–benefit balancing test, weighing discovery compulsion and potentially skewed incentivized-voting flaws against fast, cheap, and easy results. When examined in this light, on-chain dispute resolution can be likened to small claims court, in that these applications are suited to handle "relatively minor disputes involving dollar amounts that are insufficient to warrant processing the case through the normal court procedure justify expedited and simplistic handling."[253] As discussed at length, however, pseudonymity creates a major blockage to actually bringing petty claims before these informal physical halls of justice. Thus, if society's two options are (1) allowing for on-chain resolution that is imperfect and may incorrectly decide a larger percentage of cases than alternative systems or (2) forcing pseudonymous parties to go remediless, the former seems appreciably more attractive.

Again, this analysis is based on the proposition that individual identification is not possible. If blockchain does away with pseudonymity, it becomes quite clear that OArb or small claims court offer a superior alternative, even at the expense of decentralization. Indeed, in addition to removing governmental influence, decentralization also aims to enable trusted, verifiable anonymous transactions. Once this second benefit of anonymity is eliminated through identity revelation, the above cost–benefit analysis shifts. In this instance, the readily identifiable parties must balance OArb's promise of governmental compulsion against blockchain immutability. These represent the remaining distinct benefits of each system when pseudonymity and decentralization lose value. Given that OArb's reintroduction of a governmental backstop remedies blockchain's greatest flaw (no third-party discovery), and some legal framework is always necessary for proper juror incentivization, immutability does not appear overly important. Non-pseudonymous parties will receive a more thorough, principled adjudication off-chain. However, in this instance, the discrepancy between the two systems shrinks, and the author believes practical outcomes will not differ significantly on- and off-chain. Thus, despite the presence of

253 Bruce Zucker & Monica Her, *The People's Court Examined: A Legal and Empirical Analysis of the Small Claims Court System,* 37 U.S.F. L. REV. 315, 317 (2003).

inherent flaws that weaken the adjudication process, on-chain resolution may be used in limited instances for small claim disputes.

B. *Large Scale Disputes*

Any such notion of viability disappears the moment that the scale and complexity of a transaction increases. The source of complexity is largely irrelevant, as complicated contractual provisions and intricately organized disputants both erase on-chain viability. In either instance, scale magnifies the negative effects of inherent blockchain shortcomings. Recall the university and food supplier contract example.[254] In a dispute concerning the supplier's good-faith effort to timely deliver food, it would be necessary to discern the activity of multiple organization members and third-party contractors. Witness testimony would be required to understand which organizational members performed which tasks along the supply chain, who offered truthful affidavits, and what efforts were taken to fulfill obligations in good faith. Unfortunately, the information-gathering opportunities that exist with on-chain resolution systems are simply too scarce to effectively adjudicate such a complex dispute. Binders full of harmful internal documents, videos of witness testimony, and third-party communications will simply be absent. Further, even if such evidence did manifest, the exchange of documents and videos over the blockchain, along with elongated adversarial proceedings, would prove prohibitively costly.

Thus, any legitimate adjudication that fully develops a factual record and allows advocates to flesh out a claim will inescapably require (1) a loss of pseudonymity and (2) again, some sort of legal structure based on the doctrine of a centralized government. One must consider what blockchain-specific benefits remain once such pseudonymity and decentralization have disappeared. The first answer that comes to mind is immutability, but this does not seem particularly important in the resolution context. Especially if on-chain resolution does not have precedential value, the immutability of on-chain arbitrator decisions does not offer appreciable advantages over off-chain decisions.

The best argument for on-chain resolution then becomes that payment will be immediate, automatic, and final. However, the same result could theoretically be achieved via off-chain arbitration through use of a traditional escrow account. It thus seems there is no compelling explanation for subjecting complex commercial disputes to the inherent flaws of blockchain, especially when OArb or other traditional alternatives require less hoop-jumping. Any vision or expectation of a fully decentralized on-chain economy,

254 *Supra* note 250 and accompanying text.

even one in the distant future, must therefore be tempered. The inherent flaws of blockchain-dispute resolution will not enable all aspects of modern society to effectively shift to a public ledger. It is certainly possible that business-to-business transactions will migrate on-chain, but it is unlikely that decentralized dispute resolution will serve as its enforcement mechanism. Therefore, all enterprises that are contemplating smart contract adoption should build in an option for off-chain arbitration or traditional litigation. One could see "Know-Your-Customer"[255] precautionary techniques enabling this process, but such identity revelation again calls into question the need for blockchain in the first place. Thus, the benefits of immutability and decentralization may not outweigh the costs of overhauling current economic infrastructure to make all aspects of daily life crypto-compatible.

CONCLUSION

Unforeseen technological developments are certainly possible. Perhaps a new on-chain resolution application will be released tomorrow that will perfectly simulate traditional litigation at a fraction of the cost. Such a proposition, however, seems unlikely. Given the inherent, distinctive flaws that blockchain technology introduces into the dispute resolution process, cypherpunks must seek alternative solutions to errant smart contracts or fraudulent human behavior that permeates a blockchain. An inability to compel discovery, skewed juror incentives, and limits to dispute complexity all render decentralized, pseudonymous on-chain applications perpetually inferior to off-chain alternatives. This inferiority may be less impactful as dispute scale shrinks, but will rear its ugly, insufficient head the instant enterprise firms begin regularly transacting on a public blockchain.

255 James Chen, *Know Your Client (KYC)*, INVESTOPEDIA (Aug. 28, 2019), https://www.investopedia.com/terms/k/knowyourclient.asp [https://perma.cc/F594-3FSW] ("The Know Your Client or Know Your Customer is a standard in the investment industry that ensures investment advisors know detailed information about their client[] . . . .").

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