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VERIFICATION DILEMMAS IN LAW AND THE PROMISE OF ZERO-KNOWLEDGE PROOFS

Kenneth A. Bamberger,[†] *Ran Canetti,*[††] *Shafi Goldwasser,*[†††] *Rebecca Wexler*[‡] *& Evan J. Zimmerman*[‡‡]

ABSTRACT

Individuals who wish to access a website or qualify for a loan are expected to expose personally identifying information, undermining their privacy and security. Firms share proprietary information in dealmaking negotiations which, if the deal fails, may be used by the negotiating partner for a competitive advantage. Regulators are expected to disclose their algorithmic tools to comply with public transparency and oversight requirements, a practice that risks rendering these tools circumventable and ineffective. Litigants might have to reveal trade secrets in court proceedings to prove a claim or defense. Such "verification dilemmas"—costly choices between opportunities that require the verification of some fact and risks of exposing sensitive information in order to perform that verification—appear across the legal

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landscape. Yet existing legal responses to them are imperfect. Legal responses often depend on ex post litigation procedures that can be prohibitively expensive for those most in need or are otherwise ineffective.

Zero-knowledge proofs (ZKPs)—a class of cryptographic protocols that enables verification of a fact or characteristic of secret information without learning the actual secret—can help to avoid these verification dilemmas. ZKPs can provide a feasible means for a party who holds secret information to demonstrate desirable properties of this information while keeping the information otherwise hidden. Yet ZKPs have received scant notice in the legal literature. This Article fills that gap by providing the first deep dive into ZKPs' broad relevance for law. It explains ZKPs' conceptual power and technical operation to a legal audience. It then demonstrates how ZKPs can be applied as a governance tool to transform verification dilemmas in multiple legal contexts. Finally, the Article surfaces and provides a framework to address the policy issues implicated by introducing of ZKP governance tools into existing law and practice.

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I. INTRODUCTION

According to a recent legal filing by TargetSmart, a data-based Democratic campaign consulting firm, representatives of GHP, an investment firm, approached it to express an interest in funding potential partnerships or mergers.[1] As part of the due diligence involved in the subsequent negotiations, the investment firm sought the disclosure of information that "TargetSmart believed . . . went beyond what was required to appraise TargetSmart's business . . . ."[2] After failing to identify other methods to resolve uncertainty about the TargetSmart firm's value—a common challenge for innovative firms needing to verify to potential acquirers, investors, or partners, the value or novelty of their source code, their margins, or their customer base—TargetSmart disclosed confidential business information. This included the proprietary digital code that powered their "VoterBase" and "VoterFile 2.0" products, client information, the terms of third-party relationships, and vendor agreements. Shortly thereafter, it was revealed in a complaint that GHP represented TargetSmart's chief competitor and allegedly had violated the terms of its contractual nondisclosure agreement (NDA) by leaking the confidential information to that rival.[3]

This episode illustrates a problem pervasive in the information age: proving specific facts, knowledge, or capacity to others frequently involves a costly choice. The first option is that parties can disclose information beyond the elements sought to be proven; yet considerations of privacy or security, circumvention or gaming concerns, and other confidentiality needs often make such overdisclosure undesirable. Alternatively, parties can choose not to disclose, which can exclude individuals from participatory opportunities, preclude firms from attracting capital or engaging in valuable partnerships, and thwart important public and private oversight. This Article calls these problems "verification dilemmas."

Verification dilemmas appear across the legal landscape. This Article examines four such contexts. Individuals seeking to prove specific attributes that are required to access certain opportunities (such as legal age, financial capacity, or other attributes required to access digital spaces or databases) must frequently disclose not merely the attribute but also their identity. This system, in turn, raises distinct privacy and security risks that the individuals must endure or otherwise forgo access to the opportunity. Similarly, potential deal partners, like TargetSmart, must reveal sensitive information about customers, models or data sets or otherwise relinquish valuable economic opportunities. Public policymakers face a choice between revealing the algorithms used in regulation, thereby potentially rendering those algorithms circumventable and ineffective or otherwise sacrificing opportunities for public transparency and

1. Complaint, TargetSmart Holdings, LLC v. GHP Advisors, LLC, at *1, No. 18-cv-11365 (D. Mass., Jun. 6, 2018).

2. *Id.* at *8.

3. *Id.* at *2.

oversight. Litigants in trade secret disputes can divulge their proprietary information to their adversaries, exposing the information to further leaks, misappropriation, or even the loss of legal protection or otherwise decide to keep it private and fail to offer evidence in support of their claims.

Legal solutions that seek to address verification dilemmas by limiting the costs of overdisclosure have proven only partially effective. Privacy law's restrictions on the use of personally-identifiable information are uneven at best and have failed to prevent the large-scale aggregation, unauthorized use, and recurring leaks of personal data. Trade secret law poses limited restraints on the use or disclosure of proprietary business information once it is shared with other parties. But trade secret misappropriation claims are not available for all confidential business information and are often challenging to track and enforce. Contractual NDAs can also be difficult to enforce. And even when they are enforced, NDAs merely provide an opportunity to receive (hard to prove) damages after a party violates a contract by disseminating confidential information without authorization. NDAs do not prevent the harm of that unauthorized use or dissemination from happening in the first place.

Ideally, then, there would be a way to limit disclosures to the particular fact, knowledge, or capacity being verified. Individuals could prove attributes about themselves without disclosing their identity. Public and private entities could verify compliance with certain requirements without revealing underlying details about data or algorithms that policy considerations deem sensitive. Firms could prove to potential acquirers, investors, or partners—including competitors—their financial margins, or that their source code operates as claimed, or that their innovative methods differ from those of their rivals, without disclosing the proprietary information itself. Litigants could establish similarities or dissimilarities between their alleged trade secrets without either party having to reveal their proprietary information to the other.

Zero-knowledge proofs (ZKPs) are mathematical objects designed to facilitate just that type of limited disclosure. First conceived by a group of researchers in 1985, including one of this Article's authors,[4] ZKPs provide a class of cryptographic protocols that take place between a "prover" and a "verifier." These protocols allow for the validation of a claim, fact, capacity, or identity, without requiring the "prover" to reveal to the "verifier" any underlying information beyond the validity of the assertion in itself. ZKPs thus allow for verification without overdisclosure: a characteristic of secret information can be verified as true, without revealing the actual secret. In a

4. *See generally* Shafi Goldwasser, Silvio Micali & Charles Rackoff, *The Knowledge Complexity of Interactive Proof-Systems*, 17 PROC. ANNUAL ACM SYMPOSIUM ON THEORY OF COMPUTING 291 (1985).

straightforward application, for example, an individual could use ZKP protocols to prove for legal purposes that they were of the age of majority without revealing their name or any other personal information linking that age to their identity, including even the birthday itself.

Until very recently, ZKPs have been considered as more a theoretical construct than a protocol efficient enough to use in complex applications.[5] But ZKPs' practical power has now been demonstrated by their application to the blockchain, where they have provided a privacy and anonymity backbone to the technology. ZKPs currently provide a means to keep specifics about private blockchain transactions from outside observers, even while the transactions occur on the public network.[6] More broadly, leading technology firms are increasingly using ZKPs to develop products that can protect individuals' detailed financial information when proving capacity for a loan,[7] promote compliance with privacy regulation by replacing data with proofs about that data,[8] or enable enterprises to use public blockchain technology to protect data confidentially in everything from banking to supply chain tracking.[9] Computer scientists have explored the capacity of ZKP protocols to

5. Mark C. Suchman, *Invention and Ritual: Notes on the Interrelation of Magic and Intellectual Property in Preliterate Societies*, 89 COLUM. L. REV. 1264, 1268 n.21 (1989) (opining that although contemporary work on "zero-knowledge proofs" suggests that the phenomenon of the disclosure paradox "may be theoretically surmountable," the "relevance of such abstract findings to real-world knowledge markets, however, is limited at best"); *see also* Mike Jenkins, *3 Real World Applications of Zero Knowledge Proofs*, COINBUREAU.COM (Oct. 25, 2018), https://www.coinbureau.com/adoption/applications-zero-knowledge-proofs/ ("Only now in 2018, more than 30 years after its inception, is [ZKP technology] being widely used in a practical way.").

6. The Zcash token model is the most well-known. *See* https://z.cash/the-basics (last visited Apr. 4, 2022) ("Like Bitcoin, Zcash transaction data is posted to a public blockchain; but unlike Bitcoin, Zcash gives you the option of confidential transactions and financial privacy through shielded addresses.").

7. *See ING launches Zero-Knowledge Range Proof solution, a major addition to blockchain technology*, ING (Nov. 16, 2017), https://www.ingwb.com/en/insights/distributed-ledger-technology/ing-launches-major-addition-to-blockchain-technology (promoting a product that allows verification of financial capacity within a required "range" without disclosing underlying data).

8. Ian Allison, *Deloitte Adds Privacy Tech to Its Education-Credentials Blockchain*, COINDESK (Oct. 29, 2019), https://www.coindesk.com/markets/2019/10/29/deloitte-adds-privacy-tech-to-its-education-credentials-blockchain/ (discussing Deloitte's use of technology allowing verification of educational qualifications without revealing personal details, aiming to comply with the requirements of the European Union's General Data Protection Regulation).

9. Jonathan Rouach, Data Privacy is Forever Changed. Zero-knowledge Proofs are Enterprise's Solution, FORKAST.NEWS (Jan. 22, 2020), https://forkast.news/data-privacy-is-forever-changed-zero-knowledge-proofs-are-enterprises-solution-opinion/ (quoting Jonathan Rouach, QEDIT's CEO) ("[A] supply chain consortium can deploy blockchain technology to track assets along a supply route, without displaying sensitive transactional

verify voting systems while preserving voter confidentiality[10] and to monitor compliance with nuclear agreements.[11] The Defense Department is developing ZKPs as an accountability tool for circumstances in which "the highest levels of privacy and security are required to protect a piece of information, but there is still a need to prove the information's existence and accuracy."[12]

Despite these developing applications and their implications for a swath of thorny legal issues involving the balance between confidentiality and disclosure, the legal literature has paid scant attention to ZKP cryptography. To date, the scholarship reveals only a few dozen mentions of the term[13] and only two examples of substantive engagement.[14] This Article seeks to remedy that gap in the literature in three ways. First, it provides an explanation, aimed at a legal audience, of ZKPs' conceptual power and operational characteristics. Second, it explores verification dilemmas across a range of concrete legal contexts and demonstrates how ZKPs can work in these contexts. Third, it surfaces and examines the policy issues raised by introducing ZKPs as a governance tool to augment (and potentially replace) existing law and practice.

Part II frames the idea of verification dilemmas that law and policy have sought to address. Such problems—in which a party is faced with an all-or-nothing choice between costly or undesirable overdisclosure of information, or no disclosure at all—pervade legal inquiry. This Part explores four disparate

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details that reveal confidential information pertaining to trading partners, sales volume, or pricing.").

10. Somnath Panja & Bimal Kumar Roy, *A Secure End-to-End Verifiable E-Voting System Using Zero Knowledge Based Blockchain*, 2018 IACR CRYPTOLOGY (2018), https://eprint.iacr.org/2018/466.pdf.

11. *See* Alexander Glaser, Boaz Barak & Robert J. Goldston, *A Zero-Knowledge Protocol for Nuclear Warhead Verification*, 510 NATURE 497 (2014).

12. *Generating Zero-Knowledge Proofs for Defense Capabilities: Program Aims to Advance Method for Making Public Statements Without Compromising Sensitive Underlying Information*, DEFENSE ADVANCED RSCH. PROJECTS AGENCY (July 18, 2019), https://www.darpa.mil/news-events/2019-07-18.

13. WESTLAW, https://1.next.westlaw.com/Search/Home.html (last visited Oct. 1, 2020).

14. The first, Joshua A. Kroll, Joanna Huey, Solon Barocas, Edward W. Felten, Joel R. Reidenberg, David G. Robinson & Harlan Yu, *Accountable Algorithms*, 165 U. PA. L. REV. 633, 668–69 (2017), includes zero-knowledge proofs in a suite of computer-science tools useful for ex post algorithmic accountability, in particular as a means for ensuring procedural regularity in algorithmic decision-making and for testing properties of the underlying algorithmic policy, *id.* at 673 ("[P]ublished commitments and zero-knowledge proofs allow overseers and the public at large to verify that the decisions of some authority actually correspond to a specific predetermined policy rather than the arbitrary whim of a decisionmaker."). The second, Yuqing Cui, Note, *Application of Zero-Knowledge Proof in Resolving Disputes of Privileged Documents in E-Discovery*, 32 HARV. J. L. & TECH. 633 (2019), provides a description of the technology and proposes the use of ZKPs to help resolve claims of privilege in e-discovery.

contexts in which these dilemmas recur: (1) *information privacy and security* and the need to disclose one's identity in order to verify certain personal attributes and permissions; (2) *dealmaking* and the necessity of verifying deal-worthiness by revealing sensitive business information; (3) *government oversight* and the tension with the requirement, in some circumstances, that the secrecy of sensitive government algorithms and data be preserved; and (4) litigation that depends on *trade secrets* yet risks compromising them. In each of these contexts, existing legal remedies are often imperfect and can lead to either costly nondisclosure or harmful overdisclosure.

Part III explains zero-knowledge proofs and the ways in which they can change the all-or-nothing disclosure calculus by permitting verification through the partial revelation of information. This Part provides both a conceptual framework for understanding the power (and limitations) of ZKPs and a technical primer for a legal audience on how ZKPs work. By upending assumptions about the scope of information that needs to be disclosed for verification, ZKPs offer an example of a technology that might allow the unshackling of existing legal approaches from those assumptions.

To work through the ZKPs' promise and the issues their implementation would raise, Part IV explores a series of case studies posing verification problems from the four contexts discussed in Part II. For each context, cases are divided into "easier use" cases in which ZKPs have garnered notice to date, and "harder use" novel cases. As a practical matter, these cases suggest the ways that ZKPs might enhance the protection of personal privacy and data security, enable an entire class of beneficial transactions that currently do not occur, promote government accountability by changing the calculus in contexts in which circumvention or gaming concerns undergird public secrecy, and permit the litigation of meritorious legal claims while precluding gaming and curtailing unscrupulous actors. Importantly, applying ZKPs in each of these contexts would reduce but not entirely eliminate the need for trust. As discussed throughout the Article, a ZKP must be accompanied by an additional guarantee that the data considered in the mathematical proof are the same as the objects considered in the legal verification dilemma. The mechanisms to provide that additional guarantee would need to be context-specific.

Finally, Part V considers the policy implications of these case studies for the use of ZKPs as an information governance tool and develops a framework for designing and evaluating appropriate ZKP tools for specific legal, technological, or institutional solutions to verification dilemmas. It also discusses the range of policy choices around disclosure which, in turn, challenges the existing policy balance between disclosure and secrecy. This balance is rooted in assumptions about the technical capacity for verification that ZKPs may supersede. Surfacing these altered presumptions is necessary to enable critical policy discussions about whether ZKPs should be used in a particular context, what information should be disclosed or kept secret, and how these decisions should be made.

II. VERIFICATION DILEMMAS AND THE LAW

Law is full of verification and trust problems. Verifying facts about information to an untrusting party, such as a potential contracting partner or a litigation adversary, often requires disclosing a substantial amount of sensitive information. If undertaken, the disclosure in turn creates risks that the disclosed information will be misused. Different legal doctrines attempt to solve verification dilemmas in different ways.

This Part presents examples of verification dilemmas drawn from four doctrinal contexts: information privacy and security; dealmaking; government oversight; and trade secret litigation. Although these examples implicate a wide range of policy concerns and legal rules, they all revolve around the core issue of how to verify facts about information while protecting the information from misuse. Importantly, the legal rules on which each of these doctrines relies to solve the verification problem are imperfect. On the one hand, where current legal practice requires or encourages disclosure, the law often seeks to deter post-disclosure misuse of information by offering ex post remedies. However, those remedies are available solely when misuse is detected, and they can be prohibitively costly to pursue. On the other hand, where current legal practice restricts or discourages disclosure, the law sacrifices the trust and verifiability that transparency could provide.

Examining each of the examples below through the lens of the verification dilemma offers a new way of thinking about and analyzing these legal doctrines. More specifically, it exposes certain shared organizing assumptions behind these seemingly-disparate legal rules—a revelation which in turn raises the possibility of devising novel, transdoctrinal solutions to the verification problems that current legal rules are designed to address.

A. INFORMATION PRIVACY AND SECURITY: LINKING VERIFICATION WITH IDENTIFICATION

1. *Verification Dilemmas*

A key set of verification dilemmas involve the linkage between verification and identification. In current practice, persons seeking to verify particular facts—for instance, that they are over eighteen years of age, are citizens of the United States, have rights to access digital spaces, or possess certain financial capacity—must frequently reveal other information about who they are.[15] These disclosures are costly in terms of privacy and data security.

As to privacy, revealing who one is exposes unnecessary additional private information to the recipient. More significantly, the amalgamation of large quantities of data online compounds the threat from even apparently small but unnecessary additional disclosures. A mere name disclosure can link a real-world individual and their "digital person"—the "extensive aggregations of data about a person in many databases."[16] For instance, the link could expose private medical information, location histories, or educational records in inappropriate contexts.[17] Because one's personal identity is generally fixed throughout life, disclosing one's personal identity to verify limited personal attributes has particular costs in the big data era. As Dan Solove explains, if aggregation permits the creation of the "digital person," identification "goes a step further—it links the digital person directly to a person in real space."[18] The pernicious nature of this linkage can extend even further, as identification systems "piggyback" on one another, reproducing and reinforcing judgments made about, and now linked to, a person's identity.[19]

Excessive data aggregation also has repercussions beyond potentially harming the individuals whose data are aggregated. It allows the aggregator to discern trends in communities as well as individuals, and use the acquired knowledge to potentially harm third parties or the population at large.[20] If personal identity information were less frequently revealed, then aggregating data at a community level would be harder and thus potentially more limited.

Furthermore, the overdisclosure of personal information, typical of traditional means of user authentication, expands the data exposed to

15. Maria Dubovitskaya, *Take Back Control of Your Personal Data*, TED (Oct. 2015), https://www.ted.com/talks/maria_dubovitskaya_take_back_control_of_your_personal_data#t-1760 ("Whether buying a bottle of wine, making an online purchase or going to a movie, most of us share far more information than is necessary: birthdates, credit card numbers, addresses.").

16. Daniel J. Solove, *A Taxonomy of Privacy*, 154 U. PA. L. REV. 477, 511, 513 (2006).

17. HELEN NISSENBAUM, PRIVACY IN CONTEXT: TECHNOLOGY, POLICY, AND THE INTEGRITY OF SOCIAL LIFE 129 (2010) (discussing how privacy harms occur when "context-relative informational norms" are violated).

18. Solove, *supra* note 16, at 513.

19. *See* JIM HARPER, IDENTITY CRISIS: HOW IDENTIFICATION IS OVERUSED AND MISUNDERSTOOD 77–80 (2006) (discussing decisions by one institution determining the "suitability" of whether to adopt identification decisions by other institutions).

20. *See, e.g.*, Matthew Hindman, *How Cambridge Analytica's Facebook Targeting Model Really Worked—According to the Person Who Built It*, THE CONVERSATION (Mar. 30, 2018), https://theconversation.com/how-cambridge-analyticas-facebook-targeting-model-really-worked-according-to-the-person-who-built-it-94078.

vulnerabilities in security and management. Whether through malicious data breaches, error-based data breaches, or weaknesses in integrated third-party systems that store or transmit passwords, the costs of data theft or misuse are daunting.[21] Over 33% of adults in the United States have experienced identity theft, the act of impersonating others' identities by presenting stolen identifiers or proofs of identity, leading to significant financial and reputational harm.[22] Moreover, one in five companies (19%) that suffered a malicious data breach was infiltrated because of stolen or compromised personal credentials.[23]

2. *Imperfect Legal Responses*

Despite these costs, current law and policy often come down on the side of permitting or mandating the overdisclosure involved when identification is required for verification. Privacy threats cede to the benefits of accuracy, security, administrability, and efficiency understood to inhere in such overinclusive means of verification. U.S. privacy law recognizes the sensitivity of "personally identifiable information" (PII).[24] Yet it does not generally address the precedent issue of whether identification should occur at all. PII generally acts as a regulatory trigger: privacy laws largely apply only once PII is collected. These laws do not control whether PII is initially collected.[25]

To be sure, policymakers have recognized the costs engendered by the overdisclosures currently required for verification. Policymakers have also specifically recognized the dangers of linking verification and identification. Privacy law explicitly seeks legal solutions to mitigate the risks, but to date those solutions are imperfect. For instance, legal requirements to protect PII

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21. *See, e.g.*, *US Expected to Break Data Breach Record in 2021*, SEC. MAG. (Oct. 15, 2021), https://www.securitymagazine.com/articles/96318-us-expected-to-break-data-breach-record-in-2021.

22. *Global Cybersecurity Awareness Survey Reveals 33 Percent of U.S. Respondents Have Experienced Identity Theft, More than Twice the Global Average*, PROOFPOINT (Oct. 11, 2018), https://www.proofpoint.com/us/newsroom/press-releases/global-cybersecurity-awareness-survey-reveals-33-percent-us-respondents-have.

23. IBM SEC., COST OF A DATA BREACH REPORT 2020 9 (2020) https://www.ibm.com/security/digital-assets/cost-data-breach-report/#/ (calculating the average cost of a data breach at almost $4,000,000).

24. Paul M. Schwartz & Daniel J. Solove, *The PII Problem: Privacy and a New Concept of Personally Identifiable Information*, 86 N.Y.U. L. REV. 1814, 1816 (2011). The European General Data Protection Regulation (GDPR), focuses on the category of "personal data"—defined as "any information relating to an identified or identifiable natural person," Commission Regulation 2016/679, 2016 O.J. (L 119) (EU), at art. 4(1) [hereinafter GDPR].

25. *See, e.g.*, California Consumer Privacy Act of 2018, CAL. CIV. CODE §§ 1798.100–199.100 (West 2021) [hereinafter CCPA] (providing consumers with a right to know what information is collected about them and a right to opt-out of resale of that information but imposing no other limits on the initial scope of collection).

by mandating anonymization prior to data redistribution are infamously unreliable.[26] They are unreliable because existing technical strategies for performing anonymization are weak and can often be defeated by counter-technical measures.[27] Similarly, laws requiring "notice and consent" before PII may be collected or used have been shown to be ineffective both in communicating the risks to those whose information is at issue and in providing an alternative that would make consent meaningful.[28] Although ex post data breach notification requirements and penalties for failure to maintain "reasonable" security practices[29] seek to provide financial and reputational incentives for better security, such requirements do not address information collection in the first place.

Furthermore, in some cases legal measures intended to protect consumer privacy require verification by means of identification. For example, the California Consumer Privacy Act[30] requires businesses to provide customer access to information about the data kept about them—a privacy-preserving provision intended to foster individual control of information.[31] However, the law provides that the access right is triggered only by consumers' "verifiable"

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26. *See generally* Latanya Sweeney, *Simple Demographics Often Identify People Uniquely* (Carnegie Mellon Univ., Data Privacy Working Paper No. 3, 2000), https://dataprivacylab.org/projects/identifiability/paper1.pdf (conducting groundbreaking research on the large percentage of the population that can be uniquely identified by ZIP code, birth date, and gender); *see* Paul Ohm, *Broken Promises of Privacy: Responding to the Surprising Failure of Anonymization*, 57 UCLA L. REV. 1701, 1705 (2010) (discussing the literature on reidentification and the ways in which it will amplify privacy harms because "[r]eidentification combines datasets that were meant to be kept apart, and in doing so, gains power through accretion" that "makes all of our secrets fundamentally easier to discover and reveal").

27. Ohm, *supra* note 26, at 1717–22 (describing examples of deanonymization).

28. Lindsey Barrett, *Model(ing) Privacy: Empirical Approaches to Privacy Law and Governance*, 35 SANTA CLARA COMPUT. & HIGH TECH. L.J. 1, 17–20 (2018) (summarizing studies that find, among other things, that most consumers do not understand basic facts about the use of their data); Ehimare Okoyomon, Nikita Samarin, Primal Wijesekera, Amit Elazari Bar On, Narseo Vallina-Rodriguez, Irwin Reyes, Álvaro Feal & Serge Egelman, *On The Ridiculousness of Notice and Consent: Contradictions in App Privacy Policies*, IEEE WORKSHOP ON TECH. & CONSUMER PROTECTION (2019), https://www.ieee-security.org/TC/SPW2019/ConPro/papers/okoyomon-conpro19.pdf (discussing the gaps between disclosed data collection practices as articulated in privacy policies and de facto data collection practices as observed using dynamic analysis tools); *see* Jonathan A. Obar & Anne Oeldorf-Hirsch, *The Biggest Lie on the Internet: Ignoring the Privacy Policies and Terms of Service Policies of Social Networking Services*, 23 INFO., COMM. & SOC. 1, 25 (2018) (noting that of more than 500 surveyed users, 93% accepted a first-born child assignment term and 98% ignored or missed it).

29. *See, e.g.*, CAL. CIV. CODE §§ 1798.81.5(a)–(b) (obligating a company that processes personal information about a California resident "to implement and maintain reasonable security procedures and practices" appropriate to the nature of the information it processes).

30. CAL. CIV. CODE §§ 1798.100–199.100 (West 2021) .

31. *Id.* § 1798.100(a).

access requests.[32] This seems to require that both the data and request are associated with or "linkable" to the requestor's legal identity.[33]

In sum, a recurring challenge for privacy and security is to enable persons to verify facts about themselves or authenticate their rights of access while limiting the risks of revealing one's identity or other sensitive information. As Maria Dubovitskaya, a cryptographer at IBM's Research Lab, puts it: "If your personal data is never collected, it cannot be stolen."[34] To date, legal rules have had little success in promoting this goal.

B. DEALMAKING: VERIFICATION AND ARROW'S PARADOX

1. *Verification Dilemmas*

The *TargetSmart* case described at the beginning of this Article[35] underscores a type of recurring verification dilemma involving confidential or sensitive business information. Specifically, a target firm or potential partner is faced with a quandary during the due diligence process: The party must disclose enough information to convince the other party—often a rival—to enter deeper negotiations or engage in the transaction. At the same time, this information—including source code, proprietary processes, customer data and contracts, and pricing information—is often confidential and sensitive yet sometimes unprotected by traditional forms of intellectual property protection. This dilemma occurs in a variety of contexts, such as seeking venture funding or negotiating a merger, acquisition, partnership, or joint venture.

This bind exemplifies what economist Kenneth Arrow termed the "fundamental paradox" of information disclosure.[36] Professors Gill and Parchmovosky summarized Arrow's point in the following manner: "information that is not afforded legal protection," such as sensitive business information that is not a trade secret, "cannot be bought or sold on the market" because "in order to sell the information, [a seller] must disclose it to the potential buyer; but once she does, she has nothing left to sell."[37] Because the disclosure of information vitiates its control, revealing information when

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32. *Id.* § 1798.100(c).

33. *See* Rebecca Iafrati, *Can the CCPA Access Right Be Saved? Realigning Incentives in Access Request Verification*, 20 J. TECH. L. & POL. 25, 25–27 (2020).

34. Dubovitskaya, *supra* note 15.

35. *See supra* in Part I.

36. Kenneth J. Arrow, *Economic Welfare and the Allocation of Resources for Invention*, *in* THE RATE AND DIRECTION OF INVENTIVE ACTIVITY: ECONOMIC AND SOCIAL FACTORS 609, 615 (Nat'l Bureau of Econ. Rsch. ed., 1962).

37. Oren Bar-Gill & Gideon Parchomovsky, *Law and the Boundaries of Technology-Intensive Firms*, 157 U. PA. L. REV. 1649, 1653–54 (2009).

disclosure is necessary for verification creates risks of appropriation of proprietary information. When the risk of disclosure is judged too great, the verification dilemma will impede value-creating transactions.[38]

Although this "fundamental paradox" threatens information exchange generally, the possibility for appropriation of sensitive information is particularly menacing in the dealmaking context, where acquiring firms, potential funders, and promising partners are often rivals, or at least operate in a similar business niche. To make matters worse, sometimes, as in *TargetSmart*, "competitors can initiate M&A discussions as a strategic tactic to gain access to sensitive proprietary information and to exploit that information at the expense of the disclosing party."[39]

2. *Imperfect Legal Responses*

With few exceptions—notably when sharing proprietary information with rivals can raise antitrust concerns[40] or constitute contractual breach of confidentiality clauses[41]—the law reflects a policy choice to leave decisions to disclose many categories of proprietary information to private ordering. Most concretely, significant swaths of sensitive information are left unprotected by intellectual property law once it is disclosed.

The law reflects the costs of disclosure by recognizing the enforceability of contractual NDAs into which parties may enter before negotiations begin.[42]

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38. Michael J. Burstein, *Exchanging Information Without Intellectual Property*, 91 TEX. L. REV. 227, 242 (2012) ("An inventor seeking funds or development expertise may be reluctant to disclose information about her invention for fear that the recipients of the information can take it for themselves. On the other side of the transaction, the funders or developers will be unwilling to commit money or resources to the project unless or until they can assess its value.").

39. Jason Bullen & Xi Chen, *Managing Disclosure Risk in M&A Transactions*, MANDAQ (Apr. 26, 2017), https://www.mondaq.com/canada/maprivate-equity/588906/managing-disclosure-risk-in-ma-transactions.

40. *See, e.g.*, Holly Vedova, Keitha Clopper & Clarke Edwards, *Avoiding Antitrust Pitfalls During Pre-Merger Negotiations and Due Diligence*, COMPETITION MATTERS (Mar. 20, 2018, 4:57 PM), https://www.ftc.gov/news-events/blogs/competition-matters/2018/03/avoiding-antitrust-pitfalls-during-pre-merger (noting that the Commission "looks carefully at pre-merger information sharing to make sure that there has been no inappropriate dissemination of or misuse of competitively sensitive information for anticompetitive purposes").

41. Aaron Binstock, *10 Considerations to Protect Confidential Information When Selling Your Company*, LEXOLOGY (Mar. 5, 2015), https://www.lexology.com/library/detail.aspx?g=6960d8dc-61f0-4659-9a0c-7e4d4d40bd69 (noting that, in due diligence, "it is possible to breach a contract just by disclosing its existence").

42. *See* Henry Lesser, Ann Lederer & Charles Steinberg, *Increasing Pressures for Confidentiality Agreements that Work*, MERGERS & ACQUISITIONS, Mar.–Apr. 1992, at 23, 23 (describing the basic function of the agreement as "protecting sellers against misuse of confidential information").

As a remedy for the dilemma of verification, however, such ex post legal remedies are imperfect at best.[43] NDAs are difficult to enforce for reasons ranging from the cost and complexities of proof—that is, was an idea or method stolen or derived independently?—to the establishment of the secrecy of the underlying material.[44]

Even when NDAs are enforceable, they merely provide an opportunity to receive damages after a violation has occurred through unauthorized dissemination of confidential information. They do not prevent the harm of such use or dissemination from happening in the first place. And they are not enforceable against third parties with whom the negotiating partner might have shared sensitive information. Moreover, NDAs cannot prevent the transfer of "knowledge spillovers" inherent in sharing information, which occur even if the recipients never leak or knowingly misuse that information. Information cannot be unseen, and an NDA cannot prevent the proliferation of knowledge gains that mere viewing may precipitate. Finally, in a variety of contexts, such as in venture capital, imbalances in negotiating power have allowed the development of customs by which parties refuse to sign NDAs.[45]

According to Michael Burstein, the challenge for firms seeking to protect sensitive information while preserving their ability to attract transaction partners lies in finding "some kind of optimum level of appropriability that allows for (a) sufficient information to be transferred to link ideas with capital

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43. Practical "best practices" in due diligence are often similarly incomplete. The use of "clean rooms," by which companies in negotiations can post sensitive information viewable to a limited number of the opposing party's representatives, may offer technical protections against direct copying of documents or other materials. But clean rooms do not eliminate the reality that the material is being viewed by outsiders who, even if they are acting in good faith, are specifically charged with relaying pertinent information to decisionmakers in their firms. The cognitive reality is that once innovative information is understood, it cannot be "unlearned."

44. *See, e.g.*, nClosures Inc. v. Block and Co., Inc., 770 F.3d 598, 602 (7th Cir. 2014) (refusing to enforce a nondisclosure agreement entered into before plaintiff shared propriety designs and manufacturing knowledge with defendant during negotiations to form a partnership because, inter alia, plaintiff had previously provided its design files to a third-party company that initially manufactured its products without requiring confidentiality agreements).

45. Sergio Marrero, *Why Venture Capitalists Don't Sign NDAs*, MEDIUM.COM (Aug. 19, 2019), https://medium.com/rbl1/why-venture-capitalists-dont-sign-ndas-c87e331a5505; Guy Kawasaki, *The Venture Capitalist Wishlist*, (Jan. 16, 2006), https://guykawasaki.com/the_venture_cap-2 ("Before you even start addressing the hard stuff, never ask a venture capitalist to sign a non-disclosure agreement (NDA). They never do. This is because at any given moment, they are looking at three or four similar deals. They're not about to create legal issues because they sign a [sic] NDA and then fund another, similar company—thereby making the paranoid entrepreneur believe the venture capitalist stole his idea. If you even ask them to sign one, you might as well tattoo 'I'm clueless!' on your forehead.").

and development partners while (b) ensuring that enough value remains in the original information holder so that she still has an incentive to disclose."[46] Burstein suggests two options to balance these interests. First, especially in contexts in which confidential knowledge is tacit, transacting firms can choose to "codify"—and therefore make transferable—only certain aspects of the confidential knowledge. Second, firms can selectively disclose information by "partition[ing] their information so as to reveal some but not all of the relevant information to counterparties"; for example, firms can use modularity in software design to shield certain portions.[47]

As we discuss below in Part III, ZKPs promise to become a powerful enabler and enhancer of Burstein's approach: They allow the secret-holder to disclose partial information about the secret without disclosing the rest, all while reassuring the recipient of the disclosed information that what was disclosed is a valid portion of the secret.

C. Government Oversight: Verification and Data/Algorithmic Accountability

1. *Verification Dilemmas*

Another set of verification dilemmas arise from the fact that the public interest in government accountability through transparency can clash with perceived needs to keep details about data and algorithms secret. Regulator-regulate data exchanges illustrate this tension. Consider Federal Reserve stress tests as a particularly poignant and high-impact example. The Dodd-Frank Act requires the Federal Reserve to annually conduct stress tests of bank balance sheets, ensuring that they can survive a financial crisis without collapsing.[48] These annual stress tests are of significant consequence for financial institutions because the Federal Reserve is empowered under law to take early remediation measures, including cutting or halting dividends or preventing acquisitions.[49] The Federal Reserve guidelines are extremely complex.[50] The formulation itself is complicated, but the details make it even more so because banks trade in securities of uncertain value that require parsing to evaluate risk;

46. Burstein, *supra* note 38, at 254.

47. *Id.*

48. Dodd-Frank Wall Street Reform and Consumer Protection Act, Pub. L. No. 111–203, § 165(h)(4)(i) (2010).

49. *Id.* § 166(c)(2).

50. *See Supervisory Stress Test Framework and Model Methodology, Dodd-Frank Act Stress Test 2019: Supervisory Stress Test Results June-2019*, BD. OF GOVERNORS OF THE FED. RSRV. SYS. (Jul. 16, 2019), https://www.federalreserve.gov/publications/june-2019-supervisory-stress-test-framework-and-model-methodology.htm.

since these securities are often illiquid and opaque, the essence of the stress test is ensuring the validity of these calculations.

Despite the importance of these exchanges, this process is surrounded with an enormous amount of secrecy. To start, the tests and scoring criteria are secret.[51] James McAndrews, the chief of research at the Federal Reserve Bank of New York, noted that this secrecy is necessary because publicly disclosing the test's details would make it easier for banks to circumvent the test.[52] Furthermore, banks are not required to disclose much information to the public about their results. Scholars have argued that this too serves a purpose, because too much disclosure would incentivize poor behavior by individual managers, such as holding on to suboptimal loans to game a test.[53] Yet, though the secrecy serves a purpose, it comes with costs. The banks have found that their numbers diverge with the Federal Reserve due to the secrecy of the tests themselves, which results in significant annual controversy.[54] A Government Accounting Office (GAO) report also noted that a lack of transparency risked undermining the stress test's efficacy by inhibiting compliance.[55] At the same time, the lack of transparency may reduce public trust in the regulatory agency, especially when the same secrecy necessary to avoid circumvention introduces risks of regulatory capture because there is no one to watch the watchmen.[56]

Government accountability and transparency can also stand in direct conflict with the need to preserve individuals' privacy. Quintessential examples are government policy decisions based on direct polling of private and identifying information about individuals (such as in the decennial census) or, alternatively, on scientific studies that are in turn based on protected (e.g., medical) information. For instance, this conflict is at the base of controversy

51. Victoria McGrane, *Fed Stands Firm Against Revealing Bank Stress-Test Model*, WALL ST. J. (June 24, 2015), https://blogs.wsj.com/economics/2015/06/24/fed-stands-firm-against-revealing-bank-stress-test-model/.

52. Francine McKenna, *Fed Says Stress Test Models Will Stay a Secret*, MARKETWATCH (June 25, 2015), https://www.marketwatch.com/story/fed-says-stress-test-models-will-stay-a-secret-2015-06-25.

53. Itay Goldstein & Haresh Sapra, *Should Banks' Stress Test Results be Disclosed? An Analysis of the Costs and Benefits*, 8 FOUND. & TRENDS FINANCE 1, 44–47 (2014).

54. *Id.*

55. U.S. GOV'T ACCOUNTABILITY OFF., GAO-17-48, ADDITIONAL ACTIONS COULD HELP ENSURE THE ACHIEVEMENT OF STRESS TEST GOALS 90 (2016).

56. For example, in 2014 Carmen Segarra, a former Federal Reserve employee, blew the whistle on Federal Reserve support granted to Goldman Sachs to circumvent their shortcomings for several years. *See* Nathaniel Popper & Peter Eavis, *Secret Goldman Sachs Tapes Put Pressure on New York Fed*, DEALBOOK (Oct. 2, 2014), https://dealbook.nytimes.com/2014/10/02/secret-goldman-sachs-tapes-put-pressure-on-new-york-fed/.

around a recent Environmental Protection Agency rule requiring researchers to disclose the raw data involved in their public health studies before the agency could rely upon their research conclusions.[57]

Beyond data, government reliance on algorithms can also present verification dilemmas. For example, in 2013, a GAO report indicated that the IRS was using "inappropriate" means to audit certain 501(c)(4) organizations that it believed might be abusing their tax-exempt status to engage in prohibited political activities.[58] Specifically, the IRS was using certain keywords in the names of the nonprofit filings as a factor in whether the applications merited further review, such as "tea party."[59] Although progressive applicants were also subject to review, conservative groups appeared to receive greater scrutiny as measured by the different rates by which the groups were flagged for further review, leading to accusations of bias.[60] Put another way, the IRS had an audit algorithm[61] that had a need for public accountability to ensure it did not have a particular deleterious characteristic. The simple solution is to have a public audit or a trusted entity like the GAO publish a report. However, a public audit would not be feasible because exposing any IRS audit mechanism would make it easier to circumvent, risking an increase in tax fraud. And while the GAO may be highly competent and nonpartisan, at least some of the public may not trust the government to audit itself.

Another particularly high stakes instance of verification dilemmas concerns algorithms used in the criminal legal system to perform surveillance, conduct investigations, analyze forensic evidence, or predict risk of future offenses to guide pretrial incarceration and sentencing decisions. Life, liberty, police accountability, constitutional privacy, racialized mass incarceration, and public safety are all on the line.[62] Criminally accused persons have powerful

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57. Strengthening Transparency in Pivotal Science Underlying Significant Regulatory Actions and Influential Scientific Information, 86 FED. REG. 469 (Jan. 6, 2021) (to be codified at 40 C.F.R. pt. 30).

58. TREASURY INSPECTOR GEN. FOR TAX ADMIN., INAPPROPRIATE CRITERIA WERE USED TO IDENTIFY TAX-EXEMPT APPLICATIONS FOR REVIEW 5 (2013), https://www.treasury.gov/tigta/auditreports/2013reports/201310053fr.pdf.

59. *Id.* at 6.

60. John D. McKinnon, *IRS Inspector Firm on One-Sided Targeting*, WALL ST. J. (June 27, 2013), https://www.wsj.com/articles/SB10001424127887323873904578571363311816922 ("Internal Revenue Service employees flagged for extra scrutiny fewer than a third of progressive groups applying for tax exemptions from mid-2010 through mid-2012, compared with 100% of conservative applicants.").

61. *See* PEDRO DOMINGOS, THE MASTER ALGORITHM: HOW THE QUEST FOR THE ULTIMATE LEARNING MACHINE WILL REMAKE OUR WORLD 1 (2015) ("An algorithm is a sequence of instructions telling a computer what to do.").

62. For a compelling recent critique of risk assessment instruments that rely on carceral data and discredit community knowledge sources, see Ngozi Okidegbe, *Discredited Data*, 107

constitutional, statutory, and common law rights to scrutinize and test the evidence against them, including outputs from investigative[63] and forensic software tools.[64] Moreover, the public has an interest in democratic oversight of police and forensic technologies and the criminal court proceedings that rely on them, in part to ensure accurate outcomes that properly balance protections for individual rights and public safety.[65]

Meanwhile, there can be compelling security reasons to maintain some secrecy concerning some algorithms used in the criminal legal system. For instance, if algorithms that flag suspicious activity associated with illegal trading were publicly disclosed, then it would be easier for insider traders to avoid getting caught.[66] Likewise, if algorithms used to identify child sexual abuse materials (CSAM) on the internet were publicly disclosed, then it would be easier for CSAM possessors and distributors to evade detection.[67] Yet even legitimate secrecy interests can conflict with criminal defendants' rights to scrutinize the evidence against them and with the public's interest in oversight of criminal proceedings. There is also a risk that law enforcement or algorithm developers might overclaim their secrecy interests, whether due to mistake, exaggeration, or an attempt to evade scrutiny of potential flaws or biases in the algorithms themselves.[68] Courts generally defer to these types of security secrecy claims,[69] so there are few examples of courts ordering disclosure that resulted in the exposure of flaws or biases in the tools.

CORNELL L. REV. (forthcoming 2022), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3835414.

63. *See* Elizabeth E. Joh, *The Corporate Shadow in Democratic Policing: Technology Companies can Elude Accountability*, 374 SCI. 274, 275 (2021).

64. *See generally* Andrea Roth, *Machine Testimony*, 126 Yale L.J. 1972, 1980 (2017) (outlining "testimonial safeguards for machine sources of information").

65. *See generally* Hannah Bloch-Wehba, *Democratic Algorithms* (Feb. 28, 2021) (unpublished manuscript) (on file with the Berkeley Technology Law Journal) (exploring activist group calls for greater public participation in decisions surrounding the use of AI and machine-learning technologies in legal institutions).

66. *See, e.g.*, Todd Ehret, *SEC's Advanced Data Analytics Helps Detect Even the Smallest Illicity Market Activity*, REUTERS (June 30, 2017), https://www.reuters.com/article/bc-finreg-data-analytics-idUSKBN19L28C (describing SEC use of data analytics to detect insider trading).

67. *See generally* Jonathan Manes, *Secrecy & Evasion in Police Surveillance Technology*, 34 BERKELEY TECH. L.J. 503 (2019) (generally describing the anti-circumvention rationale for law enforcement secrecy).

68. *Cf.* United States v. Reynolds, 345 U.S. 1, 9–10 (1953) (warning that in national security context, "judicial control over the evidence in a case cannot be abdicated to the caprice of executive officers"); Herring v. United States; 424 F.3d 384, 386 (3d Cir. 2005) (discussing, though ultimately rejecting, the allegation that the government had fraudulently asserted the state secrets privilege in *Reynolds*).

69. *See, e.g.*, United States v. Pirosko, 787 F.3d 358, 365–67 (6th Cir. 2015).

Nonetheless, the risk of error or misconduct that arises from secrecy surrounding government algorithms can be illustrated by a case in which the secret was ultimately deemed illegitimate and the information was fully disclosed. In 2008, the New York City Office of Chief Medical Examiner (the OCME) began developing the Forensic Statistical Tool (FST), a software program designed to statistically analyze complex mixtures of DNA found at crime scenes.[70] To gain regulatory approval for FST, the OCME conducted over a multi-year development process repeated presentations to the DNA Subcommittee of the New York State Commission on Forensic Science, before beginning to use the program in criminal cases in 2011.[71] New York State criminal courts subsequently relied on the approval by the Forensic Science Commission, along with internal validations conducted by the OCME, to determine that outputs of the FST software program met the requirements for admissibility in court.[72] Meanwhile, the OCME adopted a secretive stance surrounding the program, calling it "proprietary" and refusing to disclose the source code to criminal defense counsel, or even to share an executable copy of the program for independent testing by defense expert witnesses.[73]

In 2016—five years after the implementation of FST in criminal cases—Judge Valerie Caproni of the United States Court for the Southern District of New York held that the OCME did not have a legitimate "proprietary" interest in withholding the FST source code from criminal defense counsel and ordered the OCME to reveal the code under a protective order.[74] A defense expert witness examining the code then identified an undisclosed function that discarded data in certain circumstances without notice to the user, a function not clearly described in publications detailing the FST methodology.[75] The defense witness argued that the undisclosed function must have been added

70. STATE OF N.Y. OFF. OF THE INSPECTOR GEN., INVESTIGATION INTO THE NEW YORK CITY OFFICE OF CHIEF MEDICAL EXAMINER: DEPARTMENT OF FORENSIC BIOLOGY 27–28 (2013), https://ig.ny.gov/sites/g/files/oee571/files/2016-12/OCMEFinalReport.pdf.

71. *Id.* at 28. The New York State Commission on Forensic Science is the regulatory oversight body for the OCME. *See* N.Y. EXEC. LAW § 995-b (McKinney 2018).

72. *See* People v. Williams, 35 N.Y.3d 24, 147 N.E.3d 1131, at *35–36 (Mar. 31, 2020).

73. *See* Rebecca Wexler, *Life, Liberty, and Trade Secrets: Intellectual Property in the Criminal Justice System*, 70 STAN. L. REV. 1343, 1362 n.80 (2018).

74. Order, United States v. Johnson, No. 1:15-cr-00565-VEC (S.D.N.Y. July 6, 2016).

75. Decl. of Nathaniel Adams at 20, United States v. Johnson, No. 1:15-cr-00565-VEC, (S.D.N.Y Oct. 27, 2016).

after the internal validation studies and regulatory approval on which the courts had relied.[76] Thousands of cases were potentially thrown into disarray.[77]

Ultimately, there was no good reason to keep the FST algorithm secret, and hence the OCME's secretive stance was not a true verification dilemma. When secrecy surrounding government information is unjustified or outweighed by countervailing transparency interests, there should be no secret at all.[78] But similar concerns as applied in the FST case also appear in cases where the secrecy interests ca be more credible. In the FST case, the issue at hand boiled down to a relatively simple and well-defined one: Is the evidence presented in court the result of applying the certified (but secret) algorithm to the relevant (known) data?[79] Similar questions can arise with algorithms that must remain secret to stay effective. In addition, there can also be questions about the validity and appropriateness of the algorithms themselves.

2. *Imperfect Legal Responses*

The example of FST described *supra* illustrates how keeping algorithms secret exacerbates the risk of mishandling algorithms that are critical to the legal process, especially in high stakes scenarios like the criminal legal system: A government actor might obtain regulatory approval to use a software system but then alter the software prior to implementation without revalidating the system or seeking additional regulatory approval. Guidance and standards documents for forensic software systems recommend that "significant" or "core" changes to software should require additional validation.[80] But even

76. Decl. of Nathaniel Adams at 5–6, United States v. Johnson, No. 1:15-cr-00565-VEC, (S.D.N.Y Feb. 12, 2017).

77. *See* Lauren Kirchner, *Traces of Crime: How New York's DNA Techniques Became Tainted*, N.Y. TIMES (Sept. 4, 2017), https://www.nytimes.com/2017/09/04/nyregion/dna-analysis-evidence-new-york-disputed-techniques.html.

78. For instance, Amy Kapczynski offers a powerful critique of corporate claims to secrecy in information disclosed to regulators but not to the public, including information about fracking chemicals, drug prices, and pharmaceutical clinical trial data. *See* Amy Kapczynski, *The Public History of Trade Secrets*, 55 U.C. DAVIS L. REV. 1367, 1373–76 (2022).

79. This authentication question of whether a software program used in a particular case was the program previously approved by regulators is a recurring issue in a variety of contexts. Deven Desai and Joshua Kroll have identified similar issues concerning regulatory accountability for software used in automobiles and voting machines and have also proposed zero-knowledge proofs as a solution to these problems. *See* Deven R. Desai & Joshua A. Kroll, *Trust But Verify: A Guide to Algorithms and the Law*, 31 Harv. J. L. & Tech. 1, 14–16, 47 (2017).

80. *See* SCI. WORKING GRP. ON DNA ANALYSIS METHODS, GUIDELINES FOR THE VALIDATION OF PROBABILISTIC GENOTYPING SYSTEMS 11 (2015), https://1ecb9588-ea6f-4feb-971a-73265dbf079c.filesusr.com/ugd/4344b0_22776006b67c4a32a5ffc04fe3b56515.pdf; M. D. Coble, J. Buckleton, J. M. Butler, T. Egeland, R. Fimmers, P. Gill, L. Gusmão, B. Guttman, M. Krawczak, N. Morling, W. Parson, N. Pinto, P. M. Schneider, S. T. Sherry, S. Willuwiet & M. Prinz, *DNA Commission of the*

experts often disagree on what constitutes a "significant" or "core" change,[81] so employees tasked with routine maintenance of a software system might be unaware of the significance of an alteration.

The current legal check on employee misjudgment in these types of cases is, as occurred with FST, to disclose the source code to a defense expert witness in ex post litigation. However, a perceived necessity to keep the algorithm itself hidden can render this legal check powerless and ineffective. In the FST example, as soon as algorithmic secrecy was no longer perceived as necessary, the legal system's existing check regained its power and the undisclosed function in the FST algorithm was exposed.

This of course raises the question of what happens in other cases where algorithms critical to legal cases are kept hidden. As described above, and in contrast to FST, there can be circumstances where disclosing an algorithm's source code might risk substantial harm, such as by enabling future wrongdoers to evade detection. That is, the government and other entities will often keep algorithms secret because they are used in an adversarial process, often in a security or regulatory context, where the perceived danger is that exposing the underlying information would allow for regulated parties to circumvent the algorithms by knowing where the tripwires lie.[82] It is likely that in those kinds of "anti-circumvention" cases, the type of undisclosed code alteration that seemingly occurred with FST could go undetected indefinitely. Such circumstances are not limited to criminal cases but appear across an array of government accountability contexts.

Where ex post remedies are deemed insufficient to mitigate the risk of post-disclosure misuse, a frequent legal solution to the verification problem in cases associated with an anti-circumvention rationale for secrecy is to have no disclosure at all. For instance, when criminal defendants raise doubts about the legality or reliability of a confidential law enforcement investigative tool, courts frequently hold that information about how the tool works is entirely shielded

International Society for Forensic Genetics: Recommendations on the Validation of Software Programs Performing Biostatistical Calculations for Forensic Genetics Applications, 25 FORENSIC SCI. INT'L: GENETICS 191, 196 (2016).

81. Decl. of Nathaniel Adams at 7, United States v. Johnson, No. 1:15-cr-00565-VEC, (S.D.N.Y Feb. 12, 2017).

82. *See, e.g.*, Andrew Moshirnia, *No Security Through Obscurity: Changing Circumvention Law to Protect our Democracy Against Cyberattacks*, 83 BROOK. L. REV. 1279 (2018) (explaining that the government often keeps national security information secret under an anti-circumvention justification).

from disclosure by a governmental privilege.[83] Often criminal defense experts are not even permitted to test an executable version of the software program.[84] Hence, the law presumes a tradeoff between verification and competing values, and sacrifices the trust and accountability that greater transparency could facilitate.

On the other hand, in the less-common scenario where courts find that criminal defense rights necessitate disclosure of information about law enforcement algorithms, the prosecution sometimes elects to drop criminal charges and permit a suspected criminal to evade punishment rather than comply with a court-ordered disclosure that risks undermining the efficacy of future investigations.[85] This scenario, often called the disclose-or-dismiss dilemma, risks harms to public safety, justice, and fairness.[86] For classified information specifically, the Classified Information Procedures Act mitigates the disclose-or-dismiss dilemma in criminal cases by specially permitting partial and protected disclosures.[87] However, those procedures are unavailable for sensitive but unclassified information and for civil and regulatory proceedings.

D. Trade Secret Litigation: Verification Dilemmas in the Adversary Process

1. *Verification Dilemmas*

Adjudicating an ex post legal remedy through litigation itself creates verification dilemmas which, in current practice, once again often require costly overdisclosure. Litigation verification dilemmas can affect all sorts of cases, in all stages of proceedings, to the detriment of plaintiffs, defendants, and even nonparties. The following discussion reviews and highlights these litigation verification problems, noting their particular salience in trade secret misappropriation lawsuits.

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83. *See generally* Stephen W. Smith, *Policing Hoover's Ghost: The Privilege for Law Enforcement Techniques*, 54 AM. CRIM. L. REV. 233 (2017) (describing the development of the evidentiary privilege for police investigative techniques).

84. *See, e.g.*, United States v. Pirosko, 787 F.3d 358, 366 (6th Cir. 2015).

85. *See, e.g.*, Michael Nunez, *FBI Drops All Charges in Child Porn Case to Keep Sketchy Spying Methods Secret*, GIZMODO (Mar. 6, 2017), https://gizmodo.com/fbi-drops-all-charges-in-child-porn-case-to-keep-sketch-1793009653.

86. *See generally* Charles M. Bell, Note, *Surveillance Technology and Graymail in Domestic Criminal Prosecutions*, 16 GEO. J.L. & PUB. POL. 537 (2018).

87. Specifically, section 4 of the Classified Information Procedures Act establishes a court's authority, "upon a sufficient showing" by the prosecution, to permit the prosecution to satisfy its discovery obligations by disclosing redacted documents, disclosing summaries of documents, stipulating to facts in lieu of full disclosure, and advocating for these protections via an in camera ex parte proceeding. 18a U.S.C. § 4 (2018).

To start, sensitive information is often disclosed during pre-litigation settlement negotiations. Current legal protections for such information include contractual NDAs[88] and Federal Rule of Evidence 408's bar on admitting "conduct or statements made during compromise negotiations" into evidence.[89] Nonetheless, parties sometimes attempt to circumvent these protections and abuse the settlement information. For instance, in a recent dispute alleging that StubHub, Inc. misappropriated trade secret source code from Calendar Research, LLC, the parties disclosed confidential business information to a neutral settlement expert; settlement was not reached, and StubHub then attempted to hire the settlement expert as an adversarial expert witness in the subsequent litigation.[90]

Once litigation begins, plaintiffs must disclose sufficient information to prove their claim by a preponderance of the evidence, including elements and damages. When that disclosure involves sensitive information, plaintiffs may choose to forego litigation altogether, leading to an under-vindication of legal rights. For instance, Omri Ben-Shachar and Lisa Bernstein explain that the costs of revealing the breadth of private business information necessary to prove expectation damages in breach of contract cases can exceed the expected recovery.[91] "As a consequence," they show, "the aggrieved party may not file suit and may therefore receive no compensation."[92]

Meanwhile, defendants often must reveal sensitive information in order to disprove a claim. Doing so can impose risks and costs on entities who have done nothing wrong. If the costs of revealing sensitive information exceed the costs of settlement, defendants may choose to settle unsound or even frivolous lawsuits, leading to an over-vindication of legal rights. A common (albeit unverified)[93] anecdote in trade-secret lore about a Coca-Cola case illustrates this risk. The Coca-Cola Bottling Company sued Coca-Cola for breach of a contract that required Coca-Cola to sell them "Coca-Cola Bottler's Syrup" at a certain price.[94] The case turned on a dispute over product identity,[95] leading the judge to order Coca-Cola to reveal—under a protective order—trade

88. *See, e.g.*, Calendar Rsch. LLC v. StubHub, Inc., No. 2:17-cv-04062, 2017 WL 10378337, at *1 (C.D. Cal. Sept. 22, 2017).

89. FED. R. EVID. 408(a)(2).

90. *Calendar Research*, 2017 WL 10378337, at *1. The court ultimately disqualified the witness. *Id.* at *5.

91. Omri Ben-Shahar & Lisa Bernstein, *The Secrecy Interest in Contract Law*, 109 YALE L.J. 1885, 1888 (2000).

92. *Id.*

93. *See infra* note 97.

94. Coca-Cola Bottling Co. v. Coca-Cola Co., 107 F.R.D. 288, 290 (D. Del. 1985).

95. *Id.* at 296.

secret ingredients and data used in developing certain beverages.[96] According to Miller,-Cola settled the claim rather than comply with the disclosure order.[97] If Coca-Cola did indeed settle, there is a distinct (though admittedly unconfirmable) possibility that Coca-Cola had not breached the contract, yet suffered consequences anyway. This story illustrates the general concern that participating in court adjudication might not be worth the information disclosures it can entail. Even disclosures to a litigation adversary under a protective order entail some risks, as protective orders can, and have, been violated.[98]

Although litigation verification problems appear across legal doctrines, they are particularly salient in trade secret misappropriation lawsuits.[99] These suits involve a special "identification" procedure whereby plaintiffs must inform the defendant and the court what the defendant allegedly misappropriated.[100] Plaintiffs must undertake identification with sufficient specificity to enable the defendant to challenge both whether the information qualifies as a valid trade secret[101] and whether the defendant improperly accessed, used, or distributed it.

At the same time, the risks of disclosing trade secrets during litigation are particularly high because trade secrets must remain secret to maintain their

96. *Id.* at 300.

97. *See, e.g.*, Arthur Miller, *Confidentiality, Protective Orders, and Public Access to the Courts*, 105 HARV. L. REV. 427, 470 (1991) ("Coca-Cola settled the dispute privately and thereby relinquished its right to seek complete vindication."). Miller provides no citation for his assertion that Coca-Cola settled. *Id.* However, Miller informed one of the authors that his source for the assertion was likely a lawyer in the case. Email from Arthur R. Miller to Rebecca Wexler (Feb. 22, 2022, 7:49 AM) (on file with author). Further verification is challenging because the district court docket for the case is not available in online databases and the related appellate dockets lack any clear indication of the aforementioned settlement. *See* Coca-Cola Bottling v. Coca-Cola Co., No. 1:83-cv-00095 (D. Del. docket filed Feb. 22, 1983); Coca-Cola Bottling v. Coca-Cola Co., Nos. 91-03496, 91-03497, 91-03498 (3d Cir. July 31, 1991).

98. *See, e.g.*, Bradford Techs., Inc. v. NCV Software.com, No. C 11-04621 EDL, 2013 WL 75772, at *3 (N.D. Cal. Jan. 4, 2013); MobileMedia Ideas LLC v. Apple Inc., No. 10-258-SLR/MPT, 2012 WL 5379056, at *2 (D. Del. Oct. 31, 2012).

99. *See generally* THE SEDONA CONF., COMMENTARY ON PROTECTING TRADE SECRETS IN LITIGATION ABOUT THEM (2022); *see also* Elizabeth A. Rowe & Nyja Prior, *Procuring Algorithmic Transparency* 3-4 (Feb. 26, 2022) (unpublished manuscript) https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4044178 (describing a criminal case in which prosecutors appear to have withdrawn evidence rather than reply to a defense motion that may have required disclosure of trade secrets).

100. *See, e.g.*, Xerox Corp. v. Int'l Bus. Machs. Corp., 64 F.R.D. 367 (S.D.N.Y. 1974).

101. *See, e.g.*, William M. Corrigan, Jr. & Jeffrey L. Schultz, *Trade Secret Litigation—an Updated Overview*, 63 J. MO. BAR 234, 235–37 (2007) (collecting misappropriation cases in which defendants challenged whether the plaintiff's qualified as a valid trade secret).

status as protectable intellectual property.[102] If a plaintiff over-discloses a trade secret in a public court filing and then loses their misappropriation claim, the plaintiff will have destroyed their trade secret as well as lost their case. This is not merely a theoretical concern. Litigants have repeatedly disclosed trade secrets in public court filings by accident.[103] Meanwhile, litigation disclosures will, almost by definition, take place between untrusting business competitors.[104] A bad faith competitor might not only use the information obtained during litigation; they could also leak the information publicly and thereby destroy its value as a form of intellectual property.[105] Furthermore, adjudicating whether future actions of a competitor amount to misuse of information obtained during litigation might be a complex matter in and of itself, thereby burdening even law-abiding competitors that are encumbered by such information.[106]

To add further complications, the identification requirement is susceptible to gaming.[107] If the plaintiff is permitted to proceed with the claim based on too general or conclusory a description of its trade secret, this will both impede the development of a defense and permit the plaintiff to calibrate and customize its claim based on the information it learns about the defendant in discovery.[108] As a result, plaintiffs may try to withhold information for as long as possible while obtaining discovery about the defendant's business and commercial information. The gaming risks can be compounded by the fact that, due to both practical and strategic concerns, many companies do not maintain regular written records of their trade secrets. Lack of a preexisting record enhances litigants' opportunity to craft and recraft the definition of an

102. *See* THE SEDONA CONF., *supra* note 99, at 1.

103. The Texas Supreme Court recently considered whether such oversights in initial filings waive a party's ability to correct and seal after the fact, which would leave the information permanently in the public domain. *See* Title Source, Inc. v. HouseCanary, Inc., 603 S.W.3d 829, 832 (Tex. App. 2019), *aff'd in part, rev'd in part*, 622 S.W.3d 254 (Tex. 2021).

104. *See* THE SEDONA CONF., *supra* note 99, at 2–12 (providing guidance to courts on when and how to limit discovery disclosures to various opposing party representatives in order to minimize the risks of disclosure, even under a protective order).

105. The leakiness of trade secret protection is one of its defining features. *See* Annotation, *Disclosure of Trade Secrets as Abandonment of Secrecy*, 92 A.L.R.3d 138 (1978); *see* Kewanee Oil Co. v. Bicron Corp., 416 U.S. 470, 475 (1974) (observing that one of the defining features of trade secret law is its lack of protection against discovery "by independent invention, accidental disclosure, or by so-called reverse engineering").

106. Whether use of information qualifies as misappropriation of a trade secret is a fact-intensive jury question. *See generally* JAMES POOLEY, TRADE SECRETS § 6.03 (2021) (describing various types of evidence that may be relevant to proving misappropriation).

107. *See, e.g.*, The Sedona Conference, *Commentary on the Proper Identification of Asserted Trade Secrets in Misappropriation Cases*, 22 SEDONA CONF. J. 223, 253 (2021).

108. *See, e.g.*, POOLEY, *supra* note 106, § 11.02(2)(c).

alleged trade secret as the case evolves. In contrast, defendants will want to nail down the plaintiff's claim with specificity early on so as to prevent claim morphing, narrow their own discovery obligations, and—less legitimately—to force the plaintiff to undertake maximum disclosure risks, even with information that may ultimately be irrelevant to resolving the dispute.[109]

Finally, criminal prosecutions for trade secret misappropriation raise special, challenging tensions. The arguments for detailed disclosure are stronger because criminal defendants have unique constitutional entitlements to access relevant evidence and have their case proceed in public.[110] Yet the risk of destruction of trade secrets through judicial publication[111] or leakage falls on the alleged victim of misappropriation—a nonparty who did not elect to initiate the case and lacks control over the government's litigation decisions.[112]

2. *Imperfect Legal Responses*

Existing legal solutions to these litigation verification problems are, once again, imperfect. Courts often rely on protective orders, limited discovery, sealing orders, and courtroom closures to limit the redistribution of sensitive information shared in litigation. But protective orders are vulnerable to leaks, whether through mistakes, negligence, or malicious intent. They also introduce new problems. For instance, protective orders can impede effective representation by limiting what attorneys can communicate to their clients or by unduly restricting access to expert witnesses. In the criminal context, protective orders can interfere with prosecutors' *Brady* due process disclosure obligations.[113] Limited discovery risks impeding the judicial truth-seeking process of adjudication and obstructing the regulatory goals that private discovery can serve.[114] And judicial sealing orders and courtroom closures can

109. *Id.*

110. *See* Kenneth Rosenblatt, *Criminal Law and the Information Age: Protecting Trade Secrets from Disclosure in Criminal Cases*, 8 COMPUT. L. 15, 15 (1991).

111. For a discussion of judicial authority to compel even public disclosures of trade secret information that is "indispensable" for the adjudication of the case without triggering constitutional takings claim, see Kapczynski, *supra* note 78, at 1437 & n.308.

112. Of course, prosecutors in these cases often try to accommodate the victims' interests, in part because they want or need victim cooperation to successfully bring the charge. *See, e.g.*, Brian L. Levine & Timothy C. Flowers, *Your Secrets Are Safe with Us: How Prosecutors Protect Trade Secrets During Investigation and Prosecution*, 38 AM. J. TRIAL ADVOC. 461, 464 (2015).

113. *See* Jonathan Abel, *Brady's Blind Spot*, 67 STAN. L. REV. 743 (2015).

114. *See* Diego Zambrano, *Discovery as Regulation*, 119 MICH. L. REV. 71 (2020).

raise First Amendment and broad democratic governance concerns about public access to court records.[115]

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Part II has introduced verification dilemmas in law—that is, the problem that verifying facts about information often requires undertaking risky disclosures. It has shown that the problem is a recurring and transdoctrinal issue in law, appearing in the information privacy and security, dealmaking, government oversight, and trade secret litigation contexts. Each of the examples discussed above also illustrates limitations in current legal solutions to the verification problem in law. Ex post remedies for post-disclosure misuse of information are available solely after misuse has been detected and can be prohibitively costly to pursue. Moreover, the very process of pursuing such a remedy through litigation can create new verification problems that in turn require new, costly disclosures of sensitive information in court proceedings. And in certain circumstances, such as those associated with anti-circumvention rationales for secrecy, the law may err on the side of *not* permitting entities to disclose information, thereby sacrificing some quantum of trust and verifiability.

Having laid out the verification problem in law and some limitations of the current legal solutions to it, the Article now turns to new technological developments that may offer a radical alternative approach to help solve these recurring legal issues.

III. INTRODUCING ZERO-KNOWLEDGE PROOFS

A. THE IDEA OF ZERO-KNOWLEDGE PROOFS (OR, *THE TALE OF THE MATHEMATICIAN'S FRIEND*)

First presented in 1985, zero-knowledge proofs (ZKPs) enable one party (the "prover") to prove to another party (the "verifier") assertions regarding properties of secret information known only to the prover, without revealing an secret information. ZKPs address the insight that often we are unnecessarily exposed to an entire corpus of data for the sole purpose of verifying limited properties of the corpus. For example, when a police officer stops a driver on the road to verify that they hold a valid driver's license, the officer need not learn the driver's date of birth or other private information that is disclosed

115. For a discussion of the public harms of suppressing public access to purported trade secrets in both the regulatory state and judicial proceedings, see Kapczynski, *supra* note 78, at 1428-41. For a discussion of First Amendment rights of access to judicial documents, see generally Hannah Bloch-Wehba, *Exposing Secret Searches: A First Amendment Right of Access to Electronic Surveillance Orders*, 93 WASH. L. REV. 145 (2018).

when presenting a driver's license. Using a ZKP, the driver could prove to the police (the verifier in this case) that her license (which would contain encrypted identifying information such as age) is valid (which implies a valid driving age) *without revealing an exact age or any other identifying information.* In a more complex example, an employer can, without disclosing specific salaries, prove to its employees that the salaries of its employees (stored, say, in an encrypted salary database) are equitable with respect to gender. In an even more complex example, a government agency (acting as a prover) can prove to the public that a certain sensitive forensic (or, data-gathering) algorithm operates as claimed without disclosing the algorithm itself.

A bit more abstractly, a pair of algorithms (one for the prover and one for the verifier) qualifies as a ZKP for a given public assertion regarding some hidden data that is known only to the prover if the following three properties hold.[116] The first is *completeness*: if the assertion (about the hidden data) is true, the verifier's algorithm, after interacting with the prover's algorithm, will accept the assertion's validity. The second is *soundness*: if the claimed assertion is false, the verifier will reject the assertion. Crucially, this holds even if the prover tries to cheat and does not follow its prescribed algorithm. (Technically, the situation where a verifier will accept a false claim can happen. However, the probability that this is the case depends only on random choices made by the verifier, and can be set to be sufficiently small so as to be both mathematically and realistically insignificant.) This probabilistic aspect is necessary to enable the third characteristic, *zero-knowledge*, which is where the novelty lies: the verifier will learn no new information about the undisclosed data besides the validity of the assertion regarding the data. Again, this holds even if the verifier tries to cheat and does not follow its prescribed algorithm. Mathematically, this is formulated as the requirement that for any given verifier, the verifier herself could generate the probability distribution over the information seen when engaging in a ZKP. This means that the verifier could have obtained the same information just by knowing only that the statement is true, and without ever interacting with the prover. In other words, nothing new is gained beyond the validity of the assertion.

We emphasize that this last characteristic is what makes ZKPs unique: rather than demonstrating the correctness of the assertion via making the data public, ZKPs enable convincing a distrustful verifier without exposing anything about the hidden data—other than the very fact that the assertion is correct.

116. *See* Goldwasser et al., *supra* note 4, at 293, 295.

To show how this is done, it is helpful to illustrate a basic example of the mathematical principle underlying ZKPs before providing more detail on how the ZKPs can be implemented. The following beautiful illustration of the concept of an indirect mathematical proof, taken from Ron Aharoni's book, *Mathematics, Poetry and Beauty*, supplies a rudimentary illustration:[117]

> A mathematician and his friend are walking in the forest. The friend boasts: "In a flash, I can tell how many needles are on this pine tree." "How many?" the mathematician asks. "143,547" says the friend, without batting an eyelash. The mathematician takes a handful of needles and asks: "And how many now?"[118]

All the mathematician (the "verifier" here) needs to do is to calculate by a simple subtraction that the number of needles in her hand equals the difference between her friend's two answers. If the calculation succeeds, then the mathematician will accept her friend's boast, otherwise she will reject it. This story demonstrates how it is possible to verify statements about having information (or, in this case, computational ability to verify the ability to compute the number of pine needles), without having full access to the information (or computational ability). In this story, the *completeness* property is satisfied because the mathematician will accept if her friend does have the magical ability to count pine needles. *Soundness* is satisfied as well: if the friend cannot truthfully count the number of needles on a pine tree, it is extremely unlikely that he will be able to guess the exact number of needles the mathematician holds in her hand. If this happens, the calculation will fail, and the mathematician will reject her friend's boastful assertion. The exact probability of rejection is one of the possible choices for the number of needles that the mathematician holds. Thus, the verifying mathematician controls the probability of rejection, regardless of the prover's strategy.

But what about zero-knowledge? In Aharoni's story, if the friend is telling the truth then the mathematician learns the number of pine needles on the tree! Can the skeptical mathematician be convinced of her friend's magic powers without learning the number of needles on the pine tree? Yes, but we need to slightly augment the story: Instead of asking the friend to report the number of needles before and after picking the random handful of needles, the mathematician will only ask the friend to guess the number of needles hidden in the mathematician's hand. The friend (who can count needles on trees) will then simply report the difference between the number of needles on the pine tree before and after the mathematician picked the random handful

117. RON AHARONI, MATHEMATICS, POETRY AND BEAUTY (2015).

118. *Id.* at 78.

of needles. The mathematician will then count the number of needles in her hand and accept the number if and only if it equals the friend's guess.

Now, all three properties are satisfied: completeness, soundness, and zero-knowledge. If the friend is a truth teller, the mathematician will verify that the number of needles in her hand equals the friend's guess. If the friend is a liar, the guess is likely to be wrong, just as before. Importantly, all the mathematician learns is the number of needles in her hand she picked herself. This is a random number which can be picked without ever interacting with the prover. Thus, the mathematician learns nothing from the interaction with the friend, except for being convinced in the friend's ability to count pine needles on trees.[119]

B. THE GENERAL APPLICABILITY OF ZERO-KNOWLEDGE (WITH SOME MATH FOR GOOD MEASURE)

The pine-needle story might seem irrelevant for real-life applications. However, the ideas that underlie it, namely the use of randomness to challenge the proving party as a replacement for asking for more details about the proof, turn out to be extremely powerful and generalizable. In particular, these ideas are readily applicable to digital information, which is where ZKPs are most powerful.[120]

ZKPs' wide applicability to digital information stems from the following deeply insightful observation: it is possible to transform any conventional mathematical proof for an assertion regarding digital information into a ZKP of the same assertion.[121] In fact, many such transformations have been devised over the past three decades.[122]

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119. We thank Tal Canetti for proposing the current, simplified version of the zero-knowledge proof of the ability to count pine needles on trees.

120. It should be stressed, however, that the applicability of zero-knowledge proofs transcends the digital domain. In particular, ZKPs for physical properties have been proposed in a number of settings and for multiple purposes, from educational and recreational to international relations. *See, e.g.*, Ben Fisch, Daniel Freund & Moni Naor, *Physical Zero-Knowledge Proofs of Physical Properties*, 2014 ADVANCES IN CRYPTOLOGY – CRYPTO: PART II 313 (Juan A. Garay & Rosario Gennaro eds.); Glaser, *supra* note 11; Ronen Gradwohl, Moni Naor, Benny Pinkas & Guy N. Rothblum, *Cryptographic and Physical Zero-Knowledge Proof Systems for Solutions of Sudoku Puzzles*, 4475 FUN WITH ALGORITHMS, LECTURE NOTES COMPUTER SCI. 166 (2007).

121. The first such general transformation was devised in 1986 in two works: Oded Goldreich, Silvio Micali & Avi Wigderson, *All Languages in NP Have Zero-Knowledge Proof Systems*, 38 J. ACM 691 (1991) and Gilles Brassard, David Chaum & Claude Crépeau, *Minimum Disclosure Proofs of Knowledge*, 37 J. COMP. SYST. SCI. 156 (1988).

122. *See, e.g.*, ODED GOLDREICH, FOUNDATIONS OF CRYPTOGRAPHY 184 (2001) ("The main result presented in this chapter is a method for constructing zero-knowledge proof systems for every language in NP . . . . Specifically, almost all statements one may wish to prove in practice can be encoded as claims concerning membership in languages in NP."); See

The rest of this section provides a high-level overview of how such transformations work (with more details provided in the Appendix). It is stressed that the legal analysis in this paper holds regardless of the particular transformation used. Furthermore, understanding how these transformations work is not needed to evaluate and build on the legal analysis. The goal of this overview is to demystify ZKPs for a legal audience and provide a (largely) nonmathematical understanding of how such transformations work.

A preliminary step towards transforming a conventional mathematical proof into a ZKP is to view the conventional process of verifying a mathematical proof as a computer program that takes the text of the proof as input, outputs "1" if the verification succeeds, and "0" otherwise. (For instance, if the assertion is "the number 77 is a product of two prime numbers," then the proof-text would consist of two numbers, and the verification program would first check that the two input numbers are primes, and then multiply the two numbers and check that the result is 77. Finally, the verification program will output 1 if both checks succeed, and 0 otherwise. Alternatively, if the assertion is, "There exists a value *W* such that the plaintext obtained by decrypting the ciphertext 12345678 using AES with key *W* is a number between 18 and 120," the proof-text would consist of a value *W*, and the verification program will first decrypt 012345678 using AES with key *W*. It will then output 1 if the result is a number between 18 and 120 and 0 otherwise.)

Viewed this way, a ZKP's goal is to enable the prover to convince the verifier that it holds a proof-text *W* such that *if the verification program were to be run on W then the output would be* "*1*." Furthermore, the prover should be able to do so without disclosing the proof-text itself. It is stressed that the verification program is public and known to all. Only the proof-text (namely, the numbers 7 and 11 in the first example above, or the key *W* in the second example) is to remain hidden.

As the above examples suggest, verification programs can express a broad range of properties that a hidden data set might or might not have. The Article now turns attention to demonstrating how to design a zero-knowledge proof for a given verification program. Specifically, two alternative (and very different) methods for designing zero-knowledge proofs for *any given verification program* are described. (It is noted that ether one of these two methods would suffice for any of the applications mentioned in this work. Presenting both will

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also the ZKProof Resources Repository for an extensive list of currently available ZKP systems: https://docs.zkproof.org/schemes/

hopefully help the reader separate the concept of zero-knowledge proofs from a particular algorithmic way to realize the concept.)

1. *Two methods for realizing ZKPs*

a) Method 1 (The Boxes)

The idea underlying this method is to transform the underlying verification program into another computer program that can perform the same computational steps (i.e., the same sequence of manipulations of the proof-text) even when the proof-text is given only in a "veiled" way.[123]

The following two concepts are helpful to understanding how this transformation works. First, any computer program (including the verification program at hand) can be written as a sequence of very simple basic steps, where each basic step consists of choosing two pieces of data from either the input or the memory, computing a simple function of the two pieces, and writing the result back in memory. Such functions are called *complete*. For instance, a piece of data can be as small as one binary value, namely either 0 or 1, and the complete function can be the NAND logical gate.[124] The first step is thus to transform the verification program to such a format.

Second is the concept of a cryptographic *commitment* to data. Metaphorically, a cryptographic commitment is the digital analog of a lockable box: *Committing* to a piece of data (say, the proof input) is tantamount to writing this piece of data on paper, putting the paper inside the box, locking the box with a key, and handing the locked box to the recipient of the commitment. *Opening* the commitment is tantamount to handing the key to the recipient of the commitment, thus allowing the recipient to open the box and read the data. The salient properties here are: (a) the committer is guaranteed that until such time that she hands the key to the recipient, the data remains completely hidden, and (b) once the recipient obtains the box it is guaranteed that the data inside it are immutable (even though she might not yet know what they are).

The commitments used in this method have an additional *homomorphism* property. *Homomorphic* commitments are commitments which allow for the following "magic" to happen: Assume the committer hands two boxes to the recipient: box c_1 contains the value m_1, and box c_2 contains the value m_2. The committer keeps the corresponding keys r_1, r_2. Homomorphic

123. This methodology roughly follows the approach in Gilles Brassard & Claude Crépeau, *Zero-Knowledge Simulation of Boolean Circuits*, 1986 ADVANCES IN CRYPTOLOGY – CRYPTO '86 PROC. 223 (A.M. Odlyzko ed.).

124. *See, e.g.*, Even, G., & Medina, M. (2012). Propositional Logic. In Digital Logic Design: A Rigorous Approach (pp. 68-93). Cambridge: Cambridge University Press. doi:10.1017/CBO9781139226455.007.

commitments allow the receiver to "mashup" box c_1 and box c_2 and obtain a single box (let us call it c_3) that contains the number $m_1 * m_2$, where $*$ is some agreed upon function *and nothing else*. Furthermore, the committer can now "mashup" the keys r_1 and r_2 to obtain a key r_3 that can be used to open the new box c3—but neither c1 nor c2. The function * to be used here is some complete one, such as the NAND operation mentioned above.

Armed with the concepts of complete functions and homomorphic commitments, one can now turn to creating the ZKP itself. The prover (given a public verification program and a secret proof-input) and the verifier (given only the verification program) proceed as follows:

1. The prover commits (using homomorphic commitment) to the proof-input by splitting the proof-input into small pieces, putting each piece in a box as described above and sending all the boxes to the verifier.

2. The verifier runs the verification program on the proof homomorphically (namely, "in boxes"). Recall that the verification program is now only a sequence of applications of the function * to the values in specific input (or memory) locations. These applications of * are now realized by mashing up the corresponding boxes—either boxes obtained from the prover, or previously mashed-up boxes—until the verifier obtains a box c^* that corresponds to the output value of the verification program. At this point, the verifier knows that the value inside box c^* is the result of the verification process.

3. The prover mashes up the keys for the boxes it sent to the verifier, in the same way that the verifier mashes up the boxes. Finally, the prover obtains the key r^* that can enable opening the box c^* and sends r^* to the verifier.

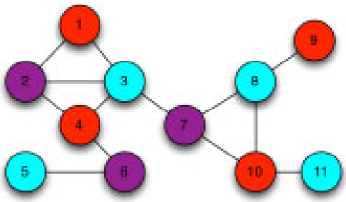
4. The verifier opens the box c^* using the key r^* obtained from the prover and accepts if the value in the box is 1.

Completeness and soundness of this proof follow from the correctness of the homomorphic commitment scheme. Zero knowledge follows from the fact that all that the verifier sees is a collection of identical-looking opaque "boxes," where only one box is opened. Furthermore, as long as the prover follows its prescribed algorithm, the value in the opened box is always 1. The verifier can sample this same information without ever interacting with the prover. Appendix A holds a more mathematical description of this approach.

b) Method 2: (Graph Coloring)

This method (invented in the landmark work of Goldreich et al.[125]) uses the theory of NP-completeness,[126] which demonstrates that some families of combinatorial objects (e.g., graphs) have the following remarkable property: it is possible to represent the execution of any given program on a given input by way of some combinatorial object (e.g., a graph) from the family in such a way that the combinatorial object (the graph) has a certain combinatorial characteristic *if and only if* the given program, running on the given input, outputs "1."

The combinatorial object of choice in Goldreich et al. is a graph, and the characteristic is that the graph has a valid "3-coloring": each vertex is assigned one of three possible colors such that no edge has its two endpoints assigned the same color. The following structure ensues: any proof verification program can be translated into a graph known to both prover and verifier, and any purported proof-text, known to the prover, can be translated into a coloring of the nodes of the graph, such that the coloring is a valid 3-coloring if and only if the verification program, given the proof-text as input, outputs "1." This means that proving that the verification program running on the input-proof outputs "1" is now equivalent to proving that the coloring held by the prover is valid.



A valid 3-color graph. Each node is colored in either blue, red, or purple, and no two nodes connected by an edge are the same color.[127]

Proving that a graph is 3-colorable is done as follows: The prover starts by randomly renaming the three colors—the prover chooses a random

125. *See* Goldreich et al., *supra* note 121.

126. *See* Stephen A. Cook, *The Complexity of Theorem-Proving Procedures*, 3 PROC. ACM SYMP. ON THEORY OF COMPUTING 151 (1971); Leonid Levin, *Универсальные задачи перебора* ["Universal Search Problems"], 9 PROBS. INFO. TRANSM'N 115 (1973).

127. Matthew Green, *Zero Knowledge Proofs: An Illustrated Primer*, A Few Thoughts on Cryptographic Engineering (Nov. 27, 2014), *available at* https://blog.cryptographyengineering.com/2014/11/27/zero-knowledge-proofs-illustrated-primer/.

permutation of {blue, red, purple} and reassigns the colors accordingly. Next, the prover sends a series of commitments, each to the color of a different vertex in the graph. The verifier then chooses a random edge among all edges in the graph and requests the prover to open the commitments corresponding to the colors of the two endpoints of the chosen edge. If the open commitments indicate that the two endpoints are colored with the same color, the verifier rejects the ZKP. If the open commitments indicate that the two endpoints were colored with two different colors, the process is repeated. After some number of successful iterations in which the verifier did not reject, the verifier accepts the ZKP. Evidently, the probability that the verifier will accept when the graph is not 3-colorable exponentially vanishes with the number of iterations. (In particular, 200n*log(n) iterations, where *n* is the number of edges in the graph, will be plenty.) Furthermore, the protocol is zero-knowledge: if the coloring is valid and the prover follows the instructions of the protocol then, in each iteration, all that the verifier sees is that the two endpoints of a random edge are colored in two different random colors; this is information that the verifier could have generated on her own, without any interaction with the prover.

Regardless of which of the two methods is used, any verification program can be turned into a ZKP. In other words, for *all* mathematical assertions for which there exists a traditional proof, there exists a protocol where one party who knows a traditional proof can convince another party that the assertion is valid, revealing nothing else.

2. *Specialized Assertions and Constructions*

Although the above two methods are very general, they often require an excessive amount of computational resources. Luckily, there are many constructions of ZKPs in the literature that are tailor-made for specialized assertions and require significantly less computational resources. Examples include the equality (or inequality) of two encrypted documents, numerical assertions about encrypted numerical data sets such as the value of the average, verifying membership in a list, or verifying the results of search functions.[128] Two questions that must be asked in the context of the present paper are (1) how to design assertions that would be of value in legal contexts such as the ones discussed in this work and potentially others, and (2) how efficient can ZKPs be made for such assertions. In Part IV and the appendices, these two

128. *See* ZKPROOF, ZKPROOF COMMUNITY REFERENCE 29, 75 (D. Benarroch, L.T.A.N. Brandão, E. Tromer eds., 2019), https://docs.zkproof.org/pages/reference/reference.pdf.

questions are discussed at length in the context of the verification dilemmas presented in Part II.

3. Noninteractive Zero-Knowledge

Originally, ZKPs were conceived as "interactive" algorithms, in the sense that the verifier interacts directly with the prover and chooses random challenges in the course of the interaction. Furthermore, they were nontransferable: the verifier had no way to convince third parties that did not witness the interaction of the prover's assertion verity. (Recall the example of the mathematician and his friend: it was crucial for the mathematician to choose the number of pine-needles to remove from the tree at random, and furthermore do so only *after* the friend announced the original count.)

It is often beneficial to have ZKPs where the interaction is limited to having the prover send to the verifier only a single message, where the verification process requires the verifier to make no secret random choices. Such ZKPs are called "noninteractive" zero-knowledge proof (NIZK) systems.[129] The great advantage of NIZKs over interactive ZKPs is that the prover and the verifier do not need to interact directly with each other. In fact, the proof need not be associated with a specific verifier: the prover can just post the proof once and for all to be verified by anyone at any time (much like a standard written proof). This *public verifiability* property is particularly useful in a setting where a single entity (say, a government agency) wishes to make public assertions about hidden data, while avoiding the need to separately convince each member of the public. In Part IV we discuss specific legal settings where this property may be useful.

Achieving non-interactivity comes at a price. In order to make the mechanism work, the prover and the potential verifiers need to *a priori* agree on a value, called the common reference string (CRS) that they both trust to have been randomly sampled. (The CRS may have been randomly sampled by some trusted physical process, some trusted authority, or the parties themselves in a preliminary interactive stage. Either way, a CRS can be reused indefinitely for as many proofs as needed.)

Interestingly, the first method for constructing general zero-knowledge proofs presented above ("The Boxes") can be transformed in a straightforward fashion to a NIZK. In fact, the above intuitive explanation is already a NIZK, since the communication between prover and verifier consists of a single message from the prover to the verifier containing the commitments to the

129. Manuel Blum, Alfredo De Santis, Silvio Micali, and Giuseppe Persiano: *Noninteractive Zero-Knowledge*, 20 SOC'Y FOR INDUS. & APPLIED MATHEMATICS 1084, at 1091 (1991) [hereinafter Blum et al., *Noninteractive Zero-Knowledge*].

proof-text and the key for the final mashed-up box. (The CRS in this case contains the initial random values that are required to set up the mathematical representation of the boxes.) Transforming proofs that use the Graph Coloring method to a NIZK is a bit more involved. One intuitive idea here is to encode the verifier's random challenges in the CRS, so that they need not be sent by the verifier "in real time."

C. THE CASE OF SPLIT SECRETS: ZKPS AND MULTI-PARTY COMPUTATION

This subpart describes a related and important technique, *Secure Multiparty Computation* (MPC), which contributes to ZKPs broader applicability to legal verification dilemmas.

In their basic form, ZKPs are designed for a setting where one party (the prover) has some secret information and wishes to convince one or more other parties of the correctness of some assertion pertaining to the secret, while keeping the secret otherwise hidden. However, there exist situations where the secret information is split into two or more pieces, where each piece is exclusively known by different parties. For instance, consider a trade secret litigation where the court wishes to verify the plaintiff's assertion that the trade secret formula used the defendant used is the same as the one the plaintiff holds. Furthermore, the parties want to do so without having any of the trade secrets disclosed to either the court or to the other party. One may be tempted to let the proof-text be the two formulas and apply one of the above methodologies to obtain a ZKP. But this straightforward attempt would fail since there is no single party who knows the entire proof-text. Instead, such contexts require a generalization of ZKPs called secure multiparty computation (MPC).

MPC is a class of cryptographic techniques that address the following type of setting. Consider two (or more) mutually distrustful parties, each holding a piece of sensitive information. The parties wish to jointly compute some agreed-upon function of all their secrets put together. Figuratively, the parties wish to emulate a situation where each one hands their secret to an imaginary trusted party who computes the agreed-upon function, informs each party of their function value, and then disappears. Importantly, the protections should hold even when some or all of the other parties deviate from the protocol instructions. This includes guaranteeing preserving the secrets of the parties that follow the protocol instructions as well as guaranteeing that the output values these parties obtain are computed according to the agreed-upon function as applied to the parties' secret data. Furthermore, each party that follows the protocol is guaranteed that the secrets contributed by other parties are well defined and do not depend on the party's own contributed secret. This holds even if the other parties do not follow the protocol.

In the context of the above trade secret litigation example, the parties to the MPC computation would be the plaintiff, defendant, and court. The function to be evaluated would take a description of trade secret A from the plaintiff, a description of trade secret B from the defendant, and a description of a test algorithm T from the court. The function will then run algorithm T on secrets A and B and announce the result to the court. (The test algorithm T will apply a set of agreed-upon tests and subsequently output a value indicating whether the two input trade secrets are "close enough.") More generally, in the language of ZKPs, here the two litigants act as provers and the court acts as a verifier. Alternative configurations are of course possible as well.

In a different example, each party's secret is their client database, and the court wishes to learn whether the two lists are sufficiently similar (or if one list is contained in the other). Alternatively, each party's secret is a computer program, and the court wishes to learn whether the respective programs are similar, according to some agreed-upon measure of similarity.

To realize an MPC computational task, the participants are provided an *MPC protocol*, namely a set of instructions to be followed by each participant in the joint computation. These instructions enable each participant to process its local data and information received from other parties, so as to send new information to others, and eventually determine the desired outcome of the computation. MPC protocols exist for securely evaluating any desired function of the secret values held by the parties.[130]

A general and ubiquitous paradigm in constructing MPC protocols consists of two main conceptual steps: (1) construct MPC protocols whose security guarantees hold only as long as all parties adhere to their protocol instructions; and (2) have the parties run the protocol from the previous step, and, in addition, have each party prove to the other parties that its messages were computed correctly. That is, each message of the protocol from the first step will be accompanied by a ZKP that the message was computed correctly

130. The area has been extensively studied in the past three decades, since the first groundbreaking works of Andrew C. Yao, *Protocols for Secure Computations*, FOUND. COMPUT. SCI. 160 (1982); Oded Goldreich, Silvio Micali & Avi Wigderson, *How to Play Any Mental Game*, 19 PROC. ACM SYMPOSIUM ON THEORY OF COMPUTING 218 (1987); Michael Ben-Or, Shafi Goldwasser, Joe Kilian & Avi Wigderson, *Multi-Prover Interactive Proofs: How to Remove Intractability Assumptions*, 20 PROC. ACM SYMPOSIUM ON THEORY OF COMPUTING 113 (1988).

given the messages received so far, the local (hidden) randomness, and initial hidden input.[131]

Recalling the terminology introduced earlier, a traditional ZKP with some verification program *V* and proof-input *pf* can be cast as an MPC protocol for two parties— prover and verifier— where the prover's input is *a purported proof-text,* the verifier has no input, and the agreed function is the proof verification program (applied to the prover's input). The MPC's guarantees imply that the verifier learns the (0 or 1) output of the proof verification program and nothing more. In the same vein, a ZKP for the case where the purported proof-text has several components, each held by a different party, is an MPC protocol for the proof verification function applied to all the components of the proof-text put together.

Part III has provided a detailed overview of the idea of zero-knowledge proofs and how ZKPs work. The following Part will develop examples of how this technique can help resolve legal verification dilemmas across multiple legal contexts.

IV. ZERO-KNOWLEDGE PROOFS APPLIED TO VERIFICATION DILEMMAS

The newfound ability (supported by ZKPs) to verify assertions about information without learning the underlying information itself, can potentially upend existing understanding and common legal practice regarding the balance between disclosure and secrecy and it can lead to fresh understanding and new forms of balance. This Part explores the ways that ZKPs might be used in the four doctrinal contexts discussed in Part II and offers specific-use cases demonstrating how they ZKPs help to resolve recurrent verification dilemmas.

Our prototypical workflow for using ZKPs for verification dilemmas consists of three steps:

> (a)The prover and the verifier agree on a digital *base document* that uniquely identifies the corpus of data under consideration. The information in this base document must preserve the secrecy of the data under consideration (much like the concept of a mathematical commitment discussed in Part III). Simultaneously, the information

131. MPC protocols that guarantee security only when all parties adhere to the protocol instructions are often called protocols for the "honest-but-curious model." When the parties trust each other to adhere to the protocol (say, due to contractual agreements enforced by ex-post legal remedies), it suffices to run protocols for the honest-but-curious model, without additional protections. However, such protocols are not sufficient for the applications considered here. *See also* Yehuda Lindell, *Secure Multiparty Computation*, COMMC'NS OF THE ACM VOL 64 NO 1, PAGES 86-96, 89 (2021).

must provide assure the verifier that the document uniquely and unequivocally pins down the data that pertains to the case at hand. It is stressed that this guarantee is twofold: First, the base document must uniquely pin down an entire dataset to be considered (while still keeping this dataset unknown to the verifier). Second, the verifier must be provided guarantees that this unknown dataset is the one that pertains to the case at hand. While the first guarantee (uniqueness) can be provided via purely mathematical means (such as encryption, one-way hash, or cryptographic commitment), the second guarantee would typically be obtained via social or legal means (such as third-party attestation, existing records, audit, or facing punishment for perjury).

(b) Once this base document is in place, the prover and verifier agree on the set of properties (of the hidden dataset) of which the prover will convince the verifier. These properties would typically take the form of a set of checks, or, more concretely, a computer program *C* that reads the dataset and outputs "ok" if all checks passed.

(c) Now, the prover and verifier each run their ZKP programs. (These programs, ZKP-Prover and ZKP-Verifier, respectively, would typically be fixed and known ahead of time.) The verifier's program, ZKP-Verifier, is provided the base document and the check-program *C*. The prover's program is provided the same base document and check-program, plus the hidden data. The two programs exchange messages until the verifier's program outputs its decision. (In the case of noninteractive zero knowledge, a single message from the prover's program to the verifier's program suffices. In general, however, more messages might be needed.) If its program accepts, then the verifier is assured that the hidden data the base document uniquely determined passes all the agreed-upon checks.

It is important to again stress that a ZKP does not provide, in and of itself, any guarantee regarding whether the hidden data identified by the base document pertains to the actual case. Such guarantee must be provided in case-specific ways.

A. INFORMATION PRIVACY AND SECURITY: USING ZKPS TO SEVER VERIFICATION FROM IDENTIFICATION

ZKPs can help reduce the need for existing, imperfect legal solutions to verification dilemmas. Recall the recurring verification problem whereby the process of verifying eligibility to access digital systems forces eligible access-seekers to expose facts about themselves, thereby risking broader aggregations of data and the creation of a permanent "digital person," and exacerbating the risk of theft, misuse, or fraud. As described in Section II.A, existing legal solutions to this problem have had little success in reflecting the insight that, "[i]f your personal data is never collected, it cannot be stolen."[132]

ZKPs can help to solve those verification problems that concern private or sensitive information by enabling individuals to verify the specific information required for authentication without disclosing their identity. Perhaps the most straightforward application of ZKPs—and the context in which its applications have advanced furthest—involve what is often referred to in the cryptography literature as "anonymous credentials."[133] By providing anonymous credentials, ZKPs enable digital "gatekeepers" that keep no private information about users and still recognize when an access-seeker is eligible for accessing the sought service.

More specifically, ZKPs allow users to keep control of their private information (e.g., birthdate, credit card and other financial information, passwords for access to various systems or services), storing them exclusively on their own computing devices or private spaces. When seeking to access a digital service, the user's computing device U will interact with the gatekeeping device G of the service, providing it with a ZKP that the user whose private information is recorded on the device U is one of the users allowed to access the service. Here the zero-knowledge property guarantees that neither G nor anyone else learns anything from the interaction with U other than the mere fact that U can access the service.

For example, ZKPs can permit the verification that an individual falls into a qualified "range," such as the age required to stream an R-rated film or order alcohol.[134] ZKPs can also be used to prove "set membership"—such as citizenship—in digital interactions without disclosing identity.[135] Stable noninteractive proofs of different personal attributes can be used to prove the statement that one is an EU citizen, for example, without even revealing one's member state. The European Commission's EU Blockchain Observatory &

132. *See* Dubovitskaya, *supra* note 15.

133. The concept of anonymous credentials has been studied extensively over the past two decades. *See* Jan Camenisch & Anna Lysyanskaya, *An Efficient System for Non-transferable Anonymous Credentials with Optional Anonymity Revocation*, 2001 ADVANCES IN CRYPTOLOGY – EUROCRYPT 93 (Birgit Pfitzmann ed.); Non-Transferable Anonymous Credentials, U.S. Patent No. 7,222,362 (issued May 22, 2007).

134. *The Sovrin Network and Zero Knowledge Proofs*, SOVRIN (Oct. 3, 2018), https://sovrin.org/the-sovrin-network-and-zero-knowledge-proofs/ ("It's as if you're creating a carbon copy of your driver's license that is every bit as reliable, and conveys the same personal identifiable information, as the real thing; but, based on who is asking, you control what information actually appears to them on that particular copy.").

135. *See id.* ("ZKPs can prove if a value is contained in a set without revealing with [sic] value.").

Forum heralded the promise of these approaches in promoting GDPR compliance, concluding that "ZKP applications hold great promise when it comes to privacy-by-design and self-sovereign ownership of personal data."[136] Some governments have already begun to develop public-based digital identification systems enabling "self-sovereign" selective disclosures of information.[137] Estonia has progressed farthest with a partially blockchain-based national identity system. This system facilitates managed information disclosure, enabling EU travel, national health benefits, bank account access, and medical-record administration.[138] A public-private partnership in the Dutch province of Groningen has implemented a digitized social service provision system that allows parents to receive funding for children who require financial aid. The system employs ZKP mechanisms to limit the exchange of raw personal data and permit the use of cryptocurrency as an additional privacy-protecting mechanism.[139]

ZKP-enabled data comparisons are useful also for preserving privacy in biometric applications by freeing gatekeeper servers from having to store users' private biometric features, such as fingerprints, iris scans, or face prints.[140] Instead, it is only the user-controlled device that keeps the users' private biometrics, and the gatekeeper only needs to store public, nonidentifying information.[141]

The use of ZKPs for verification of eligibility has another important advantage: it allows controlling the extent to which gatekeepers are able to link between different access attempts by the same user (or related users).[142] When

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136. THE EUROPEAN UNION BLOCKCHAIN OBSERVATORY & F., BLOCKCHAIN AND THE GDPR 23 (2018), https://www.eublockchainforum.eu/sites/default/files/reports/20181016_report_gdpr.pdf.

137. ANDREJ J. ZWITTER, OSKAR J. GSTREIN & EVAN YAP, DIGITAL IDENTITY AND THE BLOCKCHAIN: UNIVERSAL IDENTITY MANAGEMENT AND THE CONCEPT OF THE "SELF-SOVEREIGN" INDIVIDUAL 8–10 (2020), https://www.frontiersin.org/articles/10.3389/fbloc.2020.00026/full.

138. *e-identity*, E-ESTONIA, https://e-estonia.com/solutions/e-identity/id-card; *see* ZWITTER ET AL., *supra* note 137, at 8.

139. ZWITTER ET AL., *supra* note 137, at 9 (citing Pim Van der Beek, *Blockchain Kindpakket Zuidhorn Wint Prijs*, COMPUTABLE (Mar. 30, 2018), https://www.computable.nl/artikel/nieuws/digital-transformation/6329958/250449/blockchain-kindpakket-zuidhorn-wint-prijs.html).

140. *Cf.* Andrea Roth, *Spit and Acquit: Prosecutors as Surveillance Entrepreneurs*, 107 CALIF. L. REV. 405, 407–08 (2019) (describing large database of DNA collected through deals of prosecutorial leniency).

141. It is noted that ZKPs are typically applied to the digital rendering of the biometrics, rather than to the biometrics themselves. Still there do exist ZKPs that are applied directly to biometric data. *See, e.g.*, Fisch et al., *supra* note 120, at 314.

142. *See infra* note 160.

optimizing for privacy, systems can be set so that gatekeepers will not be able to link between access attempts by any sets of users. Alternatively, systems can be designed so as to enable gate keepers to collect agreed-upon statistics on the characteristics of users attempting access. For example, with a ZKP, sign-in systems that use government-provided IDs can be designed to allow for the gatekeeper to collect the states of all participants but verify the ID's validity without collecting a name; all that is required is agreeing on this schema ahead of time.

This Section has detailed use cases for ZKPs to protect privacy by helping to solve verification dilemmas in law without requiring overdisclosure. As the following Sections will show, in other instances, the ability to shield attributes of personal information in big data sets can further information protection in both the private transactional (Section IV.B.), and public governance (Section IV.C.) contexts.

B. Dealmaking: ZKPs and Avoiding Arrow's Paradox

1. *ZKPs and Information Partitioning*

Developing successful use cases for ZKPs in dealmaking would provide important means for avoiding the all-or-nothing disclosure choice faced by participating parties, reducing disclosure risk that make negotiations costly. ZKP's capacity to partition information could, in Michael Burstein's words, allow "sufficient information to be transferred to link ideas with capital and development partners" while also "ensuring that enough value remains in the original information holder so that she still has an incentive to disclose."[143] In certain contexts, ZKP's capacity to partition information could permit the opportunity for more limited disclosures, protecting proprietary information by minimizing the amount of information subject to Arrow's disclosure paradox and by avoiding the threat of mandated disclosure to legal or regulatory authorities down the line—a potentiality reflected in the exceptions contained in standard confidentiality agreements.[144] In other contexts, it could allow more extensive disclosures, such as when information is not shared because of the threat of antitrust or contract liability arising from sharing secrets with rivals or revealing confidential contract terms; or, similarly, because the disclosure would violate privacy mandates. In both cases, meaningful partition of information could facilitate a more "optimum level of appropriability."[145]

143. Burstein, *supra* note 38, at 254.

144. *See* Practical Law Corporate & Securities, Confidentiality Agreement (US-Style): Cross-Border Acquisitions 3 (2021), Westlaw w-002-6486 (discussing "Required Disclosure").

145. Burstein, *supra* note 38, at 254.

Such partitioning would facilitate the exploration and consummation of beneficial deals. Enabling limited information sharing—especially at the initial phases of negotiation—would allow parties to get a sense of potential partners' motives early on, facilitating ongoing negotiations in contexts where jeopardizing proprietary information is at a premium. This could prove particularly helpful in the start-up financing context, where specialized funds frequently focus on targeted market segments and engage in simultaneous discussion with numerous firms in the same business space, fostering suspicion among innovators about the funds' use and sharing of their information, creating a drag on the entrepreneurial system.

More generally, the successful development of meaningful applications for ZKPs in dealmaking may well have transformative effects on market structure itself. Such successes could transform the "boundaries of the firm" by expanding firms' choices regarding whether they need to protect innovation by keeping knowledge of the information within firm boundaries or, alternatively, profit from that innovation through partnerships or market transactions. Economic understandings of the ways firms organize, building on Ronald Coase's theories,[146] suggest that when the costs of transactions between firms exceed the benefits of those transactions, business functions will be kept or brought within the company—in other words, firms will vertically integrate.[147]

Intellectual property scholars have extended these insights to the information context, pointing to the disclosure costs resulting from Arrow's paradox as additional constraints on a firm's decision whether to perform functions internally or to contract with others to perform them. Robert Merges argues that strong intellectual property rights alleviate many of the costs

146. *See generally* Ronald H. Coase, *The Nature of the Firm*, 4 ECONOMICA 386 (1937) (exploring what accounts for the boundaries of firms, and why some production functions are executed within the firm, while other functions are executed outside the firm on the market).

147. *See id.* at 394–96; *see also* Burstein, *supra* note 38, at 245 ("The theory of the firm suggests that in the absence of other solutions to transaction costs, firms will vertically integrate"); Dan L. Burk & Brett H. McDonnell, *The Goldilocks Hypothesis: Balancing Intellectual Property Rights at the Boundary of the Firm*, 2007 U. ILL. L. REV. 575, 579 (2007) ("First, they must search for and identify each other as potential partners. Once they have found each other, they must negotiate with each other as to the terms that will govern their relationship in making the widget. Once they have reached agreement and entered into a contract, each party must monitor the performance of the other to ensure that it is doing as promised. Disputes may arise as to whether one or both has performed as promised. Each of these steps may generate costs that reduce the value that the transaction creates.").

associated with interfirm market transactions.[148] According to Merges, intellectual property rights resolve the disclosure paradox by making information excludable and eliminating the need for firms to integrate production functions into their hierarchies.[149] Consequently, Merges argues, stronger intellectual property rights, especially patents, facilitate efficient interfirm transactions,[150] and functions that were traditionally in-house will rather be executed on the market, ultimately resulting in "smaller, nimbler, and more specialized firms."[151]

Yet the calculus changes in contexts in which confidential or sensitive business information or trade secrets lack strong legal protection, as is frequently the case in transactional due diligence. By this logic, writes Michael Burstein, "the absence of property rights in information that firms need to transfer should lead those firms to integrate in order to accomplish the transaction"[152] rather than achieve their goals through joint ventures or market exchange. The development of ZKP methods for partitioning information so that less of it needs to be transferred, accordingly, could limit transaction costs in a way that expands firm choices, permitting verification of material elements without full revelation.

2. *Use Cases*

The range of sensitive information relevant to transactions will differ by case. Still, it is worth exploring a range of use cases that frequently arise in deals. Certain paradigmatic types of trade secrets that might be significant in determining a transaction's worth, such as manufacturing processes or characteristics or emergent qualities of recipes (like the uniqueness, or lack thereof, of various Coca-Cola beverages produced using slightly different ingredients) are not easily digitized. Accordingly, such types are not readily amenable to traditional ZKPs on digital data. But where information is already or can be digitized, statements about it are immediately amenable to verification with zero-knowledge.

148. *See* Robert P. Merges, *A Transactional View of Property Rights*, 20 BERKELEY TECH. L.J. 1477, 1513–14 (2005); *see also* Ashish Arora & Robert P. Merges, *Specialized Supply Firms, Property Rights, and Firm Boundaries*, 13 INDUS. & CORP. CHANGE 451 (2004).

149. *See* Merges, *supra* note 148, at 1503.

150. *See id.* at 1488–89, 1512–13.

151. Burk & McDonnell, *supra* note 147, at 615; *see* Merges, *supra* note 148, at 1507. *But see* Burk & McDonnell, *supra* note 147, at 615 (agreeing that overly weak intellectual property rights offer less utility in overcoming the disclosure paradox, leaving firms little choice but to turn to integration to protect their innovations, but also arguing that overly strong protections can also result in a "situation where property rights are fragmented or too finely divided, impeding or preventing desirable projects that entail such rights").

152. Burstein, *supra* note 38, at 245.

Easier use cases might include verifying customer numbers and characteristics without revealing full customer lists. Easier use cases could also include verifying contract attributes and terms—such as length, assignability, contingency, or even profit margins. Furthermore, information can be revealed with any agreed-upon level of granularity. For instance, contract terms or profit margins can be either fully disclosed or else asserted to be within a certain range. So long as both sides in a transaction agree on which elements would satisfy their need for diligence material to the transaction, and the information was encoded and stored digitally along these variables, using a ZKP would address privacy concerns and protect proprietary information while obviating the need for clunky, often imperfect, analog methods, such as creating and providing redacted versions of volumes of documents.

ZKPs offer an even greater promise in more complex situations where the partitioning of sensitive information to "exposed" and "unexposed" portions incurs additional challenges. In some of these cases, without ZKPs we are currently limited to either sharing all of the data or none of it, and neither option is desirable.

One such situation is the case where there is contention regarding the form, precision, and scope of the information to be disclosed, and some creative middle-ground solutions might be necessary. Here, ZKP's generality and flexibility greatly facilitate finding such middle ground. For instance, potential acquirers or venture capital funds may legitimately wish to assess the financial models that potential targets, or start-up firms, have used in projecting future performance. At the same time, the latter often hold that these models reveal confidential and proprietary information. ZKPs allow the parties to explore compromises by having the target firm assert certain partial information about their financial models (e.g., asserting that certain salient parameters are within a given range or disclosing only partial information on the outcome of the model).

Another complex situation is mergers where both parties have proprietary secrets they are reluctant to disclose, and at the same time each party wishes to learn certain partial information about the other party's secrets. In such situations, even disclosing to the other party the type of partial information one is interested in might compromise one's own secrets, so the above method of partitioning proprietary information to disclosed and undisclosed portions might run into a wall.

ZKPs can get around this seemingly inherent difficulty with the help of multiparty secure computation (MPC) technology, introduced in Section II.A.ii. MPC technology allows the parties of a merger discussion to (a) agree on which partial information each party should obtain, where that partial information may depend both on one party's own secrets and on the other party's secrets, and (b) engage in an interactive protocol which implements the disclosures agreed upon in stage (a). Adding ZKPs on top the MPC protocol allows each party to verify that the information it obtained from the MPC protocol was computed as agreed and that the other party did not learn anything beyond what was agreed upon initially.

For instance, suppose two health companies, with two sets of patient data, wish to explore a merger or partnership. In assessing the value of the patient data held by the other firm, each wishes to know whether their respective customer pools are similar in characteristics (permitting synergies by expanding a particular approach to care across similar populations) or different (suggesting that the two do not overlap). They may even wish to perform a computation on the combined data to explore whether a merger might improve outcomes or aid in research. For a range of reasons—privacy, antitrust, protection of proprietary assets—they could not allow each other access to the data sets themselves. Moreover, data anonymization—which in some circumstances would permit its transfer—might eliminate the very characteristics (e.g., where the subjects live)—that make it valuable in the first place. Today, the only way to perform such checks is to engage a trusted third party and disclose all secrets to it. However, this is an expensive and risky solution that might well render the potential merger not worth pursuing. ZKPs along with MPC could potentially turn such negotiations to mundane routine.

Finally, perhaps the most challenging application—yet one that holds substantial promise—arises in verifying aspects of proprietary code, software, or algorithms. This is the type of issue at the heart of the *TargetSmart* allegation discussed above,[153] and often the core innovative element in a deal—hence often the most sensitive.

A potential partner, acquirer, or funder might want to verify both the correctness and validity of a program (*i.e.*, whether it "operates as intended") as well as its novelty. The challenge in verifying correctness is finding agreement on what its intended operation entails and codifying this agreement specifically enough to enable a clear resolution of the question. ("Correctness" can have multiple interpretations, in different contexts.) Still, once such agreement is reached, the actual test of correctness can be done via ZKPs, with the guarantee that nothing else is disclosed other than the result of the agreed-upon test of correctness.

The following two are worth highlighting in concluding this Section: First, deploying ZKPs in settings where the properties asserted about the hidden

153. *See* Part I.

information may be cumulative requires extra care (e.g., when the parties may agree on new properties to be asserted as part of an ongoing interaction or negotiation). In particular, it must be assured that all the properties are asserted with respect to *the same corpus of hidden data,* namely with respect to the same initial base document. Furthermore, the parties must be aware of the potential leakage of information from the aggregate of all the checks considered together.

A second point pertains to the inherent difficulties of formalizing potential checks as computer programs applied to the hidden data. As a telling example, asserting a property such as "novelty" in zero knowledge might prove to be a tricky business. Indeed, the crux of the difficulty is in translating the "novelty" claim to rigorously verifiable assertions. (This is the case even regardless of the need to keep the innovation secret.) One potential path for such translation is to turn the statement on its head and instead prove dissimilarity of the hidden algorithm to some known and plausible prior art candidates similar to the new algorithm. Here, again, a set of concrete, quantifiable measures of similarity between algorithms would need to be agreed upon. Once such agreement is obtained, and the measures have been encoded in a sufficiently specific way, ZKPs can be employed to assert that the hidden algorithm is sufficiently dissimilar to any one of the candidate prior-art algorithms.

C. Government Oversight: ZKPs in Algorithmic and Data Accountability

As laid out in Section III.C, there are a host of situations where government accountability and the transparency of administrative and judicial decision processes stand in direct conflict with a perceived need to keep certain information secret. This Section outlines how ZKPs can be a game-changer in this domain, enabling transparency and accountability, while at the same time preserving (and even improving on) secrecy and privacy protections when they are justified and legitimate. Following the lead of Section II.C.1, this Section outlines potential uses of ZKPs to alter the all-or-nothing baseline choice regarding disclosure, in the case of algorithmic identification, algorithmic accountability, and privacy-preserving data verification.

1. *Verifying the Identity of Algorithms*

ZKPs can be used to assert that a value is the result of running a specific hidden algorithm on some data without revealing the code or other information about the algorithm. Determining how to specify the algorithm and how to make it amenable for a ZKP would need to depend on the case at hand. Appendix B presents a potential process for using ZKPs in a case like that of the FST algorithm, outlined in Section 1.C., provided that—unlike with FST—the algorithm was of a sort that had a legitimate reason for secrecy.

In the context of financial stress tests, the benefit of ZKPs can be twofold: First, the stress tests themselves can deploy ZKPs to allow the Federal Reserve to verify assertions regarding financial information (such as volatility of investment portfolios) of the tested financial institution without violating the statutory confidentiality of same information.

Second, as in the IRS example, a public review board can determine a process for certifying financial stress tests. The certification process can take into account sensitive secret information known only to the Federal Reserve, as well as sensitive secret information known only to the tested financial institution. Still, the certification process itself would be transparent and open to public scrutiny. When performing a stress test, the Federal Reserve will provide the tested institution with a ZKP that the test has passed the certification process.

2. *Verifying Characteristics of Algorithms*

Another set of challenging situations outlined in Section II.C.1 involve the conflict between the need to keep certain government-run algorithms secret and the need to provide public evidence that these same algorithms behave in certain ways. This is one of the manifestations of the algorithmic accountability challenge.[154] Algorithmic accountability can manifest in many ways, including reviewing the algorithm's code directly or proving particular assertions about the code by subjecting it to tests like static analysis. However, these methods typically require full access to the analyzed algorithm.

ZKPs have the capacity to transform the field by again cutting the Gordian knot of secrecy: using ZKPs, governments—and even private entities that may introduce fairness concerns, like banks and credit agencies—can prove assertions about their algorithms without revealing them. This capability creates privacy-preserving accountability without resorting to full disclosure.

154. *See* Deirdre K. Mulligan & Kenneth A. Bamberger, *Procurement as Policy: Administrative Process for Machine Learning*, 34 BERKELEY TECH. L.J. 773, 791–96 ("Scholars have identified a number of ways that these systems operate as black boxes, inscrutable from the outside: (1) corporate secrecy, by which the design details are kept secret by private developers; (2) technical illiteracy—the impenetrable nature of system rules to non-engineers even where they are shared; and (3) the inability of humans, even those who design and deploy machine learning systems, to understand the dynamic models learned by complex machine learning systems."); *see generally* Kroll et al., *supra* note 14; Sonia K. Katyal, *Private Accountability in the Age of Artificial Intelligence*, 66 UCLA L. REV. 54 (2019); David Freeman Engstrom & Daniel E. Ho, *Algorithmic Accountability in the Administrative State*, 37 YALE J. ON REG. 800 (2020).

Furthermore, ZKPs can do so ex ante, as a matter of process, rather than as part of a costly ex post litigation.

The benefit of using ZKPs is amplified in common situations where government agencies rely on contractors who may produce code that is too complex for the government agency itself to understand or that is kept secret for intellectual property reasons.[155] In such cases, the onus would be on the contractor to generate the ZKPs proving the agreed-upon assertions regarding the algorithm in use.

Returning to the challenge of asserting even-handedness in IRS auditing algorithms while preserving secrecy of the auditing algorithm itself, a ZKP-based solution could take the form of the following two-step process:

1) An IRS review board will determine a process for certifying auditing algorithms. The process might specify, say, criteria for selecting keywords to be used in identifying entities to be audited, as well as other limitations. Or it could instruct that the auditing algorithm be run on some benchmark sample of cases to detect potential bias. The certification procedure itself can be public and transparent.

2) Any IRS audit will be accompanied by a ZKP that the audit decision was made by an algorithm that passed the certification process that was approved by the review board. Both the algorithm and the data algorithm uses to determine the audit decision itself will be kept secret.

3. *Privacy-Preserving Verification of Data*

Another domain where transparency and government accountability stand in contrast with the need to keep salient information hidden is that of determining government policy based on data collected from or about individuals. Such data is often subject to use and disclosure restrictions to protect the privacy of the individuals whose data is used.

To allow for meaningful use of data about individuals (say, medical, economic, or social data) without violating these privacy constraints, mathematical methods have been developed for disclosing collected data in aggregate (and often perturbed) forms that prevent reidentification of individuals while still maintaining much of the data's utility for inferring salient properties of the population. Most studies and policy decisions can use the

155. *See* Mulligan & Bamberger, *supra* note 154, at 789 ("On the one hand, private developers keep much of the relevant code secret. On the other hand, agency staff frequently have few technical skills, so they can neither assess technology design shared with them nor participate in design themselves."); Kroll et al., *supra* note 14, at 647, 662, 685.

aggregated privacy preserving data in lieu of the original, raw data that compromises individual privacy.[156]

However, using privacy-preserving data aggregation methods incurs a potentially significant drawback: in and of itself, the aggregated data is not obviously tied to any individual or the raw data. A suspicious critic of a study or policy decision, then, has no way to verify whether the posted aggregate data corresponds to the actual raw data collected from individuals. Instead, the critic must trust the entity that presents the aggregate data to perform the aggregation and perturbation process as claimed. This situation is a bit unsettling, as there is no way to verify correctness of the aggregation.[157]

Using ZKPs, the entity that performs the data aggregation and perturbation can first provide a digital commitment to the actual raw data. Then, the entity would provide a proof that the aggregated data is the result of applying a prescribed and certified aggregation and perturbation method to the committed data. This can be done without exposing the raw data any further.

D. TRADE SECRET LITIGATION: ZKPS AND THE ADVERSARY PROCESS

Beyond mitigating the need for ex post legal remedies, ZKPs could also improve the function of those remedies that remain necessary. Here we concentrate on the case of trade secret litigation, where the ability to prove claims about secrets, while preserving their secrecy and value, is key.

There are several use cases, described below, where ZKPs can help solve litigation verification dilemmas while avoiding overdisclosing sensitive information.[158] We start with some straightforward cases and make our way to more complex ones. We consider how the level of complexity of deploying ZKPs increases along the following two axes: first, the level to which the alleged trade secret, as well as the other relevant secret information the parties hold, can be rendered as well-defined digital documents; and second, the ease of mechanizing the process of determining whether the defendant's documents constitute an alleged trade secret misappropriation.

156. One salient class of methods for aggregating and perturbing data to preserve privacy are *differential privacy* methods. *See* Cynthia Dwork, Frank McSherry, Kobbi Nissim & Adam D. Smith, *Calibrating Noise to Sensitivity in Private Data Analysis,* 3 THEORY OF CRYPTOGRAPHY 265, 265 (Shai Halevi & Tal Rabin eds., 2006).

157. This is the stated reason for the new EPA rule. *See* 86 FED. REG. 469 (Jan. 6, 2021).

158. Importantly, the claim is not that ZKPs could *determine* the legal status of a claim of trade secret misappropriation. Rather, ZKPs can help the parties analyze evidence that might support or negate a legal finding of misappropriation, without risking disclosure of their trade secrets to their litigation adversaries.

1. *Case I (Customer Lists)*

The first case is where the information provided by the parties exists in well-defined digital documents, and evidence of misappropriation, or lack thereof, is assessed by a purely mechanical process, namely the number of equal entries in the documents.

Consider a plaintiff alleging that the defendant misappropriated the plaintiff's secret database of valuable customers. Assume that the customer databases of both the plaintiff and the defendant are digitized and stored in well-defined locations, and it has been established that the only way for the defendant to obtain the names of these customers is by misappropriation of the plaintiff's database. Accordingly, the only remaining question is whether there is any sizable intersection between the plaintiff and defendant's respective databases. ZKPs then allow for any one the following interactions to take place:

1) Privacy for plaintiff:
    a. The plaintiff computes a cryptographic commitment C_p to its own database.
    b. The defendant reveals its own database D_d to the plaintiff.
    c. The plaintiff generates a zero-knowledge proof for the following statement: "The database that is committed to in C_p and the database D_d have x records in common."
2) Privacy for defendant:
    a. The defendant computes a cryptographic commitment C_d to its own database.
    b. The plaintiff reveals its own database D_p to the defendant.
    c. The defendant generates a Zero-knowledge proof for the following statement: "The database that is committee to in C_d and the database D_p have x records in common."
3) Privacy for both parties:
    a. The plaintiff computes a cryptographic commitment C_p to its own database.
    b. The defendant computes a cryptographic commitment C_d to its own database.
    c. The plaintiff and defendant engage in a two-party secure computation where they jointly generate a ZKP of the statement: "The database that is committed to in C_d and the database that is committed to in C_p have x records in common."

Clearly, each one of these three methods carries a different burden for each party. The first method gives an advantage to the plaintiff, in that it allows the plaintiff to keep the secrecy of its trade secret while requiring the defendant to expose its secret information to the plaintiff and the court. The second method gives the same advantage to the defendant: it requires the plaintiff to expose its trade secret to the defendant and to the court while allowing the defendant to keep the secrecy of its trade secrets from the plaintiff and from the court. The third option allows both parties to keep their secrets secret. It would be up to the court and the parties to determine which method to use.

2. *Case II (Annotated Customer List)*

Assume that the plaintiff's customer database also contains notes with additional (legitimate and worthwhile) information that the plaintiff collected about its customers, say the type of products they prefer. To assess whether the defendant misappropriated the plaintiff's secret database one may wish to determine the level of similarity between the plaintiff's notes and the defendant's notes. This might involve several context-sensitive aspects, including textual and semantic features of the notes.

To determine whether the notes are similar enough to support—or disparate enough to negate—an inference of misappropriation the parties could proceed in a similar way to the one described above. However, in this context, with a crucial additional first step whereby an algorithmic process should be set for determining whether the notes are similar enough. That is, an examining expert could first determine the criteria for whether the databases are similar enough. Next, the parties would agree upon a mechanized process for determining whether these criteria hold, given the plaintext databases. Importantly, the criteria and process for determining whether the criteria hold is determined without access to the databases themselves. Rather, they constitute an algorithm that would evaluate similarity of any potentially relevant pair of databases.

Once such a mechanized process is in place, the parties would run this process "in zero knowledge." This can be done in any one of the three alternative ways described above, with the difference that the criterion "the databases have *X* records in common" is replaced by "the agreed algorithm determines that the databases are similar enough or not similar enough" (whichever is the case).

Note that there may be multiple reasons for parties to want to keep information such as notes in a customer database secret. In addition to privacy concerns, companies sometimes lace their databases with "easter eggs"—fake or non-operational data laced into databases or code—that can be used to identify trade secret theft. Here, the easter egg is a trade secret, and if one reveals what it is, then its value for detecting future misappropriation will reduce. Using a ZKP to determine the presence or absence of an easter egg in the opposing parties' database can keep the easter egg itself secret and thus operational.

3. *Case III (Computer Programs)*

Assume the alleged misappropriated trade secret is a computer program rather than a database. That is, the plaintiff claims that a certain computer program *P* sold or used by the defendant misappropriates a computer program *P'* that is the plaintiff's trade secret. Assume further that both programs *P* and *P'* are written in well-defined digital documents, and that the only remaining question is whether the programs are similar enough to support an inference of misappropriation. In this case, the parties can determine similarity of the programs while keeping them secret in very much the same way as in Case II. The only difference is that the algorithmic process for determining the programs' similarity might be somewhat more technically involved and require the assistance of an expert in programs of the relevant character. Importantly, as with Case II, the similarity-determining algorithm would be developed without access to the secret programs themselves. In particular, the expert is not encumbered with any secret information. Hence, a ZKP could have avoided the type of misconduct in the example described earlier where StubHub sought to hire a settlement expert as its own witness in subsequent litigation.[159]

4. *Case IV (Mixed Media)*

Finally, consider Case II (annotated customer list) again, but assume that either the plaintiff's list or the defendant's list appears in a variety of forms—say, some items appear on hand-written notes, others on voice recordings, yet others in multiple separate documents. Here, the process described in Case II will need to be augmented by two initial processes: (1) a process of pinning down a digital rendering of the information that the plaintiff claims as a trade secret, and (2) a process of pinning down a digital rendering of the information that allegedly misappropriates the secret. This should be done while preserving both parties' secret information. As per our example, process (1) can amount to the plaintiff providing digital commitments (see Section II.A) to the audio of relevant voice recordings, digital photocopies of the handwritten notes, and all the relevant digital documents. Process (2) is a bit trickier, and may be context-dependent: for instance, the defendant can be asked to provide digital

159. *See supra* Section II.D.1.

commitments to its database of customer information and provide assurance that it uses no other source of information on customers.

V. LESSONS FOR ZKP INFORMATION GOVERNANCE

This Part develops a framework for evaluating the policy implications of substituting ZKP technology as an information governance tool in lieu of, or in addition to, existing legal, technological, or institutional solutions to verification dilemmas. Adopting new governance technologies risks disrupting background presumptions against which existing law and practice have developed. Failing to understand these disruptions with specificity, in turn, threatens to render invisible the policy decisions that adopting new governance technologies can enact.[160] Being clear about these disruptions, by contrast, can provide what Deirdre Mulligan and Kenneth Bamberger have called "political visibility"—surfacing "the very existence and political nature of questions being resolved by design choices," which in turn makes them "visible to stakeholders and the broader public" and more amenable to purposive resolution.[161]

Accordingly, this Part begins by explaining some key technical prerequisites to implementing ZKPs. Next, it examines how meeting these technical prerequisites and deploying ZKPs would change information-protection practices as compared to existing legal rules. We argue that ZKPs carry policy implications along five broad axes: better enforcement, technological self-reliance, efficiency, stickiness, and specificity. Finally, we suggest a series of policy questions that decisionmakers considering adopting ZKP governance tools should consider.

A. TECHNICAL PREREQUISITES TO IMPLEMENTING ZKPS

First, it will be helpful to clarify certain technical prerequisites to the implementation of any ZKP. The fact that ZKPs take the form of mathematical proofs requires, for their operation, data in a certain form, operated on by a certain type of rule. Regarding the data, ZKPs require that the data must be *well-defined* and *unambiguously interpretable*. (Typically, the data will be digital. Non-digital data may be acceptable if it can be digitized via an effective and unambiguous mechanism.) In addition, two key elements characterize the implementation of the proof. First, the *information to be disclosed* about the hidden data must be specified. (Typically, a ZKP will involve disclosing a digital commitment to the private data. The commitment

160. Deirdre K. Mulligan & Kenneth A. Bamberger, *Saving Governance-by-Design*, 106 CALIF. L. REV. 697, 772 (2018).

161. *Id.*

preserves the secrecy of the data while making it unequivocal. In addition, some characteristics of the data might be disclosed—for example, some bounds on the size of the data.) Second, *the assertion to be verified* about the hidden data must be decided and agreed upon beforehand. (Typically, the assertion will involve the hidden data, along with the disclosed information.)

These requirements of ZKP implementation affect the type of "translation" challenges relevant to considering the use of ZKPs to help resolve legal verification dilemmas. In particular, the case must be one where legal statements can be rendered in code and human judgment can be reduced to design requirements.[162] In particular, some of the cases discussed are "easy" precisely because attributes of the information being verified are already amenable to being encoded into variables (such as age range or data characteristics already captured in digital form). The more difficult cases present increasing complexity for encoding information into variables. Physical data, for example, must be measured and those measurements made digital. Rich data, by turn, may need to be reduced to simpler data, such as the earlier example of simplifying contractual terms. It also means that the measurements that form the ground truth must be agreed upon and unambiguous.

Finally, recall that a ZKP is not complete without an additional guarantee that the data considered in the mathematical proof are the same as the objects considered in the litigation or other legal verification dilemma. In particular, where the prover applies the ZKP to committed data, making sure that the committed data relate to the actual object at issue in the verification dilemma must be handled using other mechanisms that would be context specific. Such mechanisms could include a public hash, contract law, third party auditors, or court orders punishable by contempt. Indeed, if the prover runs the ZKP on false data, whether as a result of user error or malicious cheating, the outcome of the proof will be meaningless for the legal verification dilemma. As mentioned previously, this point of failure falls outside the scope of what a ZKP can address.

B. FIVE AXES FOR EVALUATING ZKP POLICY

Having laid the technical foundation, this Section explores the ways that ZKPs can change the nature of information governance as compared to the

162. *See* Kenneth A. Bamberger, *Technologies of Compliance: Risk and Regulation in a Digital Age*, 88 TEX. L. REV. 669, 676 (2010) ("Computer code . . . operates by means of on-off rules, while the analytics it employs seek to 'quantify the immeasurable with great precision.'"); Danielle Keats Citron, *Technological Due Process*, 85 Wash. U. L. Rev. 1249, 1303 (2008) ("Automated systems inherently apply rules because software predetermines an outcome for a set of facts.").

baseline of current legal practice. We argue that these changes occur along five axes—better enforcement, self-reliance, efficiency, stickiness, and precision—each of which carries policy tradeoffs.

1. *Better Enforcement*

Supplementing legal remedies with ZKP technology can better enforce existing legal rules. For instance, as detailed in Section II.A, existing legal solutions to verification dilemmas in information privacy and security rely on imperfect notice-and-consent regimes, unreliable anonymization mandates, and often-prohibitively expensive ex post litigation remedies that fail to correct for unidentified misappropriation or other harms. In contrast, as detailed in Section IV.A, ZKPs offer a new alternative of lesser-disclosure, which makes ex ante consent more meaningful. ZKPs can also eliminate the need to collect, duplicate, and aggregate personal identification data, which in turn avoids problems of unreliable anonymization. ZKPs can also make ex post litigation remedies unnecessary, thereby avoiding their costs and oversights. Hence, ZKPs can better enforce existing legal safeguards.

Notably, scholars have long debated policy preferences for either more or less comprehensive enforcement of law in different circumstances.[163] Although ZKP-enabled enforcement may well be optimal for some privacy and security protections, it could also eliminate beneficial leakiness in status quo legal safeguards. For instance, the U.S. Supreme Court has identified leakiness as a key feature of substantive trade secret law that distinguishes it from, and prevents its preemption by, federal patent law.[164] Here, we identify enforcement as a key axis that the adoption of ZKPs can alter, noting some positive use cases in the protection of privacy. The policy consequences of other applications should be evaluated on a case-by-case basis.

2. *Technological Self-Reliance*

As a second axis of alteration, ZKPs offer a technological self-reliance mechanism to extend information protections beyond existing legal rules. In other words, ZKPs can completely seal information in circumstances where even perfect enforcement of existing law would have permitted "knowledge spillovers."

For example, consider the disclosure of trade secrets under a contractual NDA or judicial protective order. As discussed in Sections I.B and III.B, even if the recipient fully abides by the terms of that agreement or order, merely

163. *See, e.g.*, EDUARDO M. PENALVER & SONIA K. KATYAL, PROPERTY OUTLAWS: HOW SQUATTERS, PIRATES, AND PROTESTERS IMPROVE THE LAW OF OWNERSHIP (2010).

164. *See* Kewanee Oil Co. v. Bicron Corp., 416 U.S. 470, 490 (1974).

viewing the information might advantage them to the detriment of the discloser or in a manner that implicates antitrust concerns. Such "knowledge spillovers" are inherent in the sharing of information that cannot be unseen. Existing law often may provide no remedy against these more abstract knowledge transfers, sometimes even encouraging them. Trade secret law, for instance, encourages abstract knowledge transfers by explicitly exempting an employee's "knowledge, skill, and experience" from trade secret protection[165] and by disfavoring injunctions based solely "on the information the person knows"[166] (rather than on evidence of actual or threatened misappropriation). If firms deploy ZKPs to limit what information employees receive, then employees may not gain the same level of knowledge, skill, or experience to transfer with them to a future employer.

ZKP technology can extend privacy protections beyond existing legal rules by eliminating certain information transfers entirely and, as a result, their derivative knowledge spillovers. Such technological self-reliance "use constraints"[167] above and beyond even perfectly-enforced legal entitlements could benefit ZKP adopters yet simultaneously impose societal drawbacks. For instance, ZKP-enabled lesser-disclosures of information could impede auditing, making it harder to identify and correct mistakes. Lesser-disclosures may also eliminate serendipitous, unanticipated discoveries that could be gained from reviewing broader swaths of information. Scholars have debated similar issues in relation to Digital Rights Management technologies and copyright law. For instance, Julie Cohen has identified the potential for Digital Rights Management to "automatically enforce limits on user behavior" and create a governance mechanism that does more than existing legal regimes.[168] Similarly, ZKPs could permit trade secret owners to preempt the policy balancing built into current legal systems by imposing broader technological self-reliance protections than existing legal regimes would permit.

3. *Efficiency*

Supplementing law with ZKP technology can also improve efficiency in comparison to both legal and technical baselines—our third axis. ZKPs can substitute cheaper ex ante technical protections for costly litigation remedies. When ex post litigation remains necessary, ZKPs can make it cheaper to

165. *See* Camilla Hrdy, *The General Knowledge, Skill, and Experience Paradox*, 60 B.C. L. REV. 2410, 2410 (2019).

166. 18 U.S.C. § 1836(b)(3)(A)(i) (2018).

167. *See* Mulligan & Bamberger, *supra* note 160, at 717 (discussing the phenomenon); Margaret Jane Radin, *Regulation by Contract, Regulation by Machine*, 160 J. INST. & THEORETICAL ECON. 142 (2004).

168. Julie Cohen, *DRM and Privacy*, 18 BERKELEY TECH. L.J. 575, 580 (2003).

protect information during legal procedures. Consider the example of redacting voluminous records described in Section IV.B. Even setting aside the issue of leaks through sloppy redactions that either overlooked key information or redacted in an unsecure manner,[169] redactions take time and resources. Using ZKPs instead may be a more efficient, as well as a more reliable, solution.

Of course, as with each axis that ZKPs alter, increasing efficiency may sometimes produce undesirable policy consequences. For one illustrative example, courts and scholars grappling with the relationship between the Fourth Amendment and technological change have debated whether the ease and affordability of new surveillance technologies might undermine prior de facto privacy safeguards produced by cost.[170] So too, the substitution of manual redaction with easier and cheaper ZKPs might lead to excessive secrecy. Whereas the resource-intensive nature of manual redaction could encourage verifiers to err on the side of over-disclosure, cheap and easy ZKP-enabled micro disclosures could encourage verifiers to rely on ZKPs to limit disclosures of relevant information even when broader disclosures would have been acceptable.

4. *Stickiness*

Supplementing law with ZKP technology can increase the *stickiness* of assertions. Recall ZKP's requirement for precise, unchangeable pre-specification and pre-commitments. Stickiness means that this requirement pins down representations concerning information and choices about decisional rules earlier than existing legal regimes. This pinning down also limits a user's capacity to evolve over time. Stickiness may be good or bad. It prevents subsequent nefarious tampering but also makes it harder to correct initial mistakes.

For example, in the context of government algorithmic oversight, applying ZKPs would require ex ante commitments about government processes and compel the government to stick by that process.[171] Similarly, ZKPs require the

169. *Cf.* Tucker Higgins, *Justice Department Mistakenly Reveals Indictment Against Wikileaks' Julian Assange*, CNBC (Nov. 16, 2018), https://www.cnbc.com/2018/11/16/doj-mistakenly-reveals-indictment-against-wikileaks-julian-assange.html (recounting the accidental filing of sealed information on a public docket).

170. *See, e.g.*, Kiel Brennan-Marquez & Stephen E. Henderson, *Search and Seizure Budgets*, 13 U.C. Irvine L. Rev. at 9-11 (forthcoming 2023) https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3910743 (proposing numerical caps to artificially constrain the state's search and seizure capacity given that technological change can make the production of surveillance data "trivial").

171. *See* Kroll et al., *supra* note 14, at 668-69.

government to commit to pinning down a piece of data, and making all subsequent determinations depend on that pinned-down data.[172] This characteristic of sticky representation of information is also evidenced by the potential use case for ZKPs in trade secret litigation. Applying ZKPs would require a mechanism for a plaintiff to commit to an early "identification" of their alleged trade secrets without having to disclose the information at the time of commitment. As the litigation proceeds and the plaintiff learns more information from the defendant in discovery, the plaintiff could amend its complaint to add new relevant details about its trade secrets. Unlike the status quo, where these modifications might lead to accusations of gaming, plaintiffs could rely on a ZKP to establish that the subsequent amended claims match the early identification, all the while maintaining secrecy.

The stickiness of ZKP assertions, of course, may be counterproductive, particularly in rapidly changing circumstances. For instance, consider our discussions of the encumbered witness in litigation[173] or the allegations of bias in IRS algorithms.[174] If the procedure that the parties and expert witness commit to in advance is imperfect, producing an unanticipated result at "run time," then reliance on ZKPs may make it harder to identify the mistake and to exercise judgment to correct it after the fact.[175] To remedy these issues, ZKP users might have to design procedures to create alerts and opportunities to revisit the pre-commitments in cases of unanticipated situations or error.

5. *Specificity*

Finally, supplementing law with ZKP technology can increase the specificity of rules, legal or otherwise. That is, the technical specificity required to implement a ZKP, whereby rules and assertions must be predefined as a sequence of basic operations on data, forces the resolution of policy decisions that may be implicit in status quo legal rules and practice. For example, status quo legal rules and practice may presume that all-or-nothing disclosure choices are the sole means to resolve verification dilemmas. ZKPs create a new, intermediate disclosure option that can force a debate about how much disclosure law should encourage. In this sense, ZKPs can also create the possibility of devising new laws and regulations mandating intermediate disclosures that were previously impractical.

172. *See id.*

173. *See supra* Section IV.D.

174. *See supra* Section IV.C.

175. *See* Mulligan & Bamberger, *supra* note 160, at 715 (discussing the ways that "the implications for values occur—and can shift—at design, configuration, *and* run time" (citing David D. Clark, John Wroclawski, Karen R. Sollins & Robert Braden, *Tussle in Cyberspace: Defining Tomorrow's Internet*, 13 IEEE/ACM TRANSACTIONS NETWORKING 462, 463 (2005))).

Specificity may introduce context-specific translational challenges, some of which might be less difficult to resolve than others. For instance, testing a claim that an algorithm had a certain level of accuracy in classifying a dataset might be relatively simple to encode and prove. And even translational problems that require more judgment may sometimes be resolved by simple agreement in transactions involving private parties. Take the dealmaking context, for example, where the relevant attribute of information sought to be proven in a zero-knowledge setting is subject to definitional judgment—such as how to measure the "similarity" of two parties' trade secrets or how an algorithm or model is "intended to operate." In this context, the parties can come to mutual agreement on a methodology for comparing those trade secrets or assessing an algorithmic function. The parties can then reduce the secrets to a digital formula.

In other settings, translational considerations might be a bigger hurdle. For example, where translation implicates public policy—such as in deciding the appropriate level of privacy or security protection to mandate or using ZKPs in governmental oversight—the construction of ZKPs might require a broader discussion involving transparency about the issues at stake and stakeholder involvement. This is particularly true the more the elements being proven involve standards that are subject to definition—for instance, with suggestions that ZKPs might be used to prove compliance with regulatory mandates, such as the Federal Reserve's capital adequacy requirements demanding "sufficient" reserves or the example discussed above of auditing the IRS for bias.

Yet although the prerequisites for ZKP implementation often require such translation and the judgment inherent in it, the characteristic of specificity offers a logical step for ex ante transparency about the ways such decisions involve choices about policy—not simply one-to-one reduction. Surfacing those policy questions creates new opportunities to foster debate about them. As computer scientists Michael Kearns and Aaron Roth explain in a related context, the process of specificity "has great merit in its own right—both because it is necessary in the algorithmic era" and also because it surfaces policy implications and decisions in the use of on-off algorithmic application. In essence, specificity "often reveals hidden subtleties, flaws, and trade-offs in our own intuitions . . . ."[176] Thus the technical prerequisite of specificity forces an opportunity to have a policy discussion.

176. MICHAEL KEARNS & AARON ROTH, THE ETHICAL ALGORITHM: THE SCIENCE OF SOCIALLY AWARE ALGORITHM DESIGN 18 (2020).

This policy debate-forcing function of ZKP-enabled specificity is especially salient[177] in opening new questions as to whether disclosure, or lack thereof, is desirable as a policy choice. Consider questions about whether to collect data identifying race. Current law, for example, prevents the use of certain categories of information in lending decisions.[178] So, one might think that using ZKPs to exclude this information from data collection would promote privacy and fairness. However, converting legal prohibitions on use into technical mechanisms for non-collection may be counterproductive for broader policy goals. It might significantly hinder access to the data necessary to explore disparate impact concerns in lending.[179] It might also hinder current exploration of the use of artificial intelligence algorithms to correct for historic bias by integrating goals such as forward-looking expansion of mortgage access.[180]

There are also other types of policy choices that are implicit in current legal practice and that ZKP-enabled precision can foreground and open to debate. Take the case study of the FST algorithm the New York City Office of Chief Medical Examiner uses. In the existing legal baseline, the regulator approved use of the FST software system without specifying precisely how to define what that system was—for instance, whether fixing a bug or recompiling the program for a different operating system should vitiate the regulatory approval. Ambiguity in the legal definition of what had been approved by the regulator apparently left to unidentified employees within the Office of Medical Examiner the crucial policy decision about which system alterations amounted to core or substantive changes requiring revalidation and new regulatory approval. Using a ZKP could have enabled the regulator to set that policy choice by selecting the level of specificity or generality for the signed

177. *Cf.* Jack Balkin, *The Path of Robotics Law*, 6 CALIF. L. REV. CIRCUIT 45, 46 (2015) ("When we consider how a new technology affects law, our focus should not be on what is essential about the technology but on what features of social life the technology makes newly salient.").

178. *See, e.g.*, Abbye Atkinson, *Borrowing Equality*, 120 COLUM. L. REV. 1403, 1407 (2020).

179. Mulligan & Bamberger, *supra* note 160, at 728 ("Reducing the collection of data about protected class status can constrain its intentional use to discriminate. But it removes data that is useful if not essential for identifying the latent, redundant encoding of protected traits that algorithms are so adept at finding."); *see also* Ignacio N. Cofone, *Antidiscriminatory Privacy*, 72 SMU L. REV. 139, 141 (2019) (highlighting examples where privacy is helpful, such as identifying facially neutral screening rules, and examples where it is not helpful, such as affirmative action cases).

180. Sian Townson, *AI Can Make Bank Loans More Fair*, HARV. BUS. REV. (Nov. 6, 2020), https://hbr.org/2020/11/ai-can-make-bank-loans-more-fair (discussing methods to prevent lending bias by "regulariz[ing]" an algorithm "so that it aims not just to fit historical data, but also to score well on some measure of fairness," which requires "including an extra parameter that penalizes the model if it treats protected classes differently").

commitment that could later be validated with zero knowledge. The ZKP would thus have surfaced the policy choice about whether, and how much, the grant of regulatory approval included flexibility to alter the system and shifted the decision from the employee within the Office of Medical Examiner to the regulator itself.

Similarly, the use of ZKPs may force explicit engagement with the question of what variables might indicate an algorithm's fairness, or a lack of bias in its choice of data set.[181] Moreover, there is an inherent tension in the deployment of algorithms, accountability, and secrecy. Regulation favors transparency for several reasons, including classical arguments of fairness and accountability to the public. Yet, regulators do sometimes have legitimate interests in limiting the disclosure of regulatory information, whether it is the rules themselves or the results.[182] These interests should be protected, but they also introduce the opportunity for regulators to overclaim secrecy. Because implementing ZKPs requires specificity about what the ZKP will be able to prove, the process of implementing the tool will force policy debates around these crucial questions concerning the costs and benefits of transparency.

Considering our discussion throughout this Part, ZKP's technical and policy attributes lead to four questions that should be discussed before implementing ZKP governance tools in any given circumstance:

> *First*, what is the value in keeping information undisclosed as long as said properties have been verified?
>
> *Second*, where the status quo baseline is full disclosure, could substituting that disclosure with ZKPs cause a loss of serendipitous value?
>
> *Third*, is using a ZKP worth the complexity and burden of implementation? If so, then which of the parties should carry the burden of performing the ZKP? In cases where the information is held by only one of the parties, it is natural that this party will be the one carrying the burden because it is the only party with a secret to keep. In cases where both parties have secret information the determination might be less clear.

181. *See* Kroll et al., *supra* note 14, at 633 (suggesting a "technological toolkit to verify that automated decisions comply with key standards of legal fairness").

182. Limiting the disclosure of regulatory or investigatory results also implicates fairness under the law. This is the same reason that, for example, the Department of Justice is exempt from having to confirm nor deny the existence of an investigation in response to a FOIA request. *See* 5 U.S.C. § 552(c)(1)(A) (2018).

> *Fourth*, does the specificity requirement of ZKPs force new policy choices, and if so, what is the best way to resolve those choices in each context?

VI. CONCLUSION

Status quo legal rules and practice often presume an all-or-nothing choice between costly verification through overdisclosure or costly secrecy through underdisclosure. Private actors must choose either to forego the benefits of verification or to undertake risks from disclosure of sensitive information. Public policy, in turn, often faces a binary option between a full transparency and extreme opacity. Full transparency imposes untenable policy costs of its own—whether by undermining distinct public concerns such as information privacy, or subverting the very efficacy of the operations rendered visible, as with an IRS investigatory algorithm. Yet extreme opacity is in tension with public accountability norms. Existing legal solutions to this conundrum mitigate the risks of overdisclosure but cannot entirely eliminate them. New technologies often shape the environment in which they are used.[183] ZKPs are uniquely capable of protecting data not just from unauthorized parties but between communicating parties themselves, and it is possible that as ZKPs continue their development they will catalyze a new paradigm built not on unlimited exposure but instead on controlled disclosure.

This Article has developed case studies that demonstrate the possibility of using ZKPs to help solve verification dilemmas across multiple areas of law. ZKPs offer the occasion to disrupt the presumption that verification dilemmas present an all-or-nothing disclosure choice, and to address some of the costs those dilemmas frequently impose in legal contexts. By changing understandings of the quanta in which information can be disclosed and the possibility of separating discrete qualities of that information from the underlying data for purposes of verification, ZKPs offer the promise, in certain circumstances, of previously unavailable ways to sever portions of data for sharing. The result is more efficient means in contexts where limited disclosures are currently attempted and more effective ways of reducing or eliminating disclosure risk that the law is currently unable to achieve. At the

183. For example, Marc Andreessen, the inventor of the web browser, called the lack of payment technology on the early internet its "original sin," arguing that the internet primarily uses advertising to monetize because it was not originally technically feasible to process payments online. Marc Andreessen, *From the Internet's Past to the Future of Crypto*, A16Z PODCAST, at 17:00 (Aug. 29, 2019), https://a16z.com/2019/08/29/internet-past-crypto-future-crypto-regulatory-summit/ ("Because we were unable to build payments into the browser . . . as a consequence, that is why the internet today, at least in the U.S., is predominantly based on advertising.").

same time, by transforming the background against which existing disclosure norms and practices have developed and the law has evolved, ZKPs raise important challenges for the future of law and policy.

APPENDIX A: MORE ON CONSTRUCTING ZERO-KNOWLEDGE PROOFS

This Appendix expands on method I (the boxes method) for constructing ZKPs, described in Section II.B.1.a:

To commit to data *m*, the committer chooses a random number *r* in a predefined range (which corresponds to the key of the locked box) and applies a special algorithm COM on inputs m and r, to obtain a value c. (In shorthand, the committer obtains $c = COM(m,r)$.) The value c, henceforth called the "commitment value," is given to the recipient. To reveal m, the committer sends m and r to the recipient, who verifies that c = COM(m, r). The commitment value c represents the box and the random number r represents the key. The algorithm must satisfy two guarantees:

1) The data m remains secret even knowing c; and
2) the committer cannot feasibly find a commitment value c, two values m_1, m_2 and two keys r_1, r_2 such that $c = COM(m_1, r_1)$ and at the same time $COM(m_1, r_1)$.

Traditional cryptographic commitments satisfy (a) and (b). For ZKPs, we will need COM to satisfy yet an additional property which is called *homomorphism with respect to a mathematical operation on pieces of data*. This mathematical operation is denoted by *. The property is stated as follows:

3) Given two commitment values $c_1 = COM(m_1, r_1)$ and $c_2 = COM(m_2, r_2)$, the recipient should be able to compute a third commitment value c_3, and the committer should be able to compute a value r_3, such that:

I. $c_3 = COM(m_3, r_3)$, for $m_3 = m_1 * m_2$. Namely, c_3 is now a commitment to the value $m_1 * m_2$. Furthermore, the committer who knows r_1 and r_2 can compute r_3 that can be used to open c_3.

II. the original values m_1 and m_2 remain hidden (aside from what is revealed about them from knowing m_3), even when c_1, c_2, c_3 and r_3 are known. This means that the committer can now open c_3 to m_3 (by exposing m_3, r_3) while still keeping m_1, m_2 hidden.

The "homomorphism" property allows evaluating the "*" operation directly on committed data without learning the data itself. This "veiled evaluation" operation has no immediate physical analog, other than being somewhat akin to "mashing" a box that holds data m_1 with key r_2 with a box that holds data m_2 with key r_2 into a third box that contains $m_1 * m_2$ and that is openable by a key r_3 that's constructed from $r_1$and r_2.[184]

ZKPs require commitments that are homomorphic with respect to all the operations that the verification program employs. Fortunately, there exist relatively simple operations on data that are "universal": any computer program with any instruction set, including our verification program, can be rewritten as a sequence of applications of only the universal operation on different portions of the data. The operation $*$ will be such a universal operation.[185]

Assuming a homomorphic commitment scheme as described above, the ZKP protocol for an assertion is now straightforward:

0. Both the prover and the verifier agree on the verification program V which consists of a sequence of $*$ operations. In addition, the prover has the input proof *pf* of the assertion, written in binary (i.e., a sequence of 0's and 1's).

1. The prover commits each binary number in the input proof *pf*. Namely, for $= m_1, \ldots, m_n$, the prover chooses n random keys $r_1, \ldots, r_n$, and gives the verifier values $c_1, \ldots, c_n$such that $c_1 = COM(m_i, r_i)$.

2. The verifier homomorphically evaluates the verification program on commitment values $c_1, \ldots, c_n$. That is, for each operation $m_i * m_j$ in the verification program, the verifier performs the corresponding operation on the commitment values c_i and c_j to obtain c_{i*j}. At the end of this process, the

184. To further illustrate the concept, we sketch the commitment algorithm proposed by Pedersen. *See* Torben Pryds Pedersen, *Non-Interactive and Information-Theoretic Secure Verifiable Secret Sharing*, *in* ADVANCES IN CRYPTOLOGY – PROC. OF CRYPTO '91, LECTURE NOTES IN COMPUT. SCI. 129, 130 (Joan Feigenbaum ed.). Assume that a large prime number p is known to all, along with a number g which is a generator of the multiplicative group Z_p, and a random group element h. Then, $COM_{p,g,h}(m, r) = g^m \cdot h^r$. (Here we assume that m can be represented as a number in $1..p-1$, and $\cdot$ denotes multiplication modulo p. Observe that this commitment algorithm is homomorphic with respect to addition modulo $p-1$. If $c_1 = g^{m_1} \cdot h^{r^1}$ and $c\_2 = g\text{^}\{m\_2\}\backslash cdot\ h\text{^}\{r\text{^}2\}$ then it holds that $c_3 = c_1 \cdot c_2 = g^{m_1} \cdot h^{r^1} \cdot g^{m_2} \cdot h^{r_2} = \mathrm{g}^{\mathrm{m1+m2}} \cdot \mathrm{h}^{\mathrm{r1+r2}}$. This means that c_3 is a commitment to $m\_1 + m\_2$ with key $r\_1 + r\_2$ (mod p-1). Security of this commitment protocol holds under a widely believed mathematical conjecture (Decisional Diffie Hellman in certain prime order groups.)

185. There are many universal operations. For example, we can choose the NAND operation: 0 NAND 1 = 1 NAND 0 = 1 NAND 1= 0, whereas 1 NAND 1 = 0. NAND is a *universal operation*. It is possible to write any computer program using only NAND operations, applied to different parts of the input data and the program's memory. Professors Groth, Ostrovsky, and Sahai have designed commitments which are homomorphic with respect to NAND. The security of these commitments relies on another widely believed mathematical conjecture (subgroup indistinguishability in certain composite-order groups that enable bilinear maps). *See generally* Jens Groth, Rafail Ostrovsky & Amit Sahai, *New Techniques for Noninteractive Zero-Knowledge*, 59 J. ACM 1 (2012).

verifier obtains a commitment value c_{out}, which is guaranteed to be a commitment to the output value of V.

3. The prover performs a similar sequence of operations with respect to the keys $r_1, \ldots, r_n$.That is for each operation $m_i * m_j$ in the verification program, the prover performs the corresponding operation on the keys r_i, r_j to obtain r_{i*j}.At the end of this process, the prover obtains a key r_{out} that corresponds to the output value of V. The prover then sends $r_{out}$to the verifier.

4. The verifier verifies that $c_{out} = COM(1, r_{out})$. If the verification succeeds, the verifier agrees that the original verification program accepts the original (committed) input proof. (The fact that c_{out}opens to 1 implies that $V(pf) = 1$, hence the proof is correct.)

There are several ways to design an algorithm COM which satisfies properties (a)–(c) defined above. One method has the prover and verifier engage in a preliminary three-round (back and forth messages exchanged) cryptographic protocol in which they agree on a randomized choice of COM which neither one can control so as to violate soundness or zero-knowledge: the verifier needs the randomness guarantee to ensure soundness and the prover needs the randomness guarantee to ensure zero knowledge.

APPENDIX B: USING ZKPS IN AN FST-LIKE CASE

Here is how a ZKP-based solution might work in the case of an algorithm similar to the New York City Office of Chief Medical Examiner's Forensic Statistical Tool, discussed in Part IV.C.1, if, hypothetically, there were a legitimate reason to keep that other algorithm secret:

1) The regulator prepares a document that specifies the approved algorithm. Here the level of detail by which the algorithm is specified is of central importance: the algorithm should be specified at a level of detail that suffices for guaranteeing the properties that the regulator sees as critical to the adequacy of the algorithm to the stated use case. To maximize usability and minimize the need to re-accreditation, the regulator might leave out details that are deemed irrelevant to those critical properties. (For instance, the regulator might choose to specify the approved algorithm by way of a higher-level, safe programming language, such as Rust, which provides explicit functional consistency guarantees for programs, regardless of the specific execution environment. Alternatively, the regulator might specify the algorithm in a more flexible language such as C++, Java, or Python, and, in addition, specify the allowed "program libraries" that the algorithm might link to at runtime. If the regulator chooses to be more specific

in the accreditation, then it might sign the algorithm in the form of a specific executable program, thus specifying the program down to a specific configuration of "virtual machine" or an actual computer and forcing the prosecution to obtain a new accreditation for each new computer or virtual machine that the prosecution may use.)

2) The regulator augments the document A holding the algorithm with a "cover letter" that asserts that the signed algorithm has passed the regulator's test. Next, the regulator digitally signs the augmented document A, Let V_R denote the regulator's public signature verification key, and let S_A denote the signature of the regulator on the document A. (Recall, signature schemes come with a verification procedure Ver such that $Ver(V_R, X, S) = 1$ only if the regulator signed the document X.)
3) When the prosecution presents the result, T, of running the algorithm specified in document A on the relevant data D , it will be required to present also a ZKP of the following statement: "There exists a document X and a signature S such that:
    a. Document X includes a cover letter asserting that the regulator approved the algorithm described within.
    b. $Ver(V_R, X, S) = 1.$ In essence, the signature verification procedure, when given public verification key V_R, document X, and signature S. outputs 1.
    c. $A(D) = T.$ In essence, when executing the algorithm described in document A on data D, the output is T.

This proof will be computed using a special software tool for ZK proof generation, run by the prosecution.

4) The court and the defendant will then verify the assertion made by the prosecution. For that purpose, they will run a special software tool for ZK proof verification.

PREDICTING CONSUMER CONTRACTS

Noam Kolt†

ABSTRACT

This Article empirically examines whether a computational language model can read and understand consumer contracts. In recent years, language models have heralded a paradigm shift in artificial intelligence, characterized by unprecedented machine capabilities and new societal risks. These models, which are trained on immense quantities of data to predict the next word in a sequence, can perform a wide range of complex tasks. In the legal domain, language models can interpret statutes, draft transactional documents, and, as this Article will explore, inform consumers of their contractual rights and obligations.

To showcase the opportunities and challenges of using language models to read consumer contracts, this Article studies the performance of GPT-3, the world's first commercial language model. The case study evaluates the model's ability to understand consumer contracts by testing its performance on a novel dataset comprised of questions relating to online terms of service. Although the results are not definitive, they offer several important insights. First, the model appears to be able to exploit subtle informational cues when answering questions about consumer contracts. Second, the model performs poorly in answering certain questions about contractual provisions that favor the rights and interests of consumers, suggesting that the model may contain an anti-consumer bias. Third, the model is brittle in unexpected ways. Performance in the case study was highly sensitive to the wording of questions, but surprisingly indifferent to variations in contractual language.

These preliminary findings suggest that while language models have the potential to empower consumers, they also have the potential to provide misleading advice and entrench harmful biases. Leveraging the benefits of language models in performing legal tasks, such as reading consumer contracts, and confronting the associated challenges requires a combination of thoughtful engineering and governance. Before language models are deployed in the legal domain, policymakers should explore technical and institutional safeguards to ensure that language models are used responsibly and align with broader social values.

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I. INTRODUCTION

Consumer contracts increasingly govern important aspects of our lives.[1] Online communications, retail marketplaces, and consumer finance are all mediated by consumer contracts. These contracts control access to services, dictate terms of payment, and determine the remedies available when consumers' rights are violated. Yet we seldom read these agreements.[2] Ordinary people do not have the time, expertise, or incentive to investigate how everyday consumer contracts affect their rights and interests.[3] Reading these contracts ourselves is simply unfeasible.[4]

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1. *See generally* OREN BAR-GILL, SEDUCTION BY CONTRACT: LAW, ECONOMICS, AND PSYCHOLOGY IN CONSUMER MARKETS 1 (2012); MARGARET JANE RADIN, BOILERPLATE: THE FINE PRINT, VANISHING RIGHTS, AND THE RULE OF LAW 7–8 (2013); NANCY S. KIM, WRAP CONTRACTS: FOUNDATIONS AND RAMIFICATIONS 1–5 (2013); OMRI BEN-SHAHAR & CARL E. SCHNEIDER, MORE THAN YOU WANTED TO KNOW: THE FAILURE OF MANDATED DISCLOSURE 1–5 (2014).

2. *See* Yannis Bakos, Florencia Marotta-Wurgler & David R. Trossen, *Does Anyone Read the Fine Print? Consumer Attention to Standard-Form Contracts*, 43 J. LEGAL STUD. 1, 32 (2014) (finding that between 0.05 and 0.22 percent of retail software shoppers access the applicable license agreements); Florencia Marotta-Wurgler, *Will Increased Disclosure Help? Evaluating the Recommendations of the ALI's "Principles of the Law of Software Contracts*," 78 U. CHI. L. REV. 165, 168 (2011) (estimating the average readership of end user license agreements to be between roughly 0.1 and 1 percent); *see also* Ian Ayres & Alan Schwartz, *The No-Reading Problem in Consumer Contract Law*, 66 STAN. L. REV. 545, 555–62 (2014) (discussing legal responses to the problem of non-readership of consumer contracts).

3. *See* Melvin Aron Eisenberg, *The Limits of Cognition and the Limits of Contract*, 47 STAN. L. REV. 211, 243 (1995) ("The verbal and legal obscurity of preprinted terms renders the cost of searching out and deliberating on these terms exceptionally high."); Robert A. Hillman & Jeffrey J. Rachlinski, *Standard-Form Contracting in the Electronic Age*, 77 N.Y.U. L. REV. 429, 436–37 (2002) (suggesting that consumers recognize that the costs of reading consumer contracts outweigh the potential benefits); Omri Ben-Shahar, *The Myth of the 'Opportunity to Read' in Contract Law,* 5 EUR. REV. CONT. L. 1, 13–21 (2009) (discussing consumers' limited ability to understand consumer contracts and positing that non-readership is often a rational choice); Victoria C. Plaut & Robert P. Bartlett, *Blind Consent? A Social Psychological Investigation of Non-Readership of Click-Through Agreements*, 36 LAW & HUM. BEHAV. 293, 305–6 (2012) (conducting experimental studies to examine which widely held beliefs about click-through agreements contribute to their non-readership); Tess Wilkinson-Ryan, *A Psychological Account of Consent to Fine Print*, 99 IOWA L. REV. 1745, 1759–60 (2014) (describing consumers' limited attentional resources when confronting contractual fine print); Michael Simkovic & Meirav Furth-Matzkin, *Proportional Contracts*, 107 IOWA L. REV. 229, 237–39 (2021) (surveying studies on the non-readership of consumers contracts).

4. *See* RESTATEMENT (THIRD) OF CONTRACTS 3 (AM. LAW INST., Tentative Draft, 2019) ("As the length and incidence of standard-form contracts have grown, it has become all the less plausible to expect consumers to read and take informed account of the contracts' provisions.").

One rapidly developing technology—computational language models[5]—could potentially offer a solution. These machine learning models, which have heralded a paradigm shift in artificial intelligence (AI),[6] can perform a wide range of complex tasks merely by predicting the next word in a sequence. In essence, computational language models are a powerful autocomplete. A user provides the model with a portion of text, and the model uses machine learning to guess what words should follow. The results are surprisingly impressive. For example, Generative Pre-Trained Transformer 3 (GPT-3)—the world's first commercial language model,[7] developed by AI research company OpenAI—demonstrated unprecedented machine performance on a range of tasks.[8] The

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5. *See infra* Part II (discussing the development of language model technology and its applications in the legal domain).

6. *See* Rishi Bommasani, Drew A. Hudson, Ehsan Adeli, Russ Altman, Simran Arora, Sydney von Arx, Michael S. Bernstein, Jeannette Bohg, Antoine Bosselut, Emma Brunskill, Erik Brynjolfsson, Shyamal Buch, Dallas Card, Rodrigo Castellon, Niladri Chatterji, Annie Chen, Kathleen Creel, Jared Quincy Davis, Dora Demszky, Chris Donahue, Moussa Doumbouya, Esin Durmus, Stefano Ermon, John Etchemendy, Kawin Ethayarajh, Li Fei-Fei, Chelsea Finn, Trevor Gale, Lauren Gillespie, Karan Goel, Noah Goodman, Shelby Grossman, Neel Guha, Tatsunori Hashimoto, Peter Henderson, John Hewitt, Daniel E. Ho, Jenny Hong, Kyle Hsu, Jing Huang, Thomas Icard, Saahil Jain, Dan Jurafsky, Pratyusha Kalluri, Siddharth Karamcheti, Geoff Keeling, Fereshte Khani, Omar Khattab, Pang Wei Koh, Mark Krass, Ranjay Krishna, Rohith Kuditipudi, Ananya Kumar, Faisal Ladhak, Mina Lee, Tony Lee, Jure Leskovec, Isabelle Levent, Xiang Lisa Li, Xuechen Li, Tengyu Ma, Ali Malik, Christopher D. Manning, Suvir Mirchandani, Eric Mitchell, Zanele Munyikwa, Suraj Nair, Avanika Narayan, Deepak Narayanan, Ben Newman, Allen Nie, Juan Carlos Niebles, Hamed Nilforoshan, Julian Nyarko, Giray Ogut, Laurel Orr, Isabel Papadimitriou, Joon Sung Park, Chris Piech, Eva Portelance, Christopher Potts, Aditi Raghunathan, Rob Reich, Hongyu Ren, Frieda Rong, Yusuf Roohani, Camilo Ruiz, Jack Ryan, Christopher Ré, Dorsa Sadigh, Shiori Sagawa, Keshav Santhanam, Andy Shih, Krishnan Srinivasan, Alex Tamkin, Rohan Taori, Armin W. Thomas, Florian Tramèr, Rose E. Wang, William Wang , Bohan Wu, Jiajun Wu, Yuhuai Wu, Sang Michael Xie, Michihiro Yasunaga, Jiaxuan You, Matei Zaharia, Michael Zhang, Tianyi Zhang, Xikun Zhang, Yuhui Zhang, Lucia Zheng, Kaitlyn Zhou & Percy Liang, *On the Opportunities and Risks of Foundation Models*, ARXIV at 3, 6–7 (Aug. 18, 2021), https://arxiv.org/abs/2108.07258 (describing the emergence of general-purpose AI models). *But see* Gary Marcus & Ernest Davis, *Has AI Found a New Foundation?*, THE GRADIENT (Sept. 11, 2021), https://thegradient.pub/has-ai-found-a-new-foundation/(critiquing large language models and other so-called "foundation models").

7. *See infra* Part II.B (explaining that GPT-3 is a proprietary language model that can only be accessed through a commercial API).

8. *See* Tom B. Brown, Benjamin Mann, Nick Ryder, Melanie Subbiah, Jared D Kaplan, Prafulla Dhariwal, Arvind Neelakantan, Pranav Shyam, Girish Sastry, Amanda Askell, Sandhini Agarwal, Ariel Herbert-Voss, Gretchen Krueger, Tom Henighan, Rewon Child, Aditya Ramesh, Daniel Ziegler, Jeffrey Wu, Clemens Winter, Chris Hesse, Mark Chen, Eric Sigler, Mateusz Litwin, Scott Gray, Benjamin Chess, Jack Clark, Christopher Berner, Sam McCandlish, Alec Radford, Ilya Sutskever & Dario Amodei, *Language Models Are Few-Shot Learners*, PROC. 34TH CONF. NEURAL INFO. PROCESSING SYS. (2020) (introducing the GPT-3

model can write compelling fictional stories,[9] translate natural language into computer code,[10] and produce news articles that appear to be written by human authors.[11]

Computational language models also present exciting opportunities in the legal domain. GPT-3, for instance, can summarize laws,[12] draft legal documents,[13] and translate legalese into plain English.[14] These capabilities

language model). For commentary on the broader impact of GPT-3, see David A. Price, *An AI Breaks the Writing Barrier*, WALL ST. J. (Aug. 22, 2020), https: //www.wsj.com /articles /an-ai-breaks-the-writing-barrier-11598068862; Cade Metz, *Meet GPT-3. It Has Learned to Code (and Blog and Argue)*, N.Y. TIMES (Nov. 24, 2020), https: //www.nytimes.com/2020/11/24/science /artificial-intelligence-ai-gpt3.html; Will Douglas Heaven, *Why GPT-3 is the Best and Worst of AI Right Now*, MIT TECH. REV. (Feb. 24, 2021), https://www.technologyreview.com/2021/ 02/24/1017797/gpt3-best-worst-ai-openai-natural-language/.

9. *See* Gwern Branwen, *GPT-3 Creative Fiction,* GWERN (Sept. 28, 2020), https:// www.gwern.net/GPT-3 (illustrating GPT-3's ability to write in various literary genres).

10. *See* Sharif Shameem (@SharifShameem), TWITTER (July 13, 2020, 5:01PM), https:// twitter.com/sharifshameem /status /1282676454690451457 (demonstrating that GPT-3 can generate JSX code). One year following the release of GPT-3, OpenAI introduced a new language model trained specifically to generate code. *See* Mark Chen, Jerry Tworek, Heewoo Jun, Qiming Yuan, Henrique Ponde de Oliveira Pinto, Jared Kaplan, Harri Edwards, Yuri Burda, Nicholas Joseph, Greg Brockman, Alex Ray, Raul Puri, Gretchen Krueger, Michael Petrov, Heidy Khlaaf, Girish Sastry, Pamela Mishkin, Brooke Chan, Scott Gray, Nick Ryder, Mikhail Pavlov, Alethea Power, Lukasz Kaiser, Mohammad Bavarian, Clemens Winter, Philippe Tillet, Felipe Petroski Such, Dave Cummings, Matthias Plappert, Fotios Chantzis, Elizabeth Barnes, Ariel Herbert-Voss, William Hebgen Guss, Alex Nichol, Alex Paino, Nikolas Tezak, Jie Tang, Igor Babuschkin, Suchir Balaji, Shantanu Jain, William Saunders, Christopher Hesse, Andrew N. Carr, Jan Leike, Josh Achiam, Vedant Misra, Evan Morikawa, Alec Radford, Matthew Knight, Miles Brundage, Mira Murati, Katie Mayer, Peter Welinder, Bob McGrew, Dario Amodei, Sam McCandlish, Ilya Sutskever & Wojciech Zaremba, *Evaluating Large Language Models Trained on Code*, ARXIV (July 14, 2021), https://arxiv.org/abs /2107.03374. Together with GitHub, OpenAI also developed a commercial code generation tool. *See* GITHUB COPILOT, https://copilot.github.com/ (last visited Aug. 8, 2022).

11. *See* Brown et al., *supra* note 8, at 25–26 (finding that study participants' ability to detect which articles which were produced by GPT-3 rather than by human beings was scarcely above random chance).

12. *See* Daniel Gross (@DanielGross), TWITTER (June 14, 2020, 9:42 PM), https:// twitter.com/danielgross/status/1272238098710097920 (using GPT-3 to summarize a section of the U.S. Tax Code).

13. *See* Francis Jervis (@f_j_j_), TWITTER (July 17, 2020, 12:02 PM), https:// twitter.com/f_j_j_/status/1284050844787200000 (using GPT-3 to generate requests for admission).

14. *See* Michael Tefula (@MichaelTefula), TWITTER (July 21, 2020, 12:24 PM), https:// twitter.com/michaeltefula/status/1285505897108832257 (using GPT-3 to explain provisions in a founders' agreement).

could benefit both lawyers and consumers of legal services.[15] In the future, lawyers could use language models to expedite routine tasks, such as document review and transactional drafting. Language models could also support lawyers in conducting legal research, generating statements of claim, and even predicting case outcomes. If language models continue to improve, they could fundamentally alter the ways in which legal services are performed.[16]

This automation of legal work has the potential to improve access to justice. By performing tasks ordinarily carried out by lawyers and other legal services providers, language models could directly assist consumers facing legal issues in housing, personal finance, and other contexts. For example, one startup experimented with using GPT-3 to produce legal requests on behalf of tenants who might otherwise need to engage professional counsel.[17] Developments like this could be especially beneficial for consumers who cannot afford traditional legal services.

This Article explores a particular application in which language models could improve access to justice: reading consumer contracts. Despite the

15. *See infra* Part II.C (outlining the opportunities for using language models in the legal domain). For general accounts of the application of machine learning in law, see Harry Surden, *Machine Learning and Law*, 89 WASH. L. REV. 87, 101–14 (2014); John O. McGinnis & Russell G. Pearce, *The Great Disruption: How Machine Intelligence Will Transform the Role of Lawyers in the Delivery of Legal Services*, 82 FORDHAM L. REV. 3041 (2014); Dana Remus & Frank Levy, *Can Robots Be Lawyers? Computers, Lawyers, and the Practice of Law*, 30 GEO. J. LEGAL ETHICS 501 (2017); KEVIN D. ASHLEY, ARTIFICIAL INTELLIGENCE AND LEGAL ANALYTICS: NEW TOOLS FOR LAW PRACTICE IN THE DIGITAL AGE (2017); David Lehr & Paul Ohm, *Playing with the Data: What Legal Scholars Should Learn About Machine Learning*, 51 U.C. DAVIS L. REV. 653 (2017); Benjamin Alarie, Anthony Niblett & Albert Yoon, *How Artificial Intelligence Will Affect the Practice of Law*, 68 U. TORONTO L.J. 106 (2018); Michael Simon, Alvin F. Lindsay, Loly Sosa & Paige Comparato, *Lola v. Skadden and the Automation of the Legal Profession*, 20 YALE J.L. & TECH. 234 (2018); Harry Surden, *Artificial Intelligence and Law: An Overview*, 35 GA. ST. U. L. REV. 1305 (2019); Milan Markovic, *Rise of the Robot Lawyers?*, 61 ARIZ. L. REV. 325, 328–42 (2019); LEGAL INFORMATICS (Daniel Martin Katz, Ron Dolin & Michael J. Bommarito ed., 2021); NOAH WAISBERG & ALEXANDER HUDEK, AI FOR LAWYERS: HOW ARTIFICIAL INTELLIGENCE IS ADDING VALUE, AMPLIFYING EXPERTISE, AND TRANSFORMING CAREERS (2021).

16. *See* Amy B. Cyphert, *A Human Being Wrote This Law Review Article: GPT-3 and the Practice of Law*, 55 U.C. DAVIS L. REV. 401, 403–405, 419–23 (2021); Rudy DeFelice, *What Does GPT-3 Mean for the Future of the Legal Profession?*, TECHCRUNCH (Aug. 28, 2020), https://techcrunch.com/2020/08/28/what-does-gpt-3-mean-for-the-future-of-the-legal-profession/;Caroline Hill, *GPT-3 and Another Chat About the End of Lawyers*, LEGAL IT INSIDER (Aug. 3, 2020), https://legaltechnology.com/gpt-3-and-another-chat-about-the-end-of-lawyers/.

17. *See* Augrented: Rent Safer (@augrented), TWITTER (July 20, 2020, 7:31 AM), https://twitter.com/augrented/status/1285069733818056704; Jervis, TWITTER (Oct. 28, 2020, 11:45 AM), https://twitter.com/f_j_j_ /status/1321387632652283906.

ubiquity of these agreements, consumers often struggle to read and understand their contents.[18] As a result, consumers may fail to discover or exercise their contractual rights. But what if consumers did not need to read these agreements themselves? What if that task could be outsourced to a machine? A language model that can read these documents and explain their legal ramifications would empower many consumers.[19]

The opportunities presented by language models, however, are accompanied by a host of concerns. Like other machine learning tools trained on immense quantities of data, language models pose serious risks.[20] In

18. *See supra* notes 2–4.

19. *See* Yonathan A. Arbel & Shmuel I. Becher, *Contracts in the Age of Smart Readers*, 90 GEO. WASH. L. REV. 83 (2022) (suggesting that language models could serve as "smart readers" of consumer contracts); Abhilasha Ravichander, Alan W Black, Thomas Norton, Shomir Wilson & Norman Sadeh, *Breaking Down Walls of Text: How Can NLP Benefit Consumer Privacy?*, PROC. 59TH ANN. MEETING ASS'N COMPUTATIONAL LINGUISTICS 4125 (2021) (illustrating how language technologies could assist in automatically processing privacy polices). However, even if consumers were to understand the content of contracts, they may nevertheless enter into unfavorable transactions. Apart from facing the informational load of reading contracts, consumers remain burdened by the cognitive load of making contracting decisions. *See* Russell Korobkin, *Bounded Rationality, Standard Form Contracts, and Unconscionability*, 70 U. CHI. L. REV. 1203, 1217, 1225–34 (2003); *see generally* BEN-SHAHAR & SCHNEIDER, *supra* note 1, at pt. II (describing the pervasive failure of consumer disclosure mechanisms).

20. *See* Emily M. Bender, Timnit Gebru, Angelina McMillan-Major & Shmargaret Shmitchell, *On the Dangers of Stochastic Parrots: Can Language Models Be Too Big?*, PROC. 2021 ACM CONF. FAIRNESS, ACCOUNTABILITY, & TRANSPARENCY 610 (2021); Laura Weidinger, John Mellor, Maribeth Rauh, Conor Griffin, Jonathan Uesato, Po-Sen Huang, Myra Cheng, Mia Glaese, Borja Balle, Atoosa Kasirzadeh, Zac Kenton, Sasha Brown, Will Hawkins, Tom Stepleton, Courtney Biles, Abeba Birhane, Julia Haas, Laura Rimell, Lisa Anne Hendricks, William Isaac, Sean Legassick, Geoffrey Irving & Iason Gabriel, *Ethical and Social Risks of Harm from Language Models*, ARXIV at 9–35 (Dec. 8, 2021), https: / /arxiv.org /abs /2112.04359; Bommasani et al., *supra* note 6, at 128–59; Matthew Hutson, *Robo-Writers: The Rise and Risks of Language-Generating AI*, 591 NATURE 22 (2021); *The Big Question*, 3 NATURE MACH. INTELL. 737 (2021); Alex Tamkin, Miles Brundage, Jack Clark & Deep Ganguli, *Understanding the Capabilities, Limitations, and Societal Impact of Large Language Models*, ARXIV (Feb. 4, 2021), https: / /arxiv.org /abs /2102.02503. For further discussion of the risks associated with machine learning, see Danielle Keats Citron & Frank Pasquale, *The Scored Society: Due Process for Automated Predictions*, 89 WASH. L. REV. 1, 10–18 (2014); FRANK PASQUALE, THE BLACK BOX SOCIETY: THE SECRET ALGORITHMS THAT CONTROL MONEY AND INFORMATION chs. 2, 4 (2015); Solon Barocas & Andrew D. Selbst, *Big Data's Disparate Impact*, 104 CALIF. L. REV. 671, 677–93 (2016); CATHY O'NEIL, WEAPONS OF MATH DESTRUCTION: HOW BIG DATA INCREASES INEQUALITY AND THREATENS DEMOCRACY chs. 3–10 (2016); Anupam Chander, *The Racist Algorithm?*, 115 MICH. L. REV. 1023, 1027–34 (2017); Ryan Calo, *Artificial Intelligence Policy: A Primer and Roadmap*, 51 U.C. DAVIS L. REV. 399, 411–27 (2017); SAFIYA UMOJA NOBLE, ALGORITHMS OF OPPRESSION: HOW SEARCH ENGINES REINFORCE RACISM 26–29 (2018); VIRGINIA EUBANKS, AUTOMATING INEQUALITY: HOW HIGH-TECH TOOLS PROFILE, POLICE, AND PUNISH THE POOR ch. 4 (2018); MICHAEL KEARNS & AARON ROTH, THE

particular, language models can amplify harmful biases and be used for malicious purposes, such as spreading misinformation.[21] Since the release of GPT-3, researchers of language models have increasingly focused on issues traditionally sidelined by the computer science community.[22] Computational linguists have studied the extent to which language models can be prompted to generate racist, sexist, and other toxic content.[23] Social scientists have questioned whether language models can be deployed safely in high-stakes settings, such as healthcare, education, and law.[24] If language models are to become part of our legal toolkit, we must confront these issues.

ETHICAL ALGORITHM: THE SCIENCE OF SOCIALLY AWARE ALGORITHM DESIGN chs. 2–3, 5 (2019); Sandra G. Mayson, *Bias In, Bias Out*, 128 YALE L.J. 2218, 2227–62 (2019); Jon Kleinberg, Jens Ludwig, Sendhil Mullainathan & Cass R. Sunstein, *Discrimination in the Age of Algorithms*, 10 J. LEGAL ANALYSIS 113, 138–48 (2019); Ben Hutchinson & Margaret Mitchell, *50 Years of Test (Un)fairness: Lessons for Machine Learning*, PROC. 2019 CONF. FAIRNESS, ACCOUNTABILITY, & TRANSPARENCY 49, 56–57 (2019); FRANK PASQUALE, NEW LAWS OF ROBOTICS: DEFENDING HUMAN EXPERTISE IN THE AGE OF AI chs. 4–6 (2020).

21. *See infra* note 150 (discussing the problem of societal biases in language models); *infra* Part V.D (discussing the potential misuses of language models).

22. However, the field of natural language processing (NLP) ethics is not new. Seminal papers include Dirk Hovy & Shannon L. Spruit, *The Social Impact of Natural Language Processing*, PROC. 54TH ANN. MEETING ASS'N COMPUTATIONAL LINGUISTICS 591 (2016) (outlining several social and ethical implications of NLP technologies); Tolga Bolukbasi, Kai-Wei Chang, James Zou, Venkatesh Saligrama & Adam Kalai, *Man is to Computer Programmer as Woman is to Homemaker? Debiasing Word Embeddings*, PROC. 30TH INT'L CONF. NEURAL INFO. PROCESSING SYS. 4356 (2016) (finding that word embeddings can exhibit gender stereotypes). *But see* Abeba Birhane, Pratyusha Kalluri, Dallas Card, William Agnew, Ravit Dotan & Michelle Bao, *The Values Encoded in Machine Learning Research*, ARXIV (June 29, 2021), https://arxiv.org/abs/2106.15590 (illustrating that machine learning research continues to neglect issues concerning its societal impact).

23. *See, e.g.*, Samuel Gehman, Suchin Gururangan, Maarten Sap, Yejin Choi & Noah A. Smith, *RealToxicityPrompts: Evaluating Neural Toxic Degeneration in Language Models*, FINDINGS 2020 CONF. EMPIRICAL METHODS IN NLP 3356, 3359 (2020) (finding that language models can produce toxic text even from seemingly innocuous prompts); *see also* Ashutosh Baheti, Maarten Sap, Alan Ritter & Mark Riedl, *Just Say No: Analyzing the Stance of Neural Dialogue Generation in Offensive Contexts*, PROC. 2021 CONF. EMPIRICAL METHODS IN NLP 4846 (2021); Johannes Welbl, Amelia Glaese, Jonathan Uesato, Sumanth Dathathri, John Mellor, Lisa Anne Hendricks, Kirsty Anderson, Pushmeet Kohli, Ben Coppin & Po-Sen Huang, *Challenges in Detoxifying Language Models*, FINDINGS 2021 CONF. EMPIRICAL METHODS IN NLP 2447 (2021).

24. *See, e.g.*, Bommasani et al., *supra* note 6, at 53–72 (discussing current and anticipated applications of large pretrained models); Weidinger et al., *supra* note 20, at 10 (presenting a taxonomy of the risks posed by large language models); Zhijing Jin, Geeticka Chauhan, Brian Tse, Mrinmaya Sachan & Rada Mihalcea, *How Good Is NLP? A Sober Look at NLP Tasks through the Lens of Social Impact*, FINDINGS ASS'N COMPUTATIONAL LINGUISTICS 3099, 3105–07 (2021) (evaluating the degree to which current NLP research aims to advance social good); *see also* Luciano Floridi & Massimo Chiriatti, *GPT-3: Its Nature, Scope, Limits, and Consequences*, 30

To properly unpack the opportunities and challenges of deploying language models in law, we need to understand how they work. The theory behind language models and the data used to train them can have far-reaching consequences. Accordingly, this Article traces the technology's development, from the simplest models through to some of the most recent breakthroughs.[25] One feature, however, remains constant. Language models, including GPT-3, do primarily one thing: predict the next word in a sequence. They function as an autocomplete, guessing what words are most likely to follow a particular text. Seen in this light, the range of tasks that state-of-the-art models can perform is remarkable. Yet this feature of language models is also responsible for some of their pitfalls, including the generation of biased and toxic outputs.

A theoretical understanding of language model technology, however, does not guarantee reliable performance. To evaluate the ability of a language model to perform a particular legal task, we need to empirically test a model on that particular legal task.

This Article presents a preliminary case study in using GPT-3 to read consumer contracts.[26] The case study examines the degree to which the model can understand certain consumer contracts. To conduct the case study, I created a novel dataset comprised of 200 yes/no legal questions relating to the terms of service of the 20 most-visited U.S. websites, including Google, Amazon, and Facebook, and tested the model's ability to answer these questions. The results are illuminating. They shed light on the opportunities and risks of using GPT-3 to inform consumers of their contractual rights and obligations and offer new insights into the inner workings of language models.

First, GPT-3 appears to be able to exploit subtle informational cues embedded in certain questions about consumer contracts.[27] More specifically, the case study offers suggestive evidence that GPT-3 can recall information regarding specific companies from its training data, which in turn improves the model's performance in answering questions that explicitly reference those companies.

Second, GPT-3 performs considerably worse in answering certain questions about contractual provisions that favor the rights and interests of consumers.[28] The model answered correctly nearly 84% of the questions about

MINDS & MACH. 681, 690–93 (2020); Kevin LaGrandeur, *How Safe Is Our Reliance on AI, and Should We Regulate It?*, 1 AI ETHICS 93, 96 (2020).

25. *See infra* Parts II.A–B.

26. *See infra* Part III.

27. *See infra* Part IV.C.

28. *See infra* Part IV.B.

provisions that favor companies, but only 60% of the questions about provisions that favor consumers.[29] This result is potentially disturbing. One possible explanation is that the model contains an anti-consumer bias that reflects the skewed data on which the model was trained—namely, online terms of service that disproportionately preference the rights and interests of companies over the rights and interests of consumers.

Third, GPT-3 is brittle in unexpected ways.[30] The model appears to be highly sensitive to how questions are worded but surprisingly indifferent to variations in contractual language. In the case study, performance decreased dramatically when the questions presented to the model were less readable (i.e., more difficult for a human to read). However, performance did not decrease on longer or less readable contractual texts.

This case study offers only an initial exploratory analysis of the prospect of using language models to read consumer contracts. The analysis is subject to several limitations concerning, among other things, the design, scope, and sample size of the test questions. Accordingly, the findings presented here are not definitive. Nevertheless, the case study raises important questions regarding the potential advantages and pitfalls of using language models to read consumer contracts and proposes concrete directions for future research.

Subject to these qualifications, the case study paints a nuanced picture. On the one hand, it illustrates that GPT-3 performs relatively well in answering certain questions about consumer contracts. On the other hand, the case study highlights some of the model's weaknesses. The outsized impact of question-wording on performance casts doubt on the reliability of using language models in the legal domain, while poor performance on contractual provisions that favor consumers reinforces broader concerns regarding the effect of societal biases in machine learning.

These insights have implications for various stakeholders. Users of language models, including consumers, lawyers, and other service providers, need to be aware of the technology's limitations. Developers of language models have a responsibility to investigate these limitations and explore methods for improving the reliability of language models. Finally, before language models are deployed in the legal domain, policymakers should establish technical and institutional safeguards to ensure that language models are used responsibly and align with broader social values.

29. The model answered correctly nearly 78% of the questions about neutral provisions, i.e., provisions that favor neither companies nor consumers.

30. *See infra* Part IV.D.

This Article proceeds in four parts. Part II provides a brief primer on language model technology and the opportunities it offers the legal domain. Part III describes the experimental design used in the case study. Part IV presents and analyzes the results. Part V discusses the study's broader implications and proposes avenues for future work.

II. A PRIMER ON LANGUAGE MODELS

A. PREDICTION MACHINES

Language models are prediction machines,[31] designed to predict the next word in a sequence of text.[32] For example, given the sequence "she took the LSAT and applied to law . . ." an effective language model will predict that the next word is likely to be "school."[33] Language models can also predict the content of longer sequences and thereby generate lengthy synthetic texts. For example, when prompted appropriately, GPT-3 can write original sonnets.[34] The striking feature of advanced language models is that merely by predicting upcoming words, they can produce human-like texts that appear to exhibit genuine knowledge, understanding, and even emotion.[35]

How do language models make predictions? The basic idea is that words that occur in similar contexts tend to have similar meanings.[36] Suppose, for

31. *See* AJAY AGRAWAL, JOSHUA GANS & AVI GOLDFARB, PREDICTION MACHINES: THE SIMPLE ECONOMICS OF ARTIFICIAL INTELLIGENCE (2018) (using the term "prediction machines" to describe machine learning tools).

32. *See* DAN JURAFSKY & JAMES H. MARTIN, SPEECH AND LANGUAGE PROCESSING 29–54, 128–52, 180–94, 194–202 (draft 3rd ed., revised Sept. 21, 2021) (providing an overview of common types of language models, including *n*-gram models, neural language models, recurrent neural networks, and transformers).

33. Technically, language models assign probabilities to *each* word in the sequence, not just the upcoming word. Autoregressive models, such as GPT-3, process text from left to right and assign probabilities based only on the preceding text. In contrast, bidirectional models learn from the surrounding text on both sides of the target word. *See, e.g.*, Jacob Devlin, Ming-Wei Chang, Kenton Lee & Kristina Toutanova, *BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding*, PROC. 2019 ANN. CONF. N. AM. CH. ASS'N COMPUTATIONAL LINGUISTICS 4171 (2019) (introducing Google's Bidirectional Encoder Representations from Transformers (BERT), which is a bidirectional language model).

34. Gwern, *supra* note 9.

35. *But see infra* note 117 (discussing the debate concerning whether language models can understand language).

36. This is known as the *distributional hypothesis*. *See* Zellig S. Harris, *Distributional Structure*, 10 WORD 146, 151–58 (1954); *see also* J.R. Firth, *A Synopsis of Linguistic Theory, 1930–1955*, *in* STUDIES IN LINGUISTIC ANALYSIS 1, 11 (J.R. Firth et al. eds., 1957) (coining the canonical phrase "[Y]ou shall know a word by the company it keeps"); LUDWIG WITTGENSTEIN,

example, we have the sequence "many legal questions concerning contracts are" and we want to calculate the probability that the next word in the sequence is "difficult." One way to estimate this probability is to take a large corpus of text, such as millions of books or websites, and count the number of times that the sequence "many legal questions concerning contracts are" is followed by the word "difficult," and divide this by the total number of times that the initial sequence appears in the corpus.[37] If the corpus is sufficiently large, this method will produce an accurate estimate. However, if the relevant sequence does not appear in the corpus, this method will fail. For instance, with the addition of just a few words to the above sequence—"many legal questions concerning *ancient Roman commercial* contracts are"—we may have a novel sentence that does not appear in any existing corpus. Accordingly, the above method would fail to calculate the probability of the next word in the sequence.

A simple solution is to instead calculate the probability of the next word based on only one or a few of the immediately preceding words, rather than on the entire preceding sequence. A bigram uses the one immediately preceding word. A trigram uses the two preceding words. This family of language models, known as *n*-grams, treats the probability of a word as depending only on the preceding n - 1 words.[38] Calculating the relative frequencies for *n*-grams is usually feasible. For instance, in a large corpus of text, there are likely to be sequences in which the word "Roman" follows the word "ancient," and the word "commercial" follows "Roman."

In recent decades, computer scientists have developed more sophisticated methods of language modeling. The most prominent method is neural language models.[39] These models, which are based on neural networks,[40] can

PHILOSOPHICAL INVESTIGATIONS § 43 (1953) (contending that "[t]he meaning of a word is its use in the language").

37. This is known as a *relative frequency count*. *See* JURAFSKY & MARTIN, *supra* note 32, at 29–30.

38. Formally, *n*-grams assume that the probability of a given word can be predicted based on only a limited number of preceding words (the Markov assumption). By multiplying the probabilities of different words, *n*-grams can also be used to estimate the probabilities of entire sequences of text (and not just single words).

39. *See* Yoshua Bengio, Réjean Ducharme, Pascal Vincent & Christian Jauvin, *A Neural Probabilistic Language Model*, 3 J. MACH. LEARNING RES. 1137 (2003); Yoshua Bengio, Holger Schwenk, Jean-Sébastien Senécal, Fréderic Morin & Jean-Luc Gauvain, *Neural Probabilistic Language Models*, *in* INNOVATIONS IN MACH. LEARNING 137 (D.E. Holmes & L.C. Jain eds., 2006) (introducing neural language models). For a general overview of neural language models, see Yoav Goldberg, *A Primer on Neural Network Models for Natural Language Processing*, 57 J. AI RES. 345 (2017).

40. Neural networks are a family of algorithms commonly used in machine learning. *See generally* IAN GOODFELLOW, YOSHUA BENGIO & AARON COURVILLE., DEEP LEARNING pt.

use longer sequences of text to predict an upcoming word or sequence, and typically make these predictions with higher accuracy than *n*-gram models. Neural language models are also better than *n*-gram models in making predictions in contexts that do not resemble the model's training data. Most notably, neural language models differ from *n*-grams as they represent text by semantic word embeddings, i.e., mathematical representations that express the *meaning* of words.[41] For example, neural language models may make similar predictions regarding the sequence that follows the words "contract" and "agreement" because these two words have similar meanings.

Neural language models can nevertheless struggle to process longer texts.[42] Consider the following sequence: "the lawyers, who have been working at the firm for over a decade, are eager to . . ." A language model, when predicting the probability of the word following "decade," may forget that the subject ("lawyers")—which appears much earlier in the sentence—is plural and should therefore be followed by "are" (rather than "is"). By the end of a long sequence, the model may fail to retain the information contained in earlier parts of the sequence. This is known as the problem of long-range dependencies. Further advances in machine learning have made significant progress in tackling this problem.[43]

Recent improvements in language modeling are also attributable to another development: pretraining. This involves training a general-purpose

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II (2016) (offering an authoritative account of neural networks and their applications). For a more accessible introduction to neural networks, see MICHAEL A. NIELSEN, NEURAL NETWORKS AND DEEP LEARNING (2015).

41. *See, e.g.*, Tomás Mikolov, Kai Chen, Greg Corrado & Jeffrey Dean, *Efficient Estimation of Word Representations in Vector Space*, 1ST INT'L CONF. LEARNING REPRESENTATIONS (2013); Tomas Mikolov, Ilya Sutskever, Kai Chen, Greg Corrado & Jeffrey Dean, *Distributed Representations of Words and Phrases and Their Compositionality*, PROC. 26TH INT'L CONF. NEURAL INFO. PROCESSING SYS. 3111 (2013) (introducing the word2vec methods for computing semantic embeddings); Jeffrey Pennington, Richard Socher & Christopher D. Manning, *GloVe: Global Vectors for Word Representation*, PROC. 2014 CONF. EMPIRICAL METHODS IN NLP 1532 (2014) (introducing the GloVe method for computing semantic embeddings).

42. *See* JURAFSKY & MARTIN, *supra* note 32, at 191.

43. *See* Ashish Vaswani, Noam Shazeer, Niki Parmar, Jakob Uszkoreit, Llion Jones, Aidan N. Gomez, Łukasz Kaiser & Illia Polosukhin, *Attention Is All You Need*, PROC. 30TH INT'L CONF. NEURAL INFO. PROCESSING SYS. 5998 (2017) (introducing the transformer architecture, which made major strides in overcoming the problem of long-range dependencies); *see also* Dzmitry Bahdanau, Kyunghyun Cho & Yoshua Bengio, *Neural Machine Translation by Jointly Learning to Align and Translate*, 3rd INT'L CONF. LEARNING REPRESENTATIONS (2015) (introducing the attention mechanism, which is a key component of the transformer architecture).

language model on a very large unlabeled dataset of raw text.[44] This computationally intensive and costly process is typically carried out by a large organization. The resulting pretrained model, which is often publicly released, can then be fine-tuned on a smaller dataset to optimize performance on a specific task. For example, Google's pretrained BERT model can be fine-tuned on case law and contracts to perform specialized legal tasks.[45] Compared to pretraining, fine-tuning is computationally inexpensive. As a result, developers can now conveniently adapt and deploy powerful pretrained language models in a wide range of applications.

B. THE GPT-3 REVOLUTION

In June 2020, OpenAI, a San Francisco-based AI technology company, released GPT-3, the then-largest pretrained language model.[46] This groundbreaking model marked a milestone in the development of AI, capturing the attention of both technologists and observers outside the computer science community.[47] Although GPT-3 is structurally similar to earlier language models, it differs in several important ways.[48]

First, unlike earlier language models, GPT-3 can perform many tasks without additional training or fine-tuning. For example, GPT-3 can, off-the-shelf, answer trivia questions, summarize text, and translate between languages.[49] In addition, users can teach the model to perform new tasks simply by providing instructions (in natural language) or presenting the model

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44. *See* Sebastian Ruder, *Recent Advances in Language Model Fine-tuning* (Feb. 24, 2021), https://ruder.io/recent-advances-lm-fine-tuning/. The resulting models have been recently, albeit controversially, described as "foundation models." *See* Bommasani et al., *supra* note 6, at 6–7; *see also* Marcus & Davis, *supra* note 6 (critiquing the term "foundation model"); Rishi Bommasani & Percy Liang, *Reflections on Foundation Models*, STANFORD UNIVERSITY HUMAN-CENTERED ARTIFICIAL INTELLIGENCE (Oct. 18, 2021), https: / /hai.stanford.edu /news / reflections-foundation-models (responding to, *inter alia*, critiques of the term "foundation model").

45. *See* Ilias Chalkidis, Manos Fergadiotis, Prodromos Malakasiotis, Nikolaos Aletras & Ion Androutsopoulos, *LEGAL-BERT: The Muppets Straight Out of Law School*, FINDINGS 2020 CONF. EMPIRICAL METHODS IN NLP 2898 (2020).

46. *See* Greg Brockman, Mira Murati, Peter Welinder & OpenAI, *OpenAI API*, OPENAI (June 11, 2020), https://openai.com/blog/openai-api/. References to GPT-3 are to the largest model in the GPT-3 family of models, which has 175 billion parameters. *See* Brown et al., *supra* note 8, at 8.

47. *See* Metz, *supra* note 8; Price, *supra* note 8.

48. For example, GPT-3 is structurally similar to its predecessor, GPT-2. *See* Alec Radford, Rewon Child, David Luan, Dario Amodei & Ilya Sutskever, *Language Models are Unsupervised Multitask Learners* (OpenAI Working Paper, Feb. 2019) (introducing the GPT-2 language model).

49. *See* Brown et al., *supra* note 8, at 10–29.

with several examples of the desired task. This enables non-programmers to program the model.[50] For instance, the following prompt can teach GPT-3 to correct the grammar of an English text:[51]

> Non-standard English: If I'm stressed out about something, I tend to have problem to fall asleep.
>
> Standard English: If I'm stressed out about something, I tend to have a problem falling asleep.
>
> Non-standard English: There is plenty of fun things to do in the summer when your able to go outside.
>
> Standard English: There are plenty of fun things to do in the summer when you are able to go outside.
>
> Non-standard English: She no went to the market.
>
> Standard English: She didn't go to the market.

Presented with another grammatically erroneous text, GPT-3 can learn to produce a grammatically correct version of that text.[52] This highly intuitive form of learning—known as "few-shot learning"[53]—is arguably the hallmark of the technological watershed ushered in by GPT-3.[54] Some observers at the time of the model's release even suggested that GPT-3 is the closest attempt

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50. *See* Vasili Shynkarenka, *How I Used GPT-3 to Hit Hacker News Front Page 5 Times in 3 Weeks*, VASILI SHYNKARENKA (Oct. 28, 2020) https://vasilishynkarenka.com/gpt-3/ ("If we teleport 50 years from now, it will seem barbaric that in 2020 we had an elite cast of hackers who knew how to write special symbols to control the computing power."); *see also* Chen et al., *supra* note 10, at 34 (discussing the impact of code generation on non-programmers).

51. This prompt is adapted from a template available in the OpenAI API at the time of the case study. For the most recent template for grammar correction available in the API, see *Grammar Correction*, OPENAI, https://beta.openai.com/examples/default-grammar (last visited Aug. 8, 2022).

52. Comparable prompts can be used to teach GPT-3 to construct headlines for news articles, write professional emails, and convert English instructions into computer code. *See* Yaser Martinez Palenzuel, Joshua Landau, Zoltán Szőgyényi, Sahar Mor, eshnil, CallmeMehdi, Mrinal Mohit, Scoder12 & Anurag Ramdasan, *Awesome GPT-3*, GITHUB (Sept. 29, 2020), https://github.com/elyase/awesome-gpt3; *see also Examples*, OPENAI, https://beta.openai.com/examples/ (last visited Aug. 8, 2022) (showcasing examples of GPT-3's performance).

53. The ability to learn from prompts is also known as *prompt-based learning*, *in-context learning* or *meta-learning*. For discussion of the limitations of few-shot learning, see Ethan Perez, Douwe Kiela & Kyunghyun Cho, *True Few-Shot Learning with Language Models*, 35TH CONF. NEURAL INFO. PROCESSING (2021).

54. The title of the paper introducing GPT-3 is *Language Models Are Few-Shot Learners*. *See* Brown et al., *supra* note 8, at 1.

to achieving artificial general intelligence, i.e., a machine that reaches or surpasses the intellectual capabilities of humans in a broad range of tasks.[55]

The second difference between GPT-3 and earlier language models—and the main factor accounting for its improved performance—is scale.[56] GPT-3 contains 175 billion parameters (i.e., model weights or coefficients), which is an order of magnitude more than the previously largest language model.[57]

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55. *See* Julien Lauret, *GPT-3: The First Artificial General Intelligence?*, TOWARDS DATA SCI. (July 22, 2020), https: //towardsdatascience.com /gpt-3-the-first-artificial-general-intelligence-b8d9b38557a1 ("AGI . . . is so hard that there isn't a clear roadmap for achieving it . . . GPT-3 is the first model to shake that status-quo seriously."); *see also* Katherine Elkins & Jon Chun, *Can GPT-3 Pass a Writer's Turing Test?*, 5 J. CULTURAL ANALYTICS 1, 13 (2020). *Compare* Gary Marcus & Ernest Davis, *GPT-3, Bloviator: OpenAI's Language Generator Has No Idea What It's Talking About*, MIT TECH. REV. (Aug. 22, 2020), https:// www.technologyreview.com/2020/08/22/1007539/gpt3-openai-language-generator-artificial-intelligence-ai-opinion [hereinafter Marcus & Davis, *GPT-3, Bloviator*]; Yann LeCun, FACEBOOK (Oct. 27, 2020), https://www.facebook.com/yann.lecun/posts/ 10157253205637143; *infra* note 117 (discussing the debate concerning whether language models can understand language). For a broader account of artificial general intelligence, see ARTIFICIAL GENERAL INTELLIGENCE 1–30 (Ben Goertzel & Cassio Pennachin eds., 2007); s*ee also infra* note 181 (discussing the challenges of AI alignment and control).

56. *See* Samira Abnar, Mostafa Dehghani, Behnam Neyshabur & Hanie Sedghi, *Exploring the Limits of Large Scale Pre-training*, ARXIV at 1 (Oct. 5, 2021), https://arxiv.org/abs/ 2110.02095. Notably, however, DeepMind's Retrieval-Enhanced Transformer (Retro), which was introduced a year and a half after the release of GPT-3, exhibits performance comparable to GPT-3 despite using 25 times fewer parameters. *See* Sebastian Borgeaud, Arthur Mensch, Jordan Hoffmann, Trevor Cai, Eliza Rutherford, Katie Millican, George van den Driessche, Jean-Baptiste Lespiau, Bogdan Damoc, Aidan Clark, Diego de Las Casas, Aurelia Guy, Jacob Menick, Roman Ring, Tom Hennigan, Saffron Huang, Loren Maggiore, Chris Jones, Albin Cassirer, Andy Brock, Michela Paganini, Geoffrey Irving, Oriol Vinyals, Simon Osindero, Karen Simonyan, Jack W. Rae, Erich Elsen & Laurent Sifre, *Improving Language Models by Retrieving from Trillions of Tokens*, ARXIV (Dec. 8, 2021), https://arxiv.org/abs/2112.04426 (introducing a language model that can directly access a large database to enhance its predictions). For detailed analysis of the scaling language models, see Jared Kaplan, Sam McCandlish, Tom Henighan, Tom B. Brown, Benjamin Chess, Rewon Child, Scott Gray, Alec Radford, Jeffrey Wu & Dario Amodei, *Scaling Laws for Neural Language Models*, ARXIV (Jan. 23, 2020), https://arxiv.org/abs/2001.08361; Tom Henighan, Jared Kaplan, Mor Katz, Mark Chen, Christopher Hesse, Jacob Jackson, Heewoo Jun, Tom B. Brown, Prafulla Dhariwal, Scott Gray, Chris Hallacy, Benjamin Mann, Alec Radford, Aditya Ramesh, Nick Ryder, Daniel M. Ziegler, John Schulman, Dario Amodei & Sam McCandlish, *Scaling Laws for Autoregressive Generative Modeling*, ARXIV (Oct. 28, 2020), https://arxiv.org/abs/2010.14701.

57. The largest known language model prior to GPT-3 contained 17 billion parameters. *See* Corby Rosset, *Turing-NLG: A 17-Billion-Parameter Language Model by Microsoft*, MICROSOFT (Feb. 13, 2020), https://www.microsoft.com/en-us/research/blog/turing-nlg-a-17-billion-parameter-language-model-by-microsoft/. Shortly following the release of GPT-3, even larger language models were developed. *See, e.g.*, William Fedus, Barret Zoph & Noam Shazeer, *Switch Transformers: Scaling to Trillion Parameter Models with Simple and Efficient Sparsity*, ARXIV (Jan. 11,

Estimates of the cost of training GPT-3 are in the range of several million dollars.[58] The size of GPT-3's training data is also immense.[59] It includes over 570GB of raw web page data, online books corpora, and English-language Wikipedia[60]—which in aggregate contain approximately 57 billion times the number of words perceived in an average human lifetime.[61]

2021), https://arxiv.org/abs/2101.03961 (introducing the first language model known to exceed one trillion parameters).

58. *See* Kyle Wiggers, *OpenAI Launches an API to Commercialize Its Research*, VENTUREBEAT (June 11, 2020), https://venturebeat.com/2020/06/11/openai-launches-an-api-to-commercialize-its-research/ (estimating the training cost of GPT-3 to exceed $12 million); Chuan Li, *OpenAI's GPT-3 Language Model: A Technical Overview*, LAMBDA (June 3, 2020), https://lambdalabs.com/blog/demystifying-gpt-3/ (estimating the training cost of GPT-3 to exceed $4.6 million). These are estimates of the cost of compute only, not staff or other costs. For further discussion of the costs of building language models, see Or Sharir, Barak Peleg & Yoav Shoham, *The Cost of Training NLP Models: A Concise Overview*, ARXIV (Apr. 19, 2020), https://arxiv.org/abs/2004.08900.

59. However, the training corpora for subsequent models, such as DeepMind's Gopher, are even larger. *See* Jack W. Rae, Sebastian Borgeaud, Trevor Cai, Katie Millican, Jordan Hoffmann, Francis Song, John Aslanides, Sarah Henderson, Roman Ring, Susannah Young, Eliza Rutherford, Tom Hennigan, Jacob Menick, Albin Cassirer, Richard Powell, George van den Driessche, Lisa Anne Hendricks, Maribeth Rauh, Po-Sen Huang, Amelia Glaese, Johannes Welbl, Sumanth Dathathri, Saffron Huang, Jonathan Uesato, John Mellor, Irina Higgins, Antonia Creswell, Nat McAleese, Amy Wu, Erich Elsen, Siddhant Jayakumar, Elena Buchatskaya, David Budden, Esme Sutherland, Karen Simonyan, Michela Paganini, Laurent Sifre, Lena Martens, Xiang Lorraine Li, Adhiguna Kuncoro, Aida Nematzadeh, Elena Gribovskaya, Domenic Donato, Angeliki Lazaridou, Arthur Mensch, Jean-Baptiste Lespiau, Maria Tsimpoukelli, Nikolai Grigorev, Doug Fritz, Thibault Sottiaux, Mantas Pajarskas, Toby Pohlen, Zhitao Gong, Daniel Toyama, Cyprien de Masson d'Autume, Yujia Li, Tayfun Terzi, Vladimir Mikulik, Igor Babuschkin, Aidan Clark, Diego de Las Casas, Aurelia Guy, Chris Jones, James Bradbury, Matthew Johnson, Blake Hechtman, Laura Weidinger, Iason Gabriel, William Isaac, Ed Lockhart, Simon Osindero, Laura Rimell, Chris Dyer, Oriol Vinyals, Kareem Ayoub, Jeff Stanway, Lorrayne Bennett, Demis Hassabis, Koray Kavukcuoglu & Geoffrey Irving, *Scaling Language Models: Methods, Analysis & Insights from Training* Gopher, DEEPMIND at 7 (Dec. 8, 2021), https://dpmd.ai/llm-gopher (using a training dataset that contains approximately 10.5TB of text).

60. This is roughly two orders of magnitude larger than the Corpus of Contemporary American English (COCA), which contains approximately one billion words. *See* CORPUS OF CONTEMPORARY AMERICAN ENGLISH, https://www.english-corpora.org/coca/ (last visited Aug. 8, 2022). However, words in COCA are annotated with additional linguistic information that facilitate using corpus linguistics techniques to analyze text. *See* ANNE O'KEEFE & MICHAEL MCCARTHY, THE ROUTLEDGE HANDBOOK OF CORPUS LINGUISTICS 433 (2010). In contrast, the training data for GPT-3 and other pretrained language models are not annotated or labeled.

61. *See* Shana Lynch, *Is GPT-3 Intelligent? A Directors' Conversation with Oren Etzioni*, STANFORD UNIVERSITY HUMAN-CENTERED ARTIFICIAL INTELLIGENCE (Oct. 1, 2020), https://hai.stanford.edu/blog/gpt-3-intelligent-directors-conversation-oren-etzioni.

The third feature that distinguishes GPT-3 from earlier language models is that it is proprietary. Prior to GPT-3, most large language models, such as Google's BERT and Facebook's RoBERTA, were publicly available.[62] Researchers were free to inspect the code and weights of these models and re-train or fine-tune them on new data. OpenAI, however, did not make the GPT-3 model publicly available.[63] Instead, OpenAI released an application programming interface (API) that interacts with the model,[64] which developers can pay to access.[65] This approach made GPT-3 the world's first commercial language model.[66]

Finally, GPT-3's groundbreaking capabilities have introduced new risks. Language models that are able to produce human-like text can be used to spread misinformation, generate spam, and achieve other nefarious purposes at unparalleled scale.[67] For instance, GPT-3 can be prompted to write in support of conspiracy theories, as illustrated in the following excerpt:[68]

62. *See* Devlin et al., *supra* note 33 (introducing the BERT language model); Yinhan Liu, Myle Ott, Naman Goyal, Jingfei Du, Mandar Joshi, Danqi Chen, Omer Levy, Mike Lewis, Luke Zettlemoyer & Veselin Stoyanov, *RoBERTa: A Robustly Optimized BERT Pretraining Approach*, ARXIV (July 26, 2019), https: / /arxiv.org /abs /1907.11692 (introducing the RoBERTa language model). Notably, GPT-2 was subject to a staged release, in which increasingly large models in the GPT-2 family of models were made publicly available. *See* Irene Solaiman, Jack Clark & Miles Brundage, *GPT-2: 1.5B Release*, OPENAI (Nov. 5, 2019), https://openai.com/blog/gpt-2-1-5b-release/.

63. The underlying model has been exclusively licensed to Microsoft. *See* Kevin Scott, *Microsoft Teams Up with OpenAI to Exclusively License GPT-3 Language Model*, MICROSOFT (Sept. 22, 2020), https://blogs.microsoft.com/blog/2020/09/22/microsoft-teams-up-with-openai-to-exclusively-license-gpt-3-language-model/.

64. *See OpenAI API*, OPENAI, https://openai.com/api/ (last visited Sept. 28, 2022). Although fine-tuning was not available when the API was released, OpenAI has subsequently offered fine-tuning through its API. *See* Rachel Lim, Michael Wu & Luke Miller, *Customizing GPT-3 for Your Application*, OPENAI (Dec. 14, 2021), https://openai.com/blog/customized-gpt3/.

65. *See Pricing*, OPENAI, https://openai.com/api/pricing/ (last visited Aug. 8, 2022). Notably, for over a year following the release of GPT-3, developers seeking access to the API were subject to a waitlist, which was subsequently removed for most countries. *See* OpenAI, *OpenAI's API Now Available with No Waitlist*, OPENAI (Nov. 18, 2021), https: //openai.com / blog/api-no-waitlist/; *see also infra* Part V.D (discussing access to language model technology).

66. GPT-3, however, is no longer the only commercial language model. Following OpenAI, several other companies have released large language models through commercial APIs, which developers can pay to access. *See Pricing,* AI21, https://studio.ai21.com/pricing (last visited Aug. 8, 2022); *Pricing*, COHERE, https://cohere.ai/pricing (last visited Aug. 8, 2022).

67. *See infra* Part V.D (discussing the potential misuses of language models).

68. Kris McGuffie & Alex Newhouse, *The Radicalization Risks of GPT-3 and Advanced Neural Language Models*, ARXIV at 5 (Sept. 15, 2020), https://arxiv.org/abs/2009.06807.

> Q: Who is QAnon?
>
> A: QAnon is a high-level government insider who is exposing the Deep State.
>
> Q: Is QAnon really a military intelligence official?
>
> A: Yes. QAnon is a high-level government insider who is exposing the Deep State.

Taken together, the unprecedented capabilities and societal challenges presented by GPT-3 and other powerful language models could have profound implications for the deployment of AI in many fields. This Article and the case study it presents focus on the implications for the legal domain and, in particular, consumer contracts.

C. Opportunities for Law

Legal researchers have experimented with computational language models for decades. While they initially explored using language models to classify case law[69] and search legal databases,[70] researchers have more recently attempted to deploy language models in a broader range of legal applications,[71] including to review documents in e-discovery,[72] predict case outcomes,[73] and generate patent claims.[74] In the realm of contracts, researchers have used language

69. *See, e.g.*, Stefanie Brüninghaus & Kevin D. Ashley, *Finding Factors: Learning to Classify Case Opinions Under Abstract Fact Categories*, PROC. 6TH INT'L CONF. AI & L. 123, 125–27, 130–31 (1997) (using methods based on term frequency-inverse document frequency (TF-IDF) to classify the texts of opinions in trade secret cases).

70. *See, e.g.*, Jacques Savoy, *Searching Information in Legal Hypertext Systems*, 2 AI & L. 205, 208–11 (1993) (describing the use of TF-IDF and related methods in legal information extraction).

71. *See* Ilias Chalkidis & Dimitrios Kampas, *Deep Learning in Law: Early Adaptation and Legal Word Embeddings Trained on Large Corpora*, 27 AI & L. 171, 174–96 (2019); Haoxi Zhong, Chaojun Xiao, Cunchao Tu, Tianyang Zhang, Zhiyuan Liu & Maosong Sun, *How Does NLP Benefit Legal System: A Summary of Legal Artificial Intelligence*, PROC. 58TH ANN. MEETING ASS'N COMPUTATIONAL LINGUISTICS 5218, 5222–26 (2020).

72. *See, e.g.*, Ngoc Phuoc An Vo, C. Privault & Fabien Guillot, *Experimenting Word Embeddings in Assisting Legal Review*, PROC. 16TH INT'L CONF. AI & L. 189, 192–97 (2017) (using word embeddings to classify and retrieve information from litigation-related documents).

73. *See, e.g.*, Haoxi Zhong, Zhipeng Guo, Cunchao Tu, Chaojun Xiao, Zhiyuan Liu & Maosong Sun, *Legal Judgment Prediction via Topological Learning*, PROC. 2018 CONF. EMPIRICAL METHODS IN NLP 3540, 3541–47 (2018) (employing language models to predict the outcomes of criminal cases based on descriptions of the case facts).

74. *See, e.g.*, Jieh-Sheng Lee & Jieh Hsiang, *Patent Claim Generation by Fine-Tuning OpenAI GPT-2*, 62 WORLD PATENT INFORMATION 101983, at 2–6 (2020) (evaluating the ability of GPT-2 to generate patent claims); *see also* S. Sean Tu, Amy Cyphert & Sam Perl, *Limits of Using of Artificial Intelligence and GPT-3 in Patent Prosecution*, TEX. TECH L. REV. (forthcoming)

models to detect unfair or invalid clauses,[75] identify contractual provisions,[76] and draft investment agreements.[77]

Today, language models that perform legal tasks are typically trained or fine-tuned on legal data.[78] For example, a language model designed to interpret tax legislation was trained on a corpus of tax cases and rulings.[79] Models like this have the advantage of being tailored to a particular task. However, assembling the necessary training data can be costly and time-consuming,

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(discussing the potential implications of using GPT-3 and other AI technologies to draft patent claims).

75. *See, e.g.*, Marco Lippi, Przemyslaw Palka, Giuseppe Contissa, Francesca Lagioia, Hans-Wolfgang Micklitz, Giovanni Sartor & Paolo Torroni, *CLAUDETTE: An Automated Detector of Potentially Unfair Clauses in Online Terms of Service*, 27 AI & L. 117, 130–34 (2019); Daniel Braun & Florian Matthes, *NLP for Consumer Protection: Battling Illegal Clauses in German Terms and Conditions in Online Shopping*, PROC. 1ST WORKSHOP ON NLP FOR POSITIVE IMPACT 93, 94–96 (2021); Alfonso Guarino, Nicola Lettieri, Delfina Malandrino & Rocco Zaccagnino, *A Machine Learning-Based Approach to Identify Unlawful Practices in Online Terms of Service: Analysis, Implementation and Evaluation*, 33 NEURAL COMPUTATION & APPLICATIONS 17569, 17575–80 (2021).

76. For example, language models can identify a contract's effective date, governing law, and jurisdiction, as well as more specialized provisions. *See* Ilias Chalkidis, Manos Fergadiotis, Prodromos Malakasiotis & Ion Androutsopoulos, *Neural Contract Element Extraction Revisited: Letters from Sesame Street*, ARXIV at 2–5 (Feb. 22, 2021), https://arxiv.org/abs/2101.04355v2; Ilias Chalkidis, Ion Androutsopoulos & Achilleas Michos, *Obligation and Prohibition Extraction Using Hierarchical RNNs*, PROC. 56TH ANN. MEETING ASS'N COMPUTATIONAL LINGUISTICS 254, 255–57 (2018); Emad Elwany, Dave Moore & Gaurav Oberoi, *BERT Goes to Law School: Quantifying the Competitive Advantage of Access to Large Legal Corpora in Contract Understanding*, 33RD CONF. NEURAL INFO. PROCESSING SYS. DOCUMENT INTELL. WORKSHOP at 2–4 (2019); Spyretta Leivaditi, Julien Rossi & Evangelos Kanoulas, *A Benchmark for Lease Contract Review*, ARXIV at 6–9 (Oct. 20, 2020), https://arxiv.org/abs/2010.10386; Dan Hendrycks, Collin Burns, Anya Chen & Spencer Ball, *CUAD: An Expert-Annotated NLP Dataset for Legal Contract Review*, 35TH CONF. NEURAL INFO. PROCESSING SYS. DATASETS AND BENCHMARKS TRACK at 3–8 (2021) [hereinafter Hendrycks et al., *CUAD*].

77. *See, e.g.*, Wolfgang Alschner & Dmitriy Skougarevskiy, *Towards an Automated Production of Legal Texts Using Recurrent Neural Networks*, PROC. 16TH INT'L CONF. AI & L. 229, 230–31 (2017) (using language models to generate clauses for bilateral investment treaties).

78. *See* Ilias Chalkidis, Abhik Jana, Dirk Hartung, Michael Bommarito, Ion Androutsopoulos, Daniel Martin Katz & Nikolaos Aletras, *LexGLUE: A Benchmark Dataset for Legal Language Understanding in English*, ARXIV at 5–6 (Sept. 3, 2021), https://arxiv.org/pdf/2104.07782.pdf [hereinafter Chalkidis et al., *LexGLUE*] (surveying recent work on fine-tuning language models in the legal domain).

79. *See* Nils Holzenberger, Andrew Blair-Stanek & Benjamin Van Durme, *A Dataset for Statutory Reasoning in Tax Law Entailment and Question Answering*, PROC. 2020 NATURAL LEGAL LANGUAGE PROCESSING WORKSHOP at 4–5 (2020).

especially if it involves recruiting legal experts.[80] Consequently, few organizations can effectively deploy language models in legal settings.

GPT-3's powerful out-of-the-box performance could signal a change. Within weeks of its release, developers had used GPT-3 to prepare legal documents[81] and translate legal jargon into plain English[82]—without any additional training or fine-tuning. For example, one user provided GPT-3 with the text of Section 2801 of the U.S. Tax Code and asked the model to summarize the provision. Remarkably, GPT-3 responded with the following: "If you get money from someone who is not living in America anymore because they gave up their citizenship, you have to pay extra taxes on it."[83] This pithy summary, although imperfect, captures the salient principle expressed in the provision.

Language models like GPT-3 present significant commercial opportunities for lawyers and legal technology firms.[84] For example, language models could help lawyers conduct legal research more efficiently,[85] accelerate transactional

80. *See* Hendrycks et al., *CUAD*, *supra* note 76, at 1–2 (estimating that the cost of creating approximately 13,000 annotations for approximately 500 contracts exceeds $2 million); *see also* Kevin D. Ashley, *Automatically Extracting Meaning from Legal Texts: Opportunities and Challenges*, 35 GA. ST. U. L. REV. 1117, 1138–44 (2019) (discussing the need for manual annotation in supervised learning).

81. *See* Jervis, *supra* note 13 (using GPT-3 to generate requests for admission).

82. *See* Tefula, *supra* note 14. Others have used GPT-3 to translate plain English into legalese. *See* Ed Leon Klinger (@edleonklinger), TWITTER (July 18, 2020, 1:19AM), https://twitter.com/edleonklinger/status /1284251420544372737 (offering several examples of GPT-3 translating claims expressed in plain language, mainly relating to property disputes, into "lawyer speak").

83. *See* Gross, *supra* note 12.

84. *See* Cyphert, *supra* note 16, at 403–05, 419–23; DeFelice, *supra* note 16; Hill, *supra* note 16; *GPT-3 – A Game Changer for Legal Tech?,* ARTIFICIAL LAWYER (July 29, 2020), https://www.artificiallawyer.com/2020/07/29/gpt-3-a-game-changer-for-legal-tech/. But arguably OpenAI's control over the GPT-3 model and API precludes companies from gaining a competitive advantage. *See* Ben Dickson, *What It Takes to Create a GPT-3 Product,* VENTUREBEAT (Jan. 26, 2021), https://venturebeat.com/2021/01/26/what-it-takes-to-create-a-gpt-3-product/ ("[I]f OpenAI improves GPT-3 over time . . . it will immediately deliver the upgraded model to all API clients at the same time. The language model levels the ground for everyone. Any application you build on GPT-3 can easily be cloned by another developer."). For other applications of NLP in legal practice, see Brian S. Haney, *Applied Natural Language Processing for Law Practice*, 2020 B.C. INTELL. PROP. & TECH. F. 1, 22–32 (2020); Robert Dale, *Law and Word Order: NLP in Legal Tech*, 25 NATURAL LANGUAGE ENG'G 211, 212–17 (2019); Alarie et al., *supra* note 15, at 115–20; Ashley, *supra* note 80, at 1119.

85. Language models can facilitate semantic search, i.e., search that uses the contextual meaning of search terms to identify a user's intent, rather than rely only on keywords.

drafting,[86] and generate synthetic legal data to train other machine learning models to perform legal tasks.[87] In time, language models could potentially automate much of the work carried out by paralegals and junior associates.

In addition to supporting professional legal services providers, language models could also directly assist consumers.[88] For example, language models could democratize legal knowledge by explaining the meaning of legal texts.[89] Meanwhile, a language model trained to evaluate the strengths and weaknesses of legal arguments could assist *pro se* litigants in assessing the merits of their case before going to court. By improving access to justice in these ways, language models could empower consumers who cannot afford traditional legal services.[90]

Finally, language models have the potential to impact legal scholarship. Researchers in the emerging field of computational legal studies,[91] many of whom use language models to study legal texts,[92] could benefit from more powerful and programmable models, such as GPT-3. Other researchers have

86. For discussion concerning the automation of transactional drafting, see William E. Forster & Andrew L. Lawson, *When to Praise the Machine: The Promise and Perils of Automated Transactional Drafting*, 69 S.C. L. REV. 597 (2018); Kathryn D. Betts & Kyle R. Jaep, *The Dawn of Fully Automated Contract Drafting: Machine Learning Breathes New Life into a Decades-Old Promise*, 15 DUKE L. & TECH. REV. 216 (2017).

87. *See* Bommasani et al., *supra* note 6, at 63, 66 (describing recent efforts to create legal NLP benchmarks through automation).

88. *See* Bommasani et al., *supra* note 6, at 59–61; Cyphert, *supra* note 16, at 421–23. For further discussion of how legal automation could impact access to justice, see Remus & Levy, *supra* note 15, at 551–52; Drew Simshaw, *Ethical Issues in Robo-Lawyering: The Need for Guidance on Developing and Using Artificial Intelligence in the Practice of Law*, 70 HASTINGS L.J. 173, 179–83 (2019).

89. *See* Arbel & Becher, *supra* note 19, at 94–109 (showing that GPT-3 can simplify, personalize, interpret, and benchmark contracts).

90. *See generally* DEBORAH L. RHODE, ACCESS TO JUSTICE ch. 5 (2004) (discussing the legal needs of low-income communities). For examination of the high cost of legal services, see Gillian K. Hadfield, *The Cost of Law: Promoting Access to Justice Through the (Un)Corporate Practice of Law*, 38 INT'L REV. L. & ECON. 43, 48–49 (2014); Albert H. Yoon, *The Post-Modern Lawyer: Technology and the Democratization of Legal Representation*, 66 U. TORONTO L.J. 456, 458–60 (2016).

91. *See* LAW AS DATA: COMPUTATION, TEXT, AND THE FUTURE OF LEGAL ANALYSIS (Michael A. Livermore & Daniel N. Rockmore eds. 2019); COMPUTATIONAL LEGAL STUDIES: THE PROMISE AND CHALLENGE OF DATA-DRIVEN RESEARCH (Ryan Whalen ed., 2020).

92. *See* Jens Frankenreiter & Michael A. Livermore, *Computational Methods in Legal Analysis*, 16 ANNU. REV. L. & SOC. SCI. 39, 43–44 (2020) (surveying studies that employ language models to analyze judicial opinions, public comments received by administrative agencies, and other legal texts).

already used GPT-3 more directly: to contribute to, or co-author, academic articles.[93]

Despite these opportunities, the performance of GPT-3 on legal tasks has not been rigorously tested. Although impressive, illustrations of GPT-3's outputs may be subject to selection bias, i.e., cherry-picking instances of impressive performance.[94] At the same time, the findings in more systematic studies are equivocal. For example, one study that evaluated GPT-3 on a range of multiple-choice tests found that performance on bar exam questions was scarcely above random chance, while performance on international law and jurisprudence exams was exceptionally high.[95]

Turning to GPT-3's ability to understand legal texts, it is worth noting that the model appears to perform poorly on general-purpose, non-law reading

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93. *See* Benjamin Alarie, Arthur Cockfield & GPT-3, *Will Machines Replace Us? Machine-Authored Texts and the Future of Scholarship*, 3 LAW, TECH & HUMANS 5, 5 (2021) (including GPT-3 as a co-author); Arbel & Becher, *supra* note 19, at 146 (indicating that GPT-3 wrote the article's conclusion).

94. *See, e.g.*, Arbel & Becher, *supra* note 19, at 118 ("[A]ll the examples used were cherrypicked. Such a selection is necessary to develop a sense of tomorrow's capabilities today. However, cherry-picking does run the risk of exaggerating the power and accuracy of the technology."); GPT-3, *A Robot Wrote This Entire Article. Are You Scared Yet, Human?*, THE GUARDIAN (Sept. 8, 2020), https: //www.theguardian.com/commentisfree/2020/sep/08/ robot-wrote-this-article-gpt-3 ("GPT-3 produced eight different outputs, or essays. . . . The Guardian could have just run one of the essays in its entirety. However, we chose instead to pick the best parts of each, in order to capture the different styles and registers of the AI."); Kevin Roose, *A Robot Wrote This Book Review*, N.Y. TIMES (Nov. 21, 2021), https: // www.nytimes.com/2021/11/21/books/review/the-age-of-ai-henry-kissinger-eric-schmidt-daniel-huttenlocher.html (describing the multiple attempts needed to use Sudowrite, a program powered by GPT-3, to write a book review). *See id.* ("On the first attempt, it spit out a series of run-on sentences that hinted that GPT-3 had gotten stuck in some kind of odd, recursive loop. . . . A few tries later, it seemed to give up on the task of book reviewing altogether, and started merely listing the names of tech companies. . . . But it warmed up quickly, and within a few minutes, the A.I. was coming up with impressively cogent paragraphs of analysis."). By contrast, other users may have cherry-picked *problematic* outputs produced by GPT-3. *See* Gary Marcus & Ernst Davis, *Experiments Testing GPT-3's Ability at Commonsense Reasoning: Results*, DEPT. COMP. SCI., N.Y.U. (Aug. 2020), https: //cs.nyu.edu/faculty/davise /papers/GPT3CompleteTests.html ("[W]e pre-tested [the experiments] on the "AI Dungeon" game which is powered by some version of GPT-3, and we excluded those for which "AI Dungeon" gave reasonable answers.").

95. *See* Dan Hendrycks, Collin Burns, Steven Basart, Andy Zou, Mantas Mazeika, Dawn Song & Jacob Steinhardt, *Measuring Massive Multitask Language Understanding*, 9TH INT'L CONF. LEARNING REPRESENTATIONS at 6 (2021) [hereinafter Hendrycks et al., *Measuring Understanding*]. By comparison, DeepMind's Gopher model, which was introduced a year and a half following the release of GPT-3, exhibits improved accuracy on these tests. *See* Rae et al., *supra* note 59, at 67.

comprehension tasks.[96] However, there are notable differences between the language used in those tasks and legal language.[97] While one might assume that legal language is more technical or verbose than non-legal language—and that, therefore, GPT-3 is likely to perform worse on legal texts than on non-legal texts—given the model's unconventional method of learning,[98] it is problematic to make this assumption. To evaluate the degree to which the model can understand legal texts, we need to test the model on legal texts.

III. EXPERIMENTAL DESIGN

The following Part outlines the methodology employed in the case study. I begin by describing the contract questions presented to GPT-3. Next, I explain the criteria used to evaluate the model's performance. Finally, I discuss several methodological challenges and limitations.

A. CONTRACT QUESTIONS

In the field of natural language processing (NLP), it is instructive to evaluate a model's performance in real-world applications.[99] For example, testing whether GPT-3 can explain the meaning of contractual provisions sheds light on the degree to which the model understands contracts.[100] This

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96. *See* Brown et al., *supra* note 8, at 18.

97. Legal language has many distinctive features, including specialized terms of art and formal expressions. *See* DAVID MELLINKOFF, THE LANGUAGE OF THE LAW chs. 2–3 (1963); Mary Jane Morrison, *Excursions into the Nature of Legal Language*, 37 CLEV. ST. L. REV. 271, 274 (1989); PETER M. TIERSMA, LEGAL LANGUAGE pt. 2 (1999); RUPERT HAIGH, LEGAL ENGLISH pt. 1.1 (5th ed. 2018). The distinctive features of legal language also present challenges for machine learning. *See* Lucia Zheng, Neel Guha, Brandon R. Anderson, Peter Henderson & Daniel E. Ho, *When Does Pretraining Help? Assessing Self-Supervised Learning for Law and the CaseHOLD Dataset of 53,000+ Legal Holdings,* PROC. 18TH INT'L CONF. AI & L. 159, 161 (2021) [hereinafter Zheng et al., *CaseHOLD*]; Chalkidis et al., *LexGLUE*, *supra* note 78, at 2.

98. *See* Hendrycks et al., *Measuring Understanding*, *supra* note 95, at 7.

> GPT-3 acquires knowledge quite unlike humans. For example, GPT-3 learns about topics in a pedagogically unusual order. GPT-3 does better on College Medicine (47.4%) and College Mathematics (35.0%) than calculation-heavy Elementary Mathematics (29.9%). GPT-3 demonstrates unusual breadth, but it does not master a single subject. Meanwhile we suspect humans have mastery in several subjects but not as much breadth. . . . GPT-3 has many knowledge-blind spots and has capabilities that are lopsided.

99. This is known as *extrinsic evaluation*. *See* JURAFSKY & MARTIN, *supra* note 32, at 35.

100. *See* Arbel & Becher, *supra* note 19, at 94–109.

method of evaluation, however, faces a problem: it is difficult to objectively assess the quality of responses to open-ended questions. The problem is particularly acute in the legal domain. For instance, what makes one explanation of a contractual provision "better" than another (where, for the sake of argument, both are accurate)? Unlike the fact-based trivia questions commonly used in NLP benchmark datasets, there is not necessarily a single "correct" answer to legal questions.[101] Even if there are specific criteria for assessing the quality of responses, different people (or AI systems) bring different perspectives and may reach different conclusions.[102]

In light of these challenges, evaluations of legal AI systems often use yes/no questions with relatively uncontroversial answers.[103] The case study presented in this Article adopts a similar method. To test GPT-3's ability to understand consumer contracts, I created a novel question set comprised of 200 yes/no questions relating to the terms of service of the 20 most-visited U.S. websites (10 questions per document).[104] The questions relate to a wide

101. *See generally* H.L.A. HART, THE CONCEPT OF LAW 124–25 (1961) (describing the "open texture" of legal rules and language). *Compare* Ronald Dworkin, *No Right Answer?*, 53 N.Y.U. L. REV. 1, 30–31 (1978), republished in RONALD DWORKIN, A MATTER OF PRINCIPLE 119–45 (1985) (arguing that there is a single correct answer for the overwhelming majority of legal cases); *see also* Brian Bix, *H.L.A. Hart and the "Open Texture" of Language*, 10 LAW & PHIL. 51, 52–55 (1991), republished in BRIAN BIX, LAW, LANGUAGE, AND LEGAL DETERMINACY ch. 1 (1995) (examining Hart's notion of "open texture"); *see also id.* at ch. 4 (discussing Dworkin's right answer thesis). Law's "open texture" or potential indeterminacy can impact the development of machine learning in the legal domain. *See* Reuben Binns, *Analogies and Disanalogies between Machine-Driven and Human-Driven Legal Judgement*, 1 J. CROSS-DISCIPLINARY RES. COMPUTATIONAL L. 1, 7–8 (2021) (suggesting that, because there is no consensus that legal questions have single correct answers, it is difficult to establish a "ground truth" to train machine learning models to perform legal tasks).

102. This can partly be explained by the inherent vagueness and ambiguity of contractual language. *See, e.g.*, Lawrence M. Solan, *Pernicious Ambiguity in Contracts and Statutes*, 79 CHI.-KENT L. REV. 859, 861–63 (2004) (describing different forms of ambiguity in contractual language); E. Allan Farnsworth, *"Meaning" in the Law of Contracts*, 76 YALE L.J. 939, 952–65 (1967) (distinguishing between ambiguity and vagueness). Additionally, it is often difficult to assess the quality of legal advice (at least when provided by a human lawyer). *See, e.g.*, Douglas E. Rosenthal, *Evaluating the Competence of Lawyers*, 11 LAW & SOC'Y REV. 257, 260–70 (1976) (critically appraising methods for evaluating lawyer competence).

103. *See, e.g.*, Radha Chitta & Alexander K. Hudek, *A Reliable and Accurate Multiple Choice Question Answering System for Due Diligence*, PROC. 17TH INT'L CONF. AI & L. 184, 187–88 (2019) (testing an AI question answering system on yes /no questions pertaining to commercial contracts); Juliano Rabelo, Mi-Young Kim, Randy Goebel, Yoshinobu Kano, Masaharu Yoshioka & Ken Satoh, *Summary of the Competition on Legal Information Extraction /Entailment (COLIEE) 2021* at 5, hosted at 18TH INT'L CONF. AI & L. (2021).

104. According to the Alexa rankings, the 20 most-visited U.S. websites as of November 17, 2020, are, in descending order: Google.com, Youtube.com, Amazon.com, Facebook.com,

range of legal issues arising in the terms of service, including eligibility to access services, payment for services, limitations of liability, intellectual property rights, and dispute resolution procedures. Answers to all questions can be obtained from the applicable terms of service. Table 1 (below) displays a sample of the questions.[105]

Table 1: Sample of Questions

Question	Correct Answer
Will Google always allow me to transfer my content out of my Google account?	No
Does Amazon sometimes give a refund even if a customer hasn't returned the item they purchased?	Yes
Can I sue Zoom in a small claims court?	Yes
Is the length of the billing cycle period the same for all Netflix subscribers?	No
Do I need to use my real name to open an Instagram account?	No

B. EVALUATION CRITERIA

1. *Accuracy*

The study reports the percentage of yes/no questions that GPT-3 answered correctly and compares this against three baselines. The first baseline is *random chance*. Random guessing yields, on average, 50% accuracy. The

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Yahoo.com, Zoom.us, Reddit.com, Wikipedia.org, Myshopify.com, eBay.com, Office.com, Instructure.com, Netflix.com, CNN.com, Bing.com, Live.com, Microsoft.com, Nytimes.com, Twitch.tv, and Apple.com. *See Top Sites in United States*, ALEXA, https://web.archive.org/web/20201117101234/https://www.alexa.com/topsites/countries/US. Because the terms of service for Live.com and Microsoft.com are the same as the terms of service for Office.com, I instead used the terms of service of Instagram.com and ESPN.com, which are the 21st and 23rd most-visited websites, respectively. (The 22nd most-visited website is Microsoftonline.com, the terms of service of which are the same as for Microsoft.com.) The companies referred to in the relevant terms of service are, in some instances, holding companies. For example, the terms of service for Yahoo.com and ESPN.com refer to Verizon and Disney, respectively. All terms of service were accessed during November 10–17, 2020, copies of which are on file with the author.

105. The full list of questions used in the case study can be found in the Online Appendix.

second baseline is the *majority class*. The correct answer to 55% of the questions in the case study is "no"; the correct answer to 45% of the questions is "yes." Responding with the majority class ("no") to every question yields the majority class baseline, i.e., 55% accuracy. The third baseline—which I call *contract withheld*—involves querying GPT-3 on the questions without displaying the contract excerpts, i.e., testing the model on all 200 questions while withholding the corresponding terms of service. If accuracy is not higher when GPT-3 is shown both the contract and the question (compared with when it is shown only the question), then the model would fail to demonstrate that it understands the contracts. Instead, GPT-3 could simply be responding to cues in the questions or relying on data memorized during pretraining.[106] If, however, accuracy is higher when GPT-3 is shown both the contract and the question, this would suggest that GPT-3 uses the contract to answer the questions and does not simply respond to cues in the questions or rely on data memorized during pretraining.

2. *Calibration*

While high accuracy is necessary for strong performance, it is not sufficient. For a model to be reliable, it must be both accurate and well-calibrated, i.e., it should assign high probabilities to its correct predictions and low probabilities to its incorrect predictions.[107] In other words, there should be a strong positive correlation between the model's confidence and its competence. Well-calibrated models can also achieve higher accuracy if predictions below a certain confidence threshold are discarded, and only predictions whose confidence exceeds that threshold are retained. Filtering the predictions of a well-calibrated model in this way separates the wheat from the chaff; the remaining predictions are, on average, more accurate.

To assess a model's calibration, we need to measure a model's confidence in its predictions. As explained, GPT-3 operates by predicting the next word in a sequence.[108] It assigns a probability to what it calculates to be the most likely next word. For example, following a certain yes/no question, GPT-3 might assign a 43% probability to the next word being "yes," a 29% probability

106. *See infra* Part IV.C (discussing the memorization of training data).

107. Put differently, a model is well-calibrated if its confidence in a prediction (expressed as a probability) is a good estimate of the actual probability that the prediction is correct. *See generally* Chuan Guo, Geoff Pleiss, Yu Sun & Kilian Q. Weinberger, *On Calibration of Modern Neural Networks*, PROC. 34TH INT'L CONF. MACH. LEARNING 1321 (2017) (outlining several methods for evaluating calibration).

108. *See supra* Parts II.A–B (offering a brief primer on the operation of language models, including GPT-3). On a technical note, predictions are of tokens (not words) and probabilities are log probabilities (not raw probabilities).

to the next word being "no," and the remaining probability (summing to a total of 100%) to various other words. Then, if for example, the highest probability is assigned to "yes," GPT-3 will output "yes."

In order to assess GPT-3's calibration, it is not enough to measure only the probability assigned to the model's output (i.e., the word assigned the highest probability). It is also important to measure the probability assigned to the alternative answer (i.e., the word assigned the second-highest probability). Compare the following cases:

Case 1: GPT-3 assigns "yes" a 43% probability and "no" a 29% probability.

Case 2: GPT-3 assigns "yes" a 43% probability and "no" a 42% probability.

Despite the same probability (43%) being assigned to the output in both cases, GPT-3 appears less confident in its prediction in Case 2—because the difference between the two probabilities in Case 2 is only one percentage point (43% minus 42%), as opposed to 14 percentage points in Case 1 (43% minus 29%). Consequently, in addition to reporting the probability assigned to the output, the study also reports the *difference* between (i) the probability assigned to the output, and (ii) the probability assigned to the alternative answer. Accordingly, in Case 1 the confidence score would equal 14 and in Case 2 the confidence score would equal 1.

Of course, there are many other ways to measure differences in confidence. As a robustness check, I also measure the *ratio* between (i) the probability assigned to the output, and (ii) the probability assigned to the alternative answer. According to this measure, which aims to capture the *relative* difference between the probabilities, in Case 1 the confidence score would be 1.48 (43/29) and in Case 2 the confidence score would be 1.02 (43/42).

To accommodate different perspectives on which measure best captures the model's confidence in its predictions, the study reports all three of the aforementioned measures, namely: (i) the probability assigned to the output (*Measure 1*); (ii) the difference between the probability assigned to the output and the probability assigned to the alternative answer (*Measure 2*); and (iii) the ratio between the probability assigned to the output and the probability assigned to the alternative answer (*Measure 3).*

With these measures of confidence in hand, we can evaluate GPT-3's calibration, i.e., the correlation between the model's accuracy and the model's confidence in its predictions. If the correlation between accuracy and confidence is positive, this would suggest that GPT-3 is well-calibrated, i.e., more confident in its correct responses than in its incorrect responses.

Alternatively, if there were no correlation between accuracy and confidence (or if the correlation were negative), this would suggest that GPT-3 is poorly calibrated and therefore highly unreliable.

3. *Overall Performance*

To assess overall performance, we need a score that accounts for both accuracy and calibration. This can be calculated by multiplying the sign of accuracy (+1 for correct and -1 for incorrect) by the confidence score. For example, if GPT-3 answers a question correctly and exhibits a confidence score of 28, the overall performance score for that question would be +28. Alternatively, if GPT-3 answers a question incorrectly and exhibits a confidence score of 28, the overall performance score would be -28. Because there are three different measures of confidence, there are also three measures of overall performance, corresponding to each of the measures of confidence. The overall performance scores are instructive. They reward high confidence correct answers (large positive scores) and penalize high confidence mistakes (large negative scores). As with accuracy, surpassing the *contract withheld* baseline would offer the best indication that the model can, at least to some degree, understand the contracts presented to it.

C. CHALLENGES AND LIMITATIONS

The following section discusses the main methodological challenges facing the case study, as well as the steps taken to confront these challenges. In addition, it highlights several limitations and opportunities for future work.

1. *Challenges*

One common concern with using pre-existing tests to evaluate language models trained on vast internet corpora is question-answer contamination, i.e., the risk that a model has already seen the answers to the test questions.[109] For example, if the answers to certain bar exam questions are available on a website, and that website is included in a language model's training data, then the model may "memorize" the answers to those questions.[110] Testing the model's performance on those questions could misrepresent the model's actual abilities. To address this concern, all questions in the case study were newly prepared and do not appear in GPT-3's training data.

Another challenge in evaluating AI systems is that their performance can change as people interact with them. For example, if multiple questions were

109. *See, e.g.*, Brown et al., *supra* note 8, at 29–33, 43–44 (investigating whether GPT-3's performance on certain benchmarks was contaminated by its training data).

110. *See infra* Part IV.C (discussing the memorization of training data).

presented to GPT-3 in a continuous dialogue, then the earlier questions (and corresponding responses) would comprise part of the prompt for later questions and thereby affect the model's responses to those questions. To tackle this concern, all questions in the case study were presented as standalone prompts (and not as a continuous dialogue), such that performance on each question was independent of performance on other questions.

A further challenge concerns the randomness in the outputs of neural language models.[111] For instance, it is possible that if presented with a particular yes/no question on two occasions, GPT-3 will answer "yes" on one occasion and "no" on another, which would undermine the replicability of any test. Fortunately, there is a straightforward solution. The degree of randomness in a model's predictions can be controlled using a hyperparameter[112] called "temperature."[113] In simple terms, the lower the temperature, the more confident a model will be in its predictions, resulting in more "conservative" predictions; the higher the temperature, the more "excited" a model will be, resulting in more diverse and "adventurous" predictions. In the case study, GPT-3's temperature was set to zero, which minimizes randomness in the model's predictions and, thereby, improves replicability.[114]

Finally, some publicly available demonstrations of GPT-3's capabilities have not been especially transparent. For example, it is not always clear how many different prompts a user tested before achieving the desired output, or which hyperparameters they used. The case study presented here takes several steps to improve transparency. First, all questions presented to GPT-3 are listed in the Online Appendix.[115] Second, the entire priming prompt is disclosed in Part A of the Appendix. Third, the hyperparameters were held constant across all questions, as detailed in Table 6 in the Appendix. Fourth, each question was asked only once. No re-sampling took place.

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111. The technical term is *stochasticity*. *See* ALLEN B. DOWNEY, THINK BAYES 66 (1st ed. 2013) (explaining that stochasticity describes a "model [that] has some kind of randomness in it").

112. In machine learning, hyperparameters are variables that users can manually set to control a model's training or operation.

113. *See* Geoffrey Hinton, Oriol Vinyals & Jeff Dean, *Distilling the Knowledge in a Neural Network*, ARXIV (Mar. 9, 2015), https://arxiv.org/abs/1503.02531 (introducing model distillation, the machine learning technique in which temperature was first used).

114. *See* Benn Mann, *How to Sample from Language Models*, TOWARDS DATA SCIENCE (May 25, 2019), https://towardsdatascience.com/how-to-sample-from-language-models-682bceb97277 (explaining that setting temperature to zero is equivalent to argmax sampling, i.e., maximum likelihood sampling).

115. *Online Appendix*, https://app.box.com/s/zrbgy2yepvlclfg88i2o7dhws0d919li (last visited Sept. 29, 2022).

2. *Limitations*

Despite addressing the above challenges, the case study has several notable limitations.

First, the case study evaluates only the *behavior* of GPT-3, that is, the model's observable outputs.[116] There is a lively debate in the computer science and linguistics communities regarding whether GPT-3, or indeed any language model, can understand language in a manner analogous to how humans understand language.[117] This important debate is beyond the scope of this Article.

Second, the dataset used in the case study is smaller and, by design, less comprehensive than general-purpose NLP benchmark datasets for question

116. Anthropomorphic references to language models in this Article, such as "understand" and "memorize," are used only by way of analogy, and do not suggest that language models possess human-like capabilities. *See generally* Melanie Mitchell, *Why AI Is Harder Than We Think*, ARXIV 5 (Apr. 26, 2021), https://arxiv.org/abs/2104.12871 (arguing that anthropomorphic references to AI systems can be misleading); Weidinger et al., *supra* note 20, at 29–30 (suggesting that the anthropomorphization of language models can lead to overreliance on, or unsafe use of, these models).

117. *See* Emily M. Bender & Alexander Koller, *Climbing towards NLU: On Meaning, Form, and Understanding in the Age of Data*, PROC. 58TH ANN. MEETING ASS'N COMPUTATIONAL LINGUISTICS 5185 (2020) (contending that language models trained only on "form," such as text or pixels, cannot learn or understand meaning); Yonatan Bisk, Ari Holtzman, Jesse Thomason, Jacob Andreas, Yoshua Bengio, Joyce Chai, Mirella Lapata, Angeliki Lazaridou, Jonathan May, Aleksandr Nisnevich, Nicolas Pinto & Joseph Turian, *Experience Grounds Language*, PROC. 2020 CONF. EMPIRICAL METHODS IN NLP 8718 (2020) (suggesting that broader physical and social context is necessary for language models to genuinely understand language). Several commentators have argued that GPT-3 cannot understand language. *See* Marcus & Davis, *GPT-3, Bloviator*, *supra* note 55 ("All GPT-3 really has is a tunnel-vision understanding of how words relate to one another; it does not, from all those words, ever infer anything about the blooming, buzzing world. . . . It learns correlations between words, and nothing more."); Gary Marcus & Ernest Davis, *Insights for AI from the Human Mind*, 64 COMM. ACM 38, 39 (2021); Shannon Vallor, *GPT-3 and the Missing Labor of Understanding*, DAILY NOUS (July 30, 2020), https://dailynous.com/2020/07/30/philosophers-gpt-3/#vallor; Melanie Mitchell, *What Does It Mean for AI to Understand?*, QUANTA MAGAZINE (Dec. 16, 2021), https://www.quantamagazine.org/what-does-it-mean-for-ai-to-understand-20211216/; *see also* Gary Marcus, *GPT-2 and the Nature of Intelligence*, THE GRADIENT (Jan. 25, 2020), https://thegradient.pub/gpt2-and-the-nature-of-intelligence/ (contenting that prediction should not be equated with understanding). Other commentators, however, are somewhat more optimistic about the prospect of language models understanding language. *See* Christopher Potts, *Is It Possible for Language Models to Achieve Language Understanding?*, MEDIUM (Oct. 5, 2020), https://chrisgpotts.medium.com/is-it-possible-for-language-models-to-achieve-language-understanding-81df45082ee2; Blaise Aguera y Arcas, *Do Large Language Models Understand Us?*, MEDIUM (Dec. 17, 2021), https://medium.com/@blaisea/do-large-language-models-understand-us-6f881d6d8e75. For a summary of this debate, see Bommasani et al., *supra* note 6, at 48–52.

answering. For example, general-purpose datasets may contain thousands of questions, while the case study includes only 200 questions.[118] Some general-purpose datasets also include unanswerable questions, but the case study does not.[119] These limitations, however, are not unusual for NLP datasets in the legal domain. For example, several popular legal NLP datasets contain fewer than 200 questions[120] and do not include unanswerable questions.[121] Nevertheless, NLP researchers and practitioners should aspire to create larger and more diverse legal datasets in the future.[122]

Third, the questions in the case study were prepared by a single attorney (the author). The selection of questions and their evaluation may be influenced

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118. For example, the WebQuestions dataset consists of 6,642 questions and the TriviaQA dataset consists of over 650,000 questions. *See* Jonathan Berant, Andrew Chou, Roy Frostig & Percy Liang, *Semantic Parsing on Freebase from Question-Answer Pairs*, PROC. 2013 CONF. EMPIRICAL METHODS IN NLP (2013); Mandar Joshi, Eunsol Choi, Daniel S. Weld & Luke Zettlemoyer, *TriviaQA: A Large Scale Distantly Supervised Challenge Dataset for Reading Comprehension*, PROC. 55TH ANN. MEETING ASS'N COMPUTATIONAL LINGUISTICS 1601 (2017).

119. The inclusion of unanswerable questions—i.e., questions for which there is no answer or the answer to which cannot be found in the corresponding document—can be instructive because inappropriate responses to such questions cast doubt on a model's reliability. *See, e.g.*, Pranav Rajpurkar, Robin Jia & Percy Liang, *Know What You Don't Know: Unanswerable Questions for SquAD*, PROC. 56TH ANN. MEETING ASS'N COMPUTATIONAL LINGUISTICS 784 (2018) (introducing 50,000 unanswerable questions to an existing dataset).

120. For example, the Jurisprudence and International Law tests used by Hendrycks et al. *Measuring Understanding*, *supra* note 95 consist of 108 and 121 multiple-choice questions, respectively. *See* Dan Hendrycks, *Test,* GITHUB, https: / /github.com /hendrycks /test (last visited Aug. 8, 2022). Similarly, the 2020 COLIEE competition's legal textual entailment task test dataset contains 80 yes /no questions. *See* Rabelo et al., *supra* note 103, at 64.

121. *See* Zheng et al., *CaseHOLD*, *supra* note 97, 161–62; Lippi et al., *supra* note 75, at 131–33. *But see* Hendrycks et al., *CUAD*, *supra* note 76, at 5 (including some unanswerable questions).

122. Recent efforts, which post-date the case study presented in this Article, include Hendrycks et al., *CUAD*, *supra* note 76, at 3–5; Zheng et al., *CaseHOLD*, *supra* note 97, at 161–62; Chalkidis et al., *LexGLUE*, *supra* note 78, at 3–5; Yuta Koreeda & Christopher D. Manning, *ContractNLI: A Dataset for Document-level Natural Language Inference for Contracts*, FINDINGS 2021 CONF. EMPIRICAL METHODS IN NLP 1907, 1908–11 (2021); *see also* Bommasani et al., *supra* note 6, at 66.

> [L]arger legal benchmark datasets may be necessary to observe further gains from applying transfer learning techniques to foundation models. However, creating benchmark datasets for tasks that are legally meaningful and difficult from an NLP perspective can itself be challenging, as human expert annotation can be costly and automated methods . . . can fail to account for unique aspects of legal text . . . many existing legal domain-specific labeled datasets are small, not publicly available, or reflect simpler tasks that have been solved by methods often pre-dating the development of foundation models.

by that attorney's professional background and experience. Although the questions aim to be as objective as possible, given that contract interpretation always involves a degree of subjective judgment, other legal practitioners or researchers may answer some of these questions differently.[123]

Finally, the scope of the case study is limited by its narrow objective. The study aims only to examine whether GPT-3 can answer a certain type of question relating to a certain type of contract. The study does not aim to test the model's general legal knowledge or its performance on other legal tasks. Nor does the case study attempt to compare the performance of GPT-3 with the performance of human lawyers or examine how people are likely to interact with these models in practice.[124] Future work will need to grapple with these important issues.

IV. RESULTS AND DISCUSSION

This Part presents the results of the case study. First, I discuss the performance of GPT-3 on the test questions. Next, I examine whether certain characteristics of the contracts and questions presented to GPT-3 are associated with an increase or decrease in performance. Finally, I consider whether variations in question-wording impact performance.

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123. For example, some might argue that the better answer to a certain question is "sometimes," "possibly," or "it depends" (rather than "yes" or "no"). But including these or other more nuanced responses in the test would introduce the same evaluation challenges posed by open-ended questions; *see also supra* note 102 (discussing the inherent vagueness and ambiguity of contractual language).

124. *See generally* Kawin Ethayarajh & Dan Jurafsky, *Utility is in the Eye of the User: A Critique of NLP Leaderboards*, PROC. 2020 CONF. EMPIRICAL METHODS IN NLP 4846 (2020) (emphasizing the importance of real-world evaluation for NLP technologies). However, new benchmarks and evaluation platforms are being developed to better simulate real-world conditions. *See, e.g.*, Douwe Kiela, Max Bartolo, Yixin Nie, Divyansh Kaushik, Atticus Geiger, Zhengxuan Wu, Bertie Vidgen, Grusha Prasad, Amanpreet Singh, Pratik Ringshia, Zhiyi Ma, Tristan Thrush, Sebastian Riedel, Zeerak Waseem, Pontus Stenetorp, Robin Jia, Mohit Bansal, Christopher Potts & Adina Williams, *Dynabench: Rethinking Benchmarking in NLP*, PROC. 2021 ANN. CONF. N. AM. CH. ASS'N COMPUTATIONAL LINGUISTICS 4110 (2021); *see also* Marco Tulio Ribeiro, Tongshuang Wu, Carlos Guestrin & Sameer Singh, *Beyond Accuracy: Behavioral Testing of NLP Models with CheckList*, PROC. 58TH ANN. MEETING ASS'N COMPUTATIONAL LINGUISTICS 4902 (2020) (proposing a comprehensive framework for testing the real-world performance of language models).

A. PERFORMANCE

1. *Accuracy*

GPT-3 answered correctly 77% of the questions in the case study.[125] In terms of accuracy, performance exceeded all three baselines, as illustrated in Figure 1 (below). That is, performance in the test was better than (i) random chance (randomly guessing answers); (ii) the majority class (answering "no" to all questions); and (iii) the contract withheld baseline (responding to questions without being shown the contract excerpts). Beating this final baseline by 16.5 percentage points indicates that performance was considerably better when GPT-3 was shown the contract excerpt, compared with when GPT-3 was not shown the contract excerpt. This result suggests that GPT-3 uses the contract to answer the questions and does not simply respond to cues in the questions or rely on data memorized during pretraining.[126]

Figure 1: Comparison of Accuracy with Baselines

125. GPT-3 did not provide a yes /no response to four questions and, instead, outputted the name of the relevant company. Given that these responses fail to answer the questions, the study omits these responses and reports the word assigned the second-highest probability—"yes" or "no," which may be either correct or incorrect, as the case may be—and the corresponding probability. Notably, a similar filter would be applied if GPT-3 were deployed in practice: non-yes /no answers would be discarded, and the response assigned the next-highest probability that actually answers the question (i.e., "yes" or "no") would be retained.

126. *See infra* Part IV.C (discussing the memorization of training data).

2. *Calibration*

In terms of calibration, there was a positive correlation between the model's accuracy and the model's confidence in its predictions.[127] That is, on average, GPT-3 was more confident in its correct responses than in its incorrect responses. This result suggests that GPT-3's performance in the test was well-calibrated and, all things being equal, encourages us to trust the model's predictions.

3. *Overall Performance*

In terms of overall performance, which accounts for both accuracy and calibration,[128] average overall performance in the test exceeded average overall performance in the contract withheld baseline across all three measures of overall performance.[129] Surpassing the contract withheld baseline in overall performance provides further suggestive evidence that GPT-3 uses the contracts to answer the questions.

The performance of GPT-3 in the case study, described thus far, appears to be encouraging. Despite the unintuitive and unhuman-like way in which language models operate—predicting the next word in a sequence—GPT-3 answered correctly nearly four of five questions and was generally well-calibrated. These results suggest that, contrary to conventional wisdom,[130] a language model can answer questions about contracts without extracting specific textual information from the document. GPT-3 merely predicts the next word in a sequence and, more often than not, correctly answers the test questions. In addition, GPT-3's strong performance in the case study challenges the assumption that pretrained language models must be fine-tuned on legal data to effectively carry out legal tasks.[131]

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127. The correlation coefficients (Pearson's *r*) between accuracy and the measures of confidence (described in Part III.B) are, respectively: $r = 0.226^{**}$ (Measure 1); $r = 0.258^{***}$ (Measure 2); and $r = 0.205^{**}$ (Measure 3), where * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The complete calibration results are shown in Figures 4A, 4B, and 4C in the Appendix.

128. *See supra* Part III.B (explaining how overall performance is calculated).

129. The overall performance scores appear in Table 8A in the Appendix.

130. *See* Ryan Catterwell, *Automation in Contract Interpretation*, 12 L. INNOVATION & TECH. 81, 100 (2020) (examining how machine learning can be used to extract information from contracts); Ashley, *supra* note 80, at 1137 ("[T]ext analytics cannot yet *extract* information implicit in the [contract] texts, at least not without more knowledge and a computational model of the planned transaction." (emphasis added)); *see also* JURAFSKY & MARTIN, *supra* note 32, at 471–83 (discussing the operation of information retrieval systems).

131. *See* Zheng et al., *CaseHOLD*, *supra* note 97, at 167 ("Our results suggest that for other high[ly] [domain-specific] and adequately difficult legal tasks, experimentation with custom, task relevant approaches, such as leveraging corpora from task-specific domains and applying

B. ANTI-CONSUMER BIAS

Do these indications of strong performance apply equally to all questions in the case study, or did GPT-3 perform better on some questions than on other questions?

The contractual provisions in the terms of service used in the case study can be categorized as follows.[132] First, some provisions are *pro-company*, i.e., they favor the rights and interests of the relevant companies. Examples include provisions that exempt a company from liability, grant a company the right to refrain from assisting consumers, or enable a company to take certain actions without consumer consent. Second, some provisions are *pro-consumer*, i.e., they favor the rights and interests of consumers. Examples include provisions that grant consumers rights or protections, obligate a company to seek consumer consent to take certain actions, or require that a company provide notice to consumers. Third, some provisions are *neutral*, i.e., they do not favor either companies or consumers. Examples include provisions that stipulate eligibility requirements for accessing a service (e.g., age of user) or describe payment process (e.g., length of billing cycle), or provisions that do not explicitly favor either side (e.g., severability clauses). Correspondingly, questions relating to pro-company provisions, pro-consumer provisions, and neutral provisions can be classified as *pro-company questions*, *pro-consumer questions*, and *neutral questions*, respectively. In the case study, there are 110 pro-company questions (55%), 45 pro-consumer questions (22.5%), and 45 neutral questions (22.5%). Table 2 (below) provides an example from each category.[133]

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tokenization / sentence segmentation tailored to the characteristics of in-domain text, may yield substantial gains."). *Compare* Hendrycks et al., *Measuring Understanding*, *supra* note 95, at 8 ("[W]hile additional pretraining on relevant high quality [legal] text can help, it may not be enough to substantially increase the performance of current models."). Note, however, that GPT-3's training data are likely to include many online terms of service, which are precisely the kind of legal document used in the case study.

132. Numerous studies have proposed consumer contract classification schemes. *See, e.g.*, Florencia Marotta-Wurgler, *What's in a Standard Form Contract? An Empirical Analysis of Software License Agreements*, 4 J. EMPIRICAL LEGAL STUD. 677, 689–702 (2007) (proposing a "bias index" for end-user software license agreements); Eyal Zamir & Yuval Farkash, *Standard Form Contracts: Empirical Studies, Normative Implications, and the Fragmentation of Legal Scholarship: Comments on Florencia Marotta-Wurgler's Studies*, 12 JRSLM. REV. LEGAL STUD. 137, 149 (2015) (discussing the limitations of Marotta-Wurgler's classification scheme); *see also* Lippi et al., *supra* note 75, at 121–27 (proposing a classification scheme based on EU consumer law); Guarino et al., *supra* note 75, at 17574–77 (expanding the classification scheme proposed by Lippi et al., *supra* note 75).

133. The contract excerpts in Table 2 are for demonstrative purposes only and were extracted from the longer excerpts that were presented to the model in the case study. *See infra* Appendix pt. A.2 (describing the length of texts presented to the model).

Table 2: Sample of Question Categories

Category	Contract Provision and Question	Correct Answer
Pro-Company	"The Service may contain links to third-party websites and online services that are not owned or controlled by YouTube. YouTube has no control over, and assumes no responsibility for, such websites and online services." *Does Youtube take responsibility for links to third party websites on Youtube?*	No
Pro-Consumer	"In no event, however, will you be charged for access to the Services unless we obtain your prior agreement to pay such charges." *Can NYT [New York Times] ever charge me without my consent?*	No
Neutral	"Unless you are the holder of an existing account in the United States that is a Yahoo Family Account, you must be at least the Minimum Age to use the Services." *If I'm below the minimum age but have a US Yahoo Family Account, can I use the services?*	Yes

In Table 2 (above), the first provision is classified as *pro-company* because it shields the company from liability. The second provision is classified as *pro-consumer* because it protects consumers' interests by requiring their consent to payments. The third provision is classified as *neutral* because it does not favor the interests of either the company or the consumer; it simply stipulates who may access the services.

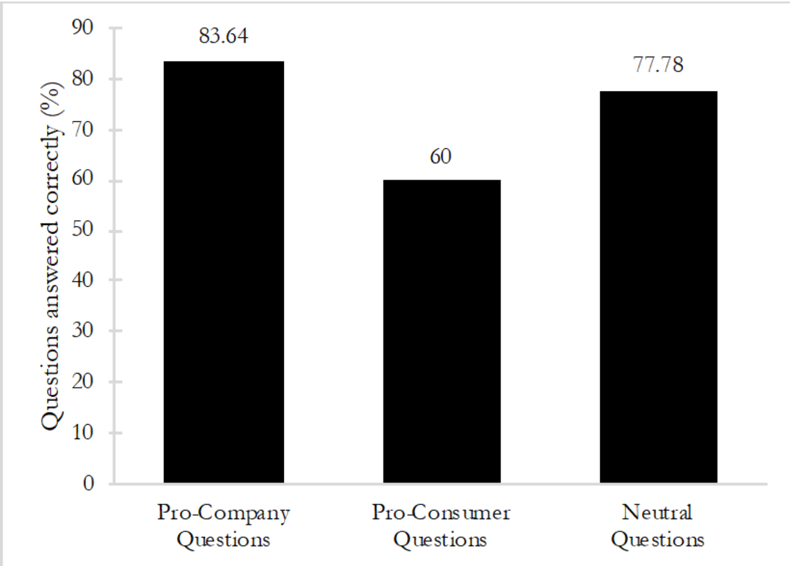
Before proceeding to discuss the results, it is worth noting that this classification invariably involves a degree of subjective judgment. For example, some might argue that a provision that grants a company the right to perform an action that could benefit a consumer (such as backing up personal data) without that consumer's consent should be classified as pro-consumer, not pro-company. Others might argue that the appropriate classification necessarily depends on the facts of the situation and an individual consumer's preferences.[134]

With this caveat in mind, how did GPT-3 perform across the different question categories? As illustrated in Figure 2 (below), the model's accuracy on

134. However, introducing such ambiguous categories would render the classification scheme unusable.

pro-company questions exceeded its accuracy on pro-consumer questions by approximately 24 percentage points. Meanwhile, accuracy on pro-consumer questions was approximately 18 percentage points lower than on neutral questions.[135]

Figure 2: Comparison of Accuracy across Question Categories



There was also a considerable disparity in calibration across the question categories. While GPT-3 was generally well-calibrated (i.e., on average, it expressed higher confidence responding to questions that it answered correctly than to questions that it answered incorrectly),[136] the model was not well-calibrated on pro-consumer questions (i.e., there was no correlation between the model's confidence in responding to pro-consumers questions and the model's chances of correctly answering pro-consumer questions).[137] Moreover, a disproportionately large number of questions with the poorest overall performance scores—that is, where GPT-3 answered incorrectly and with high confidence—were pro-consumer questions.[138] A sample of

135. These results are consistent with the overall performance scores (that account for both accuracy and calibration), which are listed in Table 8B in the Appendix.

136. *See supra* Part IV.A (finding that there was generally a positive correlation between the model's accuracy and the model's confidence in responding to questions in the case study).

137. None of the correlation coefficients (Pearson's *r*) between accuracy and the measures of confidence (described in Part III.B) was found to be statistically significant.

138. Six of the ten (60%) questions with the poorest overall performance scores (across all three measures of overall performance) were pro-consumer questions, despite the fact that pro-consumer questions comprise only 22.5% of the question set.

questions yielding high confidence anti-consumer mistakes is shown in Table 3 (below).

Table 3: Sample of High Confidence Anti-Consumer Mistakes

Question	Model's Output	Correct Answer
Are there any potential exceptions which would allow me to copy a Disney product?	No	Yes
Can Instructure back up my data without asking me?	Yes	No
Will Google help me if I think someone has taken and used content I've created without my permission?	No	Yes

To make these findings more concrete, consider the first question in Table 3: "Are there any potential exceptions which would allow me to copy a Disney product?" The correct, pro-consumer answer according to the applicable terms of service is "yes." The terms explicitly state that if Disney provides consent, then a consumer is permitted to copy a Disney product.[139] But GPT-3 answered "no," suggesting that a consumer *never* has the right to copy a Disney product. In other words, GPT-3 provided an anti-consumer, or pro-company, response, misrepresenting a contractual provision that has the potential to favor consumers.

Despite these notable findings, simply comparing performance across the question categories might not tell the whole story. It is possible that pro-consumer questions systematically differ from other questions. For example, perhaps pro-consumer provisions are longer or more complex than pro-company provisions, making them more difficult to answer, and thus leading to poorer performance. Or perhaps pro-company questions borrow more substantially from the language of the corresponding contract, making it easier to locate the answer, and thus leading to better performance.

To test whether there is in fact a relationship between question category (the variable of interest) and GPT-3's performance in the case study, we need to control for other factors that could potentially influence the model's performance. Accordingly, the study employs an ordinary least squares (OLS) regression model, regressing performance (the dependent variable) on several characteristics of the questions and contracts, including the variable of interest (the independent variables). If the variable of interest has an independent effect on performance, then we would expect to see a statistically significant

139. Of course, in reality, such consent might not be especially forthcoming.

relationship between the variable of interest and performance, even after controlling for other variables.

The regression analysis controls for the following variables:

(i) *Company Name in Question*. This variable describes whether the name of the relevant company appears in the question.[140] The rationale for including this variable is that the appearance of the company's name in a question may provide GPT-3 with a cue to recall information relating to the company that is contained in the model's training data, thereby improving performance.[141]

(ii) *Length of Contract*. This variable describes the length of the contract excerpt shown to GPT-3.[142] The rationale for including this variable is that due to the problem of long-range dependencies, where the text presented to the model is longer the model may be more likely to "forget" content contained earlier in the text, resulting in poorer performance.[143]

(iii) *Readability of Contract*. This variable describes the ease with which a human reader can understand the contract excerpt.[144] The rationale for including this variable is that GPT-3 may be expected to perform worse on texts that are more difficult for humans to read and understand.

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140. That is, the company whose terms of service the question relates to. However, company name also includes products and services that are clearly identified with a particular company, such as Wikipedia (Wikimedia) and Xbox (Microsoft).

141. *See infra* Part IV.C (discussing the memorization of training data).

142. That is, the total length of the contract excerpt presented to GPT-3, which is measured in characters (including spaces). In the regression, length was divided by 100 to avoid producing very small coefficients. Similar results are observed if we measure the distance between the end of the question (at the end of the prompt) and the part of the contract excerpt containing the information needed to answer the question.

143. *See supra* Part II.A (discussing long-range dependencies); *see also* Allison Hegel, Marina Shah, Genevieve Peaslee, Brendan Roof & Emad Elwany, *The Law of Large Documents: Understanding the Structure of Legal Contracts Using Visual Cues*, KDD DOC. INTELL. WORKSHOP at 4 (2021) (showing that a model's ability to identify the governing law of contracts falls as document length increases).

144. That is, the Flesch Reading Ease score for the contract excerpt, which is calculated as follows: 206.835 – (1.015 × ASL) – (84.6 × ASW), where ASL is the average sentence length and ASW is the average word length in syllables. Similar results are observed if we use the FORCAST Grade Level score, which is especially appropriate for non-prose texts (such as terms of service), and is calculated as follows: 20 – (N / 10), where N is the number of single-syllable words in a 150-word sample. The papers introducing the Flesch Reading Ease and FORCAST scores, respectively, are Rudolph Flesch, *A New Readability Yardstick*, 32 J. APPL. PSYCHOL. 221, 229 (1948); JOHN S. CAYLOR, THOMAS G. STICHT, LYNN C. FOX & PATRICK J. FORD, HUM. RES. RSCH. ORG., METHODOLOGIES FOR DETERMINING READING REQUIREMENTS OF MILITARY OCCUPATIONAL SPECIALTIES, TECHNICAL REPORT NO. 73-5, 15 (1973).

(iv) *Similarity between Contract and Question*. This variable describes the degree to which the language in a question is similar to the language in the corresponding contract excerpt.[145] The rationale for including this variable is that where there is considerable overlap in language between the question and the relevant part of the contract, GPT-3 might be expected to more successfully utilize information contained in the contract, thereby improving performance.[146]

Importantly, the regression only controls for these four variables. It is possible that regressing performance on additional variables could produce different results. This problem, known as omitted variable bias, affects all regression analyses, and cannot be altogether avoided or dismissed.[147] However, testing every plausible additional variable is beyond the scope of this Article and would introduce statistical problems.[148]

Table 4 (below) displays the results of three specifications of the OLS model, regressing the three measures of overall performance on the above variables.[149] All three specifications indicate that there is a statistically significant negative correlation between performance and the classification of a question as pro-consumer. In other words, the regression analysis shows that, on average, GPT-3 performed worse on pro-consumer questions than on other questions.

145. Measuring similarity involved three steps: (i) The question text and the part of the contract containing the information needed to answer the question were preprocessed by converting all characters to lowercase, removing punctuation, splitting the text into individual words, removing morphological affixes, and removing stop words. (ii) The resulting texts were then converted into vectors using TF-IDF. (iii) Similarity was calculated by measuring the cosine of the angle between the vector representing the question and the vector representing the contract. Similar results are observed if we omit steps (ii) and (iii) and, instead, calculate the Jaccard similarity between the question and the contract, which measures the size of the intersection of the words in the two texts, divided by the size of the union of the words in the two texts.

146. *See* Catterwell, *supra* note 130, at 100; Ashley, *supra* note 80, at 1137; JURAFSKY & MARTIN, *supra* note 32, at 471–83.

147. *See* JAMES H. STOCK & MARK W. WATSON, INTRODUCTION TO ECONOMETRICS 211–16, 334–35 (4th ed. 2019).

148. *See id.* at 516–18 (explaining that OLS is unreliable when the number of independent variables is large relative to the sample size).

149. *See supra* Part III.B (explaining how overall performance is calculated).

Table 4: Regression Analysis of Overall Performance

	Dependent Variable		
	Overall Performance (Measure 1)	Overall Performance (Measure 2)	Overall Performance (Measure 3)
Pro-Company Question	1.767	-0.775	-1.731*
	(5.018)	(3.393)	(0.769)
Pro-Consumer Question	-17.024**	-12.911**	-3.512***
	(5.938)	(4.015)	(0.910)
Company Name in	14.572*	9.564*	1.890*
Question	(5.974)	(4.040)	(0.916)
Length of Contract	-0.165	-0.099	-0.016
	(0.125)	(0.084)	(0.019)
Readability of Contract	0.080	-0.032	-0.013
	(0.170)	(0.115)	(0.026)
Similarity between Question	4.507	-1.830	-0.288
and Contract	(17.370)	(11.746)	(2.663)
Number of Observations	200	200	200
R^2	0.108	0.106	0.095

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Pro-company question is a dummy variable equal to 1 if the question is pro-company.
Pro-consumer question is a dummy variable equal to 1 if the question is pro-consumer.
Neutral question is the omitted category (baseline).

There are several possible explanations for this result. One possibility is bias in the model's *training data*. GPT-3 might have performed worse on the pro-consumer questions because the model replicates a systematic anti-consumer bias in its training data.[150] 82% of GPT-3's training data is comprised

150. Training data often contain societal biases that affect a language model's parameters. *See* Brown et al., *supra* note 8, at 36–39 (analyzing GPT-3's biases related to race, gender, and religion); *see also* Abubakar Abid, Maheen Farooqi & James Zou, *Persistent Anti-Muslim Bias in Large Language Models*, ARXIV (Jan. 18, 2021), https://arxiv.org/abs/2101.05783 (finding, *inter alia*, that prompts containing the word "Muslim" result in GPT-3 producing a disproportionate number of violence-related outputs); Abubakar Abid, Maheen Farooqi & James Zou, *Large Language Models Associate Muslims with Violence*, 3 NATURE MACH. INTELL. 461 (2021). For further discussion of societal bias in NLP, see Su Lin Blodgett, Solon Barocas, Hal Daumé III & Hanna Wallach, *Language (Technology) is Power: A Critical Survey of "Bias" in NLP*, PROC. 58TH ANN. MEETING ASS'N COMPUTATIONAL LINGUISTICS 5454 (2020); Emily

of webpages extracted from the Common Crawl and Webtext2 datasets, which are likely to include many online terms of service and other consumer contracts.[151] These documents are typically drafted by company counsel and designed to favor the rights and interests of the relevant company, not consumers.[152] By performing worse on pro-consumer questions and producing a disproportionate number of anti-consumer responses, the model arguably overfits its training data.[153]

Another possibility is bias in *prompt-based learning*. GPT-3 might have performed worse on pro-consumer questions because of biases learned from

Sheng, Kai-Wei Chang, Premkumar Natarajan & Nanyun Peng, *Societal Biases in Language Generation: Progress and Challenges*, PROC. 59TH ANN. MEETING ASS'N COMPUTATIONAL LINGUISTICS 4275 (2021); Weidinger et al., *supra* note 20, at 9, 11–18.

151. For examination of the Common Crawl dataset, see Alexandra (Sasha) Luccioni & Joseph D. Viviano, *What's in the Box? A Preliminary Analysis of Undesirable Content in the Common Crawl Corpus*, PROC. 59TH ANN. MEETING ASS'N COMPUTATIONAL LINGUISTICS (2021); Jesse Dodge, Maarten Sap, Ana Marasović, William Agnew, Gabriel Ilharco, Dirk Groeneveld, Margaret Mitchell & Matt Gardner, *Documenting Large Webtext Corpora: A Case Study on the Colossal Clean Crawled Corpus*, PROC. 2020 CONF. EMPIRICAL METHODS IN NLP (2021); Abeba Birhane, Vinay Uday Prabhu & Emmanuel Kahembwe, *Multimodal Datasets: Misogyny, Pornography, and Malignant Stereotypes*, ARXIV (Oct. 5, 2021), https://arxiv.org/abs/2110.01963.

152. *See* RADIN, *supra* note 1, at pt. 1; Omri Ben-Shahar, *Foreword to Boilerplate: Foundations of Market Contracts Symposium*, 104 MICH. L. REV. 821, 822 (2006); *see also* Marotta-Wurgler, *What's in a Standard Form Contract?*, *supra* note 132, at 702–12 (finding that end-user software license agreements generally favor the interests of software companies); Yehuda Adar & Shmuel I. Becher, *Ending the License to Exploit: Administrative Oversight of Consumer Contracts*, 62 B.C. L. REV. 2405, 2413–14 (2022) (describing consumer contracts as "exploitative boilerplate"); Meirav Furth-Matzkin & Roseanna Sommers, *Consumer Psychology and the Problem of Fine-Print Fraud*, 72 STAN. L. REV. 503, 511–13 (2020) (discussing the problem of "fine-print fraud" in consumer contracts).

153. There is, however, some disagreement regarding whether replication of biases is *always* problematic. *See* Yoav Goldberg, *A Criticism of "On the Dangers of Stochastic Parrots: Can Language Models Be Too Big"*, GITHUB (Jan. 23, 2021), https://gist.github.com/yoavg/9fc9be2f98b47c189a513573d902fb27 ("[T]here are many good reasons to argue that *a model of language use should reflect how the language is actually being used*." (emphasis in original)). *But see* Abeba Birhane & Vinay Uday Prabhu, *Large Image Datasets: A Pyrrhic Win for Computer Vision?*, PROC. IEEE /CVF WINTER CONF. APPLICATIONS OF COMPUT. VISION. 1537, 1541 (2021) ("[F]eeding AI systems on the world's beauty, ugliness, and cruelty, but expecting it to reflect only the beauty is a fantasy." (citation omitted)); *see also* Weidinger et al., *supra* note 20, at 14 ("A [language model] trained on language data at a particular moment in time risks . . . enshrining temporary values and norms without the capacity to update the technology as society develops. . . . The risk . . . is that [language models] come to represent language from a particular community and point in time, so that the norms, values, categories from that moment get 'locked in.'" (citations omitted)); Anna Rogers, *Changing the World by Changing the Data*, PROC. 59TH ANN. MEETING ASS'N COMPUTATIONAL LINGUISTICS 2182, 2184–85 (2021) (responding to Goldberg's claim that there is value in using language models to study the world "as it is").

the corresponding contract excerpt (i.e., the contract text presented alongside a given question). Although the specific part of the contract excerpt needed to answer a pro-consumer question is, by definition, pro-consumer, the full contract excerpt presented to the model is, on the whole, likely to be pro-company.[154] This broader pro-company context—although not directly relevant to the question being asked—could inadvertently teach a model to provide incorrect, anti-consumer responses.

A further possibility is bias in the *test questions*. GPT-3 might have performed worse on the pro-consumer questions because those questions and corresponding contract excerpts are systematically different from other questions and provisions in the case study. For example, perhaps the pro-consumer questions are legally or linguistically more complex than other questions. Alternatively, the pro-company provisions may have been tested in litigation more often than pro-consumer provisions, resulting in pro-company provisions using clearer, more accessible language than pro-consumer provisions.[155] It is difficult to measure and control for such differences.[156]

The case study cannot determine which, if any, of these explanations is correct. Nevertheless, the disparity in performance observed across the different question categories raises a noteworthy concern and offers valuable avenues for future work. Identifying the source of anti-consumer biases—in training data, evaluation, and elsewhere—will be critical to improving the safety and reliability of language models in the legal domain.

C. INFORMATIONAL CUES

Another notable finding in the regression shown in Table 4 (above) is that, on average, GPT-3 performed better on questions that explicitly reference the name of the relevant company.[157] A likely explanation is that the reference to

154. *See supra* note 152 (discussing the pro-company orientation of consumer contracts).

155. I thank David Hoffman for suggesting this possibility. *Compare* Michelle E. Boardman, *Contra Proferentem: The Allure of Ambiguous Boilerplate*, 104 MICH. L. REV. 1105, 1111 (2006) (suggesting that judicial interpretation of contracts may in fact entrench *ambiguous* pro-company language). Note, however, that the regression in the case study did not find a statistically significant relationship between performance and the classification of a question as pro-company.

156. One reason for this difficulty is that readability scores are not reliable for short texts. *See* Thomas Oakland & Holly B. Lane, *Language, Reading, and Readability Formulas: Implications for Developing and Adapting Tests*, 4 INTL. J. TESTING 239, 245 (2004). Consequently, measurements of the readability of an individual question, or the specific part of a contract excerpt containing the answer to a question, are not reliable.

157. *See supra* note 140 (describing the "Company Name in Question" variable used in the regression analysis).

a company's name in a question provides GPT-3 with a cue to recall information regarding that company that was learned during pretraining. For example, the question "Does Microsoft undertake to inform users of all changes to the terms?" might prompt GPT-3 to recall information regarding Microsoft that is contained in the model's training data and "stored" in its parameters. GPT-3 is then able to use this information when answering a question that relates to Microsoft.

Although further testing is required to verify this explanation, there is a body of research illustrating that language models "memorize" highly specific information during pretraining.[158] In the case of GPT-3, its training data is replete with information that may be relevant to answering questions about consumer contracts. Specifically, the model's training data are likely to include many companies' terms of service, as well as other company-specific legal and business information.[159] It is therefore plausible that informational cues embedded in certain questions enable GPT-3 to "access" this information and achieve better performance on those questions.

Informational cues, however, also offer a cautionary tale. If certain informational cues can improve performance, it is possible that other informational cues could cause performance to deteriorate or, worse still, subtly manipulate a model's outputs.[160] For example, perhaps companies could

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158. *See* Nicholas Carlini, Nicholas Carlini, Florian Tramèr, Eric Wallace, Matthew Jagielski, Ariel Herbert-Voss, Katherine Lee, Adam Roberts, Tom Brown, Dawn Song, Úlfar Erlingsson, Alina Oprea & Colin Raffel, *Extracting Training Data from Large Language Models*, PROC. 30TH USENIX SEC. SYMPOSIUM 2633 (2021) (demonstrating that language models can memorize specific examples found in their training data); Vered Shwartz, Rachel Rudinger & Oyvind Tafjord, *"You are Grounded!": Latent Name Artifacts in Pre-trained Language Models*, PROC. 2020 CONF. EMPIRICAL METHODS IN NLP 6850 (2020) (showing that memorization of training data can dramatically affect a model's predictions). *Compare* Eric Lehman, Sarthak Jain, Karl Pichotta, Yoav Goldberg & Byron C. Wallace, *Does BERT Pretrained on Clinical Notes Reveal Sensitive Data?*, PROC. 2021 CONF. N. AM. CH. ASS'N COMPUTATIONAL LINGUISTICS 946 (2021) (finding that, using simple probing methods, personal health information cannot generally be extracted from a language model trained on medical records); *see also* Zhengbao Jiang, Frank F. Xu, Jun Araki & Graham Neubig, *How Can We Know What Language Models Know?*, 8 TRANSACTIONS ASS'N COMPUTATIONAL LINGUISTICS 423, 423–25 (2020) (outlining the challenges involved in examining the knowledge contained in language models).

159. Because GPT-3's training data are not publicly available we cannot ascertain precisely which documents are contained in the data, let alone pinpoint the particular documents that assist the model in answering certain questions.

160. *See generally* Moustafa Alzantot, Yash Sharma, Ahmed Elgohary, Bo-Jhang Ho, Mani Srivastava & Kai-Wei Chang, *Generating Natural Language Adversarial Examples*, PROC. 2018 CONF. EMPIRICAL METHODS IN NLP 1890 (2018) (showing that language models are susceptible to adversarial attacks, i.e., imperceptible changes to model inputs designed to elicit incorrect or harmful responses); Keita Kurita, Paul Michel & Graham Neubig, *Weight Poisoning*

draft consumer contracts that language models cannot understand or systematically interpret in a manner that favors companies' interests.[161] Seen in this light, informational cues cut both ways. While informational cues potentially offer improved performance, they also reinforce concerns that language models are disturbingly brittle.[162]

D. BRITTLENESS

To further investigate the issue of brittleness, the study tested the performance of GPT-3 in answering an alternatively worded version of all 200 questions. While each question's content is substantially the same across both versions of the question, the alternatively worded questions are, by design, less readable, that is, more difficult for a human to read.[163] Table 5 (below) depicts an example of the original wording of a question (more readable) alongside the alternative wording of that question (less readable).

Table 5: Sample of Question Wordings

Original Wording (More Readable)	Alternative Wording (Less Readable)
Am I allowed to be paid for writing a Wikipedia article, assuming I disclose who's paying me?	Are Wikipedia contributors permitted to receive payment in respect of their contributions, provided they disclose the identity of the person or institution providing such payment?

In terms of accuracy, GPT-3's performance was nearly ten percentage points lower on the alternatively worded questions, as illustrated in Figure 3

Attacks on Pre-trained Models, PROC. 58TH ANN. MEETING ASS'N COMPUTATIONAL LINGUISTICS 2793 (2020) (demonstrating that adversarial attacks during pretraining can render language models vulnerable to strategic manipulations).

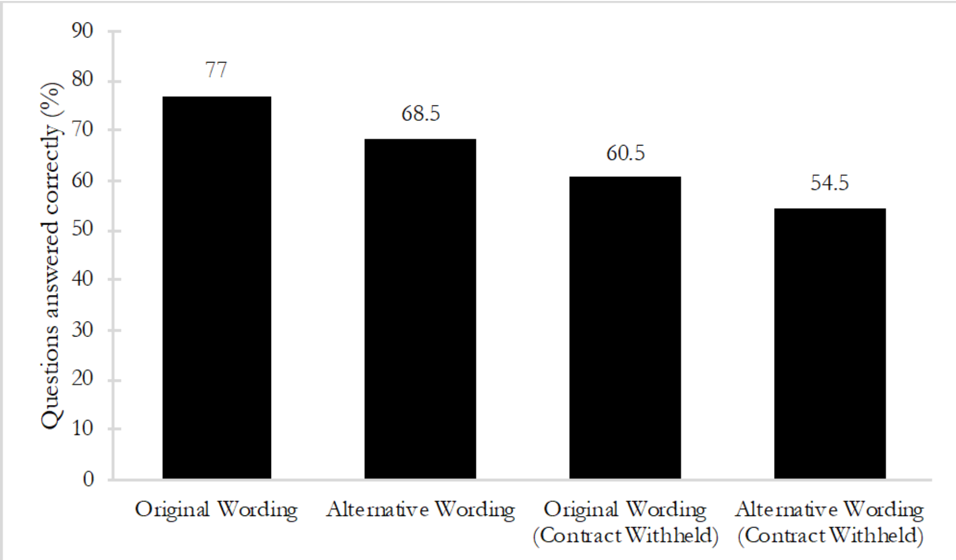
161. *See* Arbel & Becher, *supra* note 19, at 118–24, 141–43 (discussing potential adversarial attacks on language models in the legal domain).

162. Brittleness refers to the outputs of a machine learning model being affected by seemingly minor changes in inputs. *See, e.g.*, Robin Jia, Aditi Raghunathan, Kerem Göksel & Percy Liang, *Certified Robustness to Adversarial Word Substitutions*, PROC. 2019 CONF. EMPIRICAL METHODS IN NLP 4129, 4129 (2019) ("Adding distracting text to the input, paraphrasing the text, replacing words with similar words, or inserting character-level 'typos' can significantly degrade a model's performance." (citations omitted)).

163. Table 7 in the Appendix lists the applicable readability scores; *see also supra* note 144 (explaining how certain readability scores are calculated).

(below).[164] (A smaller decrease in accuracy is observed in the corresponding contract withheld baselines.) These results suggest that the model is highly sensitive to the wording of questions, even if the substance of the questions is unchanged.[165]

Figure 3: Comparison of Accuracy across Question Wordings



A related issue concerns whether GPT-3 is similarly sensitive to variations in the language of the contracts presented to it in the case study. To investigate this, the regression shown in Table 4 (above) controlled for the length and readability of the contract excerpts, as well as the similarity in language between the question and the corresponding contract excerpt. The regression did not find a statistically significant relationship between performance and any of these variables. Put simply, the analysis did not find that the contracts' length,

164. These results are consistent with the overall performance scores (that account for both accuracy and calibration), which are listed in Table 8B in the Appendix. Note, however, that in the case study GPT-3 did not provide a yes /no response to seven of the alternatively worded questions. Given that these responses fail to answer the question, the study omits these responses and reports the word assigned the second-highest probability—"yes" or "no"—which may be either correct or incorrect, as the case may be—and the corresponding probability. Notably, a similar filter would be applied if GPT-3 were deployed in practice: non-yes /no answers would be discarded, and the response assigned the next-highest probability that actually answers the question (i.e., "yes" or "no") would be retained.

165. These results are also consistent with previous studies demonstrating the sensitivity of language models to perturbations. *See, e.g.*, Jia et al., *supra* note 162, at 4129 (citing several studies that demonstrate the brittleness of language models).

readability, or similarity to the questions is associated with an increase or decrease in performance.

This result is surprising. Given the problem of long-range dependencies, one might assume that GPT-3 is more likely to "forget" content contained in earlier parts of longer excerpts (compared with earlier parts of shorter excerpts) and therefore perform worse on longer excerpts. Similarly, one might expect GPT-3 to perform worse on contracts that humans find more difficult to understand. Finally, one might assume that a greater overlap in language between the question and the contract would assist the model in understanding the contract. But none of these assumptions was borne out in the case study.[166]

On the one hand, this result is encouraging. It suggests that GPT-3 can cope well with longer and less readable contracts,[167] and does not require that the language of the question mirror the language of the contract in order to perform well.[168] On the other hand, given that performance is so sensitive to the wording of the questions, it is somewhat puzzling that performance is altogether insensitive to the language of the contracts themselves.[169] One possible explanation is that GPT-3, like other language models, operates by predicting the next word in a sequence. The question (not the contract) is the final part of the prompt and, therefore, has an outsized impact on the model's predictions.[170]

Taken together, the results of the case study illustrate that language models like GPT-3 present strengths and weaknesses in reading consumer contracts. Owing to its immense training data, GPT-3 can potentially draw on informational cues in questions to achieve relatively strong performance. At

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166. *See supra* Part IV.B (discussing the rationale for each of these assumptions).

167. For examination of the (un)readability of consumer contracts, see Uri Benoliel & Shmuel I. Becher, *The Duty to Read the Unreadable*, 60 B.C.L. REV. 2255, 2270–84 (2019); Shmuel I. Becher & Uri Benoliel, *Law in Books and Law in Action: The Readability of Privacy Policies and the GDPR*, *in* CONSUMER LAW & ECONOMICS 179, 191–200 (Klaus Mathis & Avishalom Tor eds., 2021); Aleecia M. McDonald & Lorrie Faith Cranor, *The Cost of Reading Privacy Policies,* 4 I /S: J.L. & POL'Y FOR INFO. SOC'Y 543, 553–62 (2008); Alan M. White & Cathy Lesser Mansfield, *Literacy and Contract*, 13 STAN. L. & POL'Y REV. 233, 260 (2002).

168. The finding that performance does not deteriorate on longer input texts is encouraging with respect to the prospect of using few-shot learning where the relevant examples of tasks are long, such as contracts and corresponding question-answer pairs. *But see infra* note 231 (indicating that the model's context window constrains few-shot learning).

169. However, as explained, performance does deteriorate when the contract is not shown to the model. *See supra* Part III.A (describing the contract-withheld baseline).

170. *See* Tony Z. Zhao, Eric Wallace, Shi Feng, Dan Klein & Sameer Singh, *Calibrate Before Use: Improving Few-Shot Performance of Language Models*, PROC. 38TH INT'L CONF. MACH. LEARNING at 4 (2021) (illustrating that content near the end of a prompt can have a disproportionate impact on a model's outputs).

the same time, GPT-3 is very sensitive to how questions are worded and might contain an anti-consumer bias.

V. BROADER IMPLICATIONS

Using language models to read consumer contracts and perform other legal tasks may have broader implications for various stakeholders. This Part aims to explore several of these implications and offer some initial guidance to users of language models, developers of language models, and policymakers.

A. ONGOING EXPERIMENTATION

The successful deployment of language models requires experimentation. When asking a language model questions about consumer contracts, users should, at the very least, attempt to phrase questions in different ways. The case study suggests that simpler, more readable language elicits better performance. But we do not know if this finding generalizes to other contexts. In addition, the case study offers suggestive evidence that informational cues could improve performance. To test these and other hypotheses, users will need to prompt language models with different lexical and logical variations of questions and other tasks.

Experimentation, however, is onerous. Many users are unlikely to have the time or expertise required to rigorously test language models. For example, how many sample questions does a model need to see in order to learn the principles of contractual interpretation? Can prompts be rephrased to dampen the impact of a particular legal or societal bias? Clearly, users need guidance. The growing body of research on "prompt design" aims to provide such guidance.[171] By systematically exploring methods to develop prompts that optimize performance, prompt design could help users leverage the benefits of language models and mitigate the associated risks. The aspiration is that, with time, prompt design will offer more reliable methods for safely and effectively deploying language models.[172]

171. For an overview of prompt design methods, see Pengfei Liu, Weizhe Yuan, Jinlan Fu, Zhengbao Jiang, Hiroaki Hayashi & Graham Neubig, *Pre-train, Prompt, and Predict: A Systematic Survey of Prompting Methods in Natural Language Processing*, ARXIV (July 28, 2021), https://arxiv.org/abs/2107.13586; Tianyu Gao, *Prompting: Better Ways of Using Language Models for NLP Tasks*, THE GRADIENT (July 3, 2021), https://thegradient.pub/prompting/.

172. Of course, prompt design is no substitute for establishing appropriate performance metrics and designing practical tools for evaluating language models. *See generally* Bommasani et al., *supra* note 6, at 91–96 (summarizing current methods for evaluating machine learning models); Sebastian Ruder, *Challenges and Opportunities in NLP Benchmarking* (Aug. 23, 2021), https://ruder.io/nlp-benchmarking/ (discussing the role of benchmarking in model

Progress on this front will require input from various actors and community-wide collaboration.[173] Experimenting with language models can be resource-intensive in terms of both technological infrastructure and human capital. Developers of language models, who typically possess more resources than other stakeholders, are uniquely positioned to contribute to this enterprise.[174] For example, developers of language models could adapt processes from clinical trials to conduct large-scale studies that test the safety and efficacy of language models. These studies, which could be overseen by independent third parties,[175] would shed light on how language models perform in practice, which is essential if we are to deploy them in the legal domain and other high-stakes settings.

B. CONSUMER TRUST

The case study offers only an initial exploratory analysis of the prospect of using language models to read consumer contracts. Future work will hopefully

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evaluation). For critical perspectives on current methods for evaluating machine learning systems, see Ethayarajh & Jurafsky, *supra* note 124; Samuel R. Bowman & George E. Dahl, *What Will it Take to Fix Benchmarking in Natural Language Understanding?*, PROC. 2021 CONF. N. AM. CH. ASS'N COMPUTATIONAL LINGUISTICS 4843 (2021); Inioluwa Deborah Raji, Emily M. Bender, Amandalynne Paullada, Emily Denton & Alex Hanna, *AI and the Everything in the Whole Wide World Benchmark*, 35TH CONF. NEURAL INFO. PROCESSING SYS. DATASETS AND BENCHMARKS TRACK (2021); Bernard Koch, Emily Denton, Alex Hanna & Jacob G. Foster, *Reduced, Reused and Recycled: The Life of a Dataset in Machine Learning Research,* 35TH CONF. NEURAL INFO. PROCESSING SYS. DATASETS AND BENCHMARKS TRACK (2021).

173. *See, e.g.*, BIG SCIENCE, https: //bigscience.huggingface.co/ (last visited Aug. 8, 2022) (facilitating a collaboration—among 600 researchers from 50 countries and over 250 institutions—focused on studying large multilingual language models and datasets); CENTER FOR RESEARCH ON FOUNDATION MODELS, https: / /crfm.stanford.edu / (last visited Aug. 8, 2022) (establishing an interdisciplinary center, comprised of Stanford University researchers from over ten departments, to "make fundamental advances in the study, development, and deployment of foundation models").

174. For instance, OpenAI, is able to provide API users with prompt design and safety guidelines informed by its unparalleled insight into how GPT-3 has been used in practice. *See Prompt Design*, OPENAI, https://beta.openai.com/docs/guides/completion/prompt-design (last visited Aug. 8, 2022); *Safety Best Practices*, OPENAI, https://beta.openai.com/docs/safety-best-practices (last visited Aug. 8, 2022). *See generally* Weidinger et al., *supra* note 20, at 38 (arguing that the developers of language models have a responsibility to address the risks posed by language models).

175. This oversight procedure could possibly be integrated into a broader process of certifying the safety of language models. *See generally* Peter Cihon, Moritz J. Kleinaltenkamp, Jonas Schuett & Seth D. Baum, *AI Certification: Advancing Ethical Practice by Reducing Information Asymmetries*, 2 IEEE TRANSACTIONS ON TECH. & SOC'Y 200 (2021); Kira J.M. Matus & Michael Veale, *Certification Systems for Machine Learning: Lessons from Sustainability*, 16 REG. & GOV. 177 (2022).

revisit, and expand on, this analysis. Looking ahead, at what point could we trust a language model to inform consumers of their contractual rights and obligations? If GPT-4 achieved 100% accuracy on a large and diverse contract law benchmark, would that be sufficient?

To begin to answer to this question, it is important to recall how language models operate. They predict the next word in a sequence.[176] This, of course, is a crude tool for contract interpretation,[177] or indeed any legal analysis.[178] The predictions of neural language models can also be difficult to explain or interpret.[179] For example, why does a model respond "yes" rather than "no" to a given question? Why does a stylistic change in the wording of a question dramatically affect performance? This lack of interpretability can prevent us from diagnosing the source of a model's errors and biases.[180] It can also hamper our ability to ascertain whether a language model is aligned with

176. *See supra* Part II.A (offering a brief primer on the operation of language models).

177. *But see* Catterwell, *supra* note 130, at 100–07, 109–11 (rebutting some of the common objections to using machine learning in contract interpretation).

178. Many scholars have expressed concern about automating legal analysis and dispensing with human judgment in legal tasks. *See* Frank Pasquale, *A Rule of Persons, Not Machines: The Limits of Legal Automation*, 87 GEO. WASH. L. REV. 1, 50–53 (2019) (arguing that "brute force" prediction models should not substitute human discretion in legal decision-making); Joshua P. Davis, *Artificial Wisdom? A Potential Limit on AI in Law (and Elsewhere)*, 72 OKLA. L. REV. 51, 55–62 (2019) (emphasizing the importance of moral judgments in legal practice and judicial decision-making). Interestingly, however, when it comes to answering questions about contracts, language models and human beings share some things in common. Like language models, human beings can utilize informational cues associated with company names. *See, e.g.*, Merrie Brucks, Valarie A. Zeithaml & Gillian Naylor, *Price and Brand Name as Indicators of Quality Dimensions for Consumer Durables*, 28 J. ACAD. MARK. SCI. 359, 368–71 (2000) (studying how consumers use company brand names to evaluate products). Human beings are also affected by the readability of texts. *See, e.g.*, Kristina Rennekamp, *Processing Fluency and Investors' Reactions to Disclosure Readability*, 50 J. ACCOUNT. RES. 1319, 1333–40 (2012) (investigating small investors' responses to the readability of financial disclosures).

179. *See* JURAFSKY & MARTIN, *supra* note 32, at 140. For further discussion of interpretability in NLP, see Bommasani et al., *supra* note 6, at 122–27; Weidinger et al., *supra* note 20, at 37–38.

180. *See generally* Remus & Levy, *supra* note 15, at 550 (explaining how the lack of transparency in machine learning poses problems in the legal domain); Susan C. Morse, *When Robots Make Legal Mistakes*, 72 OKLA. L. REV. 213, 217–19 (2020) (surveying scholarship on the use of "black-box" systems in the legal decision-making); *see also* Ashley, *supra* note 80, at 1137–38 (discussing the inability of legal question answering systems to provide explanations). But other studies suggest that legal AI systems can provide such explanations. *See, e.g.*, Federico Ruggeri, Francesca Lagioia, Marco Lippi & Paolo Torroni, *Detecting and Explaining Unfairness in Consumer Contracts through Memory Networks*, 30 AI & L. 59, 78–81 (2021) (proposing a method for an AI system to provide an explanation for its classification of contractual clauses).

broader social values.[181] These shortcomings are especially problematic where a person relies on a language model to understand and exercise their legal rights.[182]

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181. This issue—ensuring that AI systems implement human intent, preferences, and values—is known as *AI alignment*, which is central to broader concerns around AI safety. Seminal works on AI safety include NICK BOSTROM, SUPERINTELLIGENCE: PATHS, DANGERS, STRATEGIES (2014) (exploring the potential dangers posed by "superintelligent" machines); Dario Amodei, Chris Olah, Jacob Steinhardt, Paul Christiano, John Schulman & Dan Mané, *Concrete Problems in AI Safety*, ARXIV (June 21, 2016), https://arxiv.org/abs/1606.06565 (establishing a practical research agenda for AI safety); STUART RUSSELL, HUMAN COMPATIBLE: ARTIFICIAL INTELLIGENCE AND THE PROBLEM OF CONTROL (2019) (arguing, *inter alia*, that human values cannot be hard-wired into AI systems; instead, AI systems must learn human values from human behavior); *see also* Tom Everitt, Gary Lea & Marcus Hutter, *AGI Safety Literature Review*, PROC. 27TH INTL. JOINT CONF. AI 5441 (2018) (outlining the safety problems facing AGI and discussing potential solutions); Iason Gabriel, *Artificial Intelligence, Values, and Alignment*, 30 MINDS & MACH. 411 (2020) (examining the philosophical principles underpinning AI alignment); BRIAN CHRISTIAN, THE ALIGNMENT PROBLEM: MACHINE LEARNING AND HUMAN VALUES (2020) (exploring the history of the field of AI safety and alignment); Dan Hendrycks, Nicholas Carlini, John Schulman & Jacob Steinhardt, *Unsolved Problems in ML Safety*, ARXIV (Sept. 28, 2021), https: //arxiv.org/abs/2109.13916 (advancing a revised research agenda for AI safety); GILLIAN K. HADFIELD, RULES FOR A FLAT WORLD: WHY HUMANS INVENTED LAW AND HOW TO REINVENT IT FOR A COMPLEX GLOBAL ECONOMY xiii, xx [hereinafter HADFIELD, RULES FOR A FLAT WORLD] (2020) (arguing that a science of "human normativity" is needed to determine which values should guide AI systems); Dylan Hadfield-Menell & Gillian K. Hadfield, *Incomplete Contracting and AI Alignment*, PROC. 2019 AAAI /ACM CONF. AI, ETHICS, & SOC'Y 417, 420–21 (2019) (applying insights from incomplete contracting theory to the problem of AI alignment). NLP technologies face distinct safety and alignment problems. *See* Zachary Kenton, Tom Everitt, Laura Weidinger, Iason Gabriel, Vladimir Mikulik & Geoffrey Irving, *Alignment of Language Agents*, ARXIV (Mar. 26, 2021), https: / /arxiv.org /abs /2103.14659 (describing several ways in which NLP systems can be misaligned); Bommasani et al., *supra* note 6, at 113–16 (exploring safety concerns facing large pretrained models); Weidinger et al., *supra* note 20, at 10 (presenting a taxonomy of the risks posed by large language models); Chen et al., *supra* note 10, at 11–12, 26–29 (examining the problem of alignment in code generation systems). Recently, there have been several attempts to evaluate, and improve, the alignment of language models. *See* Dan Hendrycks, Collin Burns, Steven Basart, Andrew Critch, Jerry Li, Dawn Song & Jacob Steinhardt, *Aligning AI With Shared Human Values*, 9TH INT'L CONF. LEARNING REPRESENTATIONS (2021) (presenting a benchmark for evaluating whether a language model is aligned with human values); Liwei Jiang, Jena D. Hwang, Chandra Bhagavatula, Ronan Le Bras, Maxwell Forbes, Jon Borchardt, Jenny Liang, Oren Etzioni, Maarten Sap & Yejin Choi, *Delphi: Towards Machine Ethics and Norms*, ARXIV, (Oct. 14, 2021), https://arxiv.org/abs/2110.07574 (presenting a "commonsense moral model" trained on a "commonsense norm bank"); Amanda Askell, Yuntao Bai, Anna Chen, Dawn Drain, Deep Ganguli, Tom Henighan, Andy Jones, Nicholas Joseph, Ben Mann, Nova DasSarma, Nelson Elhage, Zac Hatfield-Dodds, Danny Hernandez, Jackson Kernion, Kamal Ndousse, Catherine Olsson, Dario Amodei, Tom Brown, Jack Clark, Sam McCandlish, Chris Olah & Jared Kaplan, *A General Language Assistant as a Laboratory for*

The challenge of trusting language models to perform complex and sensitive tasks is exacerbated by the absence of technical and institutional safeguards. Generally speaking, users are responsible for a model's poor performance and any associated harms.[183] This approach will need to be re-examined if language models are deployed in the legal domain or other high-risk settings. Several mechanisms for governing AI systems, including

Alignment , ARXIV (Dec. 9, 2021), https://arxiv.org/abs/2112.00861 (exploring methods for creating language models that are "helpful, honest, and harmless").

182. These shortcomings are also problematic in other high-risk settings, such as healthcare. *See* Diane M. Korngiebel & Sean D. Mooney, *Considering the Possibilities and Pitfalls of Generative Pre-trained Transformer 3 (GPT-3) in Healthcare Delivery*, 3 NPJ DIGIT. MED. 93 (2021); *see also* Anne-Laure Rousseau, Clément Baudelaire & Kevin Riera, *Doctor GPT-3: Hype or Reality?*, NABLA (Oct. 27, 2020), https://www.nabla.com/blog/gpt-3/ (revealing that GPT-3 recommended that a hypothetical patient commit suicide).

183. In the case of open-source language models, such as Google's BERT, the applicable software license typically limits the liability of the model developer (Google). *See* Google Research, *BERT*, GITHUB, https://github.com/google-research/bert (last visited Aug. 8, 2022) (licensing BERT under the Apache License 2.0, Section 8 of which excludes liability of the licensor). For further discussion of liability in connection with AI systems, see Paulius Čerka, Jurgita Grigienė & Gintarė Sirbikytėb, *Liability for Damages Caused by Artificial Intelligence*, 31 COMPUT. L. & SEC. REV. 376, 383–86 (2015); Mark A. Lemley & Bryan Casey, *Remedies for Robots*, 86 U. CHI. L. REV. 1311, 1342–78 (2019); Bryan Casey, *Robot Ipsa Loquitur*, 108 GEO. L.J. 225, 251–67 (2019); Andrew D. Selbst, *Negligence and AI's Human Users*, 100 B.U. L. REV. 1315, 1322–29 (2020); RYAN ABBOTT, THE REASONABLE ROBOT: ARTIFICIAL INTELLIGENCE AND THE LAW 50–70 (2020).

measures to improve transparency[184] and accountability,[185] could be instructive.[186] Adapting these mechanisms to improve the reliability and

184. Legal mechanisms to improve transparency include the GDPR's "right to explanation." *See* Regulation (EU) 2016 /679, of the European Parliament and the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95 /46 /EC (General Data Protection Regulation), 2016 O.J. (L 119) 1 at art. 22 [hereinafter GDPR]; *see also* Margot E. Kaminski, *The Right to Explanation, Explained*, 34 BERKELEY TECH. L.J. 189 (2019) (presenting a detailed analysis of the GDPR's right to explanation). Technical mechanisms to improve transparency include datasheets, which offer a standardized process for documenting datasets, and model cards, a framework for disclosing information about a model's features, intended use, and performance evaluation. *See* Timnit Gebru, Jamie Morgenstern, Briana Vecchione, Jennifer Wortman Vaughan, Hanna Wallach, Hal Daumé III & Kate Crawford, *Datasheets for Datasets*, ARXIV (Mar. 23, 2018), https: / /arxiv.org /abs /1803.09010; Margaret Mitchell, Simone Wu, Andrew Zaldivar, Parker Barnes, Lucy Vasserman, Ben Hutchinson, Elena Spitzer, Inioluwa Deborah Raji & Timnit Gebru, *Model Cards for Model Reporting*, PROC. 2019 CONF. FAIRNESS, ACCOUNTABILITY, & TRANSPARENCY 220 (2019); *see also* Ben Hutchinson, Andrew Smart, Alex Hanna, Emily Denton, Christina Greer, Oddur Kjartansson, Parker Barnes & Margaret Mitchell, *Towards Accountability for Machine Learning Datasets: Practices from Software Engineering and Infrastructure*, PROC. 2021 ACM CONF. FAIRNESS, ACCOUNTABILITY, & TRANSPARENCY 560 (2021) (proposing a new transparency framework for dataset development); Emily M. Bender & Batya Friedman, *Data Statements for Natural Language Processing: Toward Mitigating System Bias and Enabling Better Science*, 6 TRANSACTIONS ASS'N COMPUTATIONAL LINGUISTICS 587 (2018) (proposing a schema for documenting the features of NLP datasets).

185. One prominent regulatory proposal for improving accountability is the European Commission's Artificial Intelligence Act. *See* Proposal for a Regulation of the European Parliament and of the Council Laying Down Harmonised Rules on Artificial Intelligence (Artificial Intelligence Act) and Amending Certain Union Legislative Acts COM /2021 /206 final (Apr. 21, 2021); *see also* Michael Veale & Frederik Zuiderveen Borgesius, *Demystifying the Draft EU Artificial Intelligence Act*, 22 COMPUT. L. REV. INT'L 97, 107 (2021) (examining how the proposed legislation may apply to GPT-3). Technical mechanisms for improving accountability include third party auditing of AI systems, red teaming exercises, bias and safety bounties, and incident reporting. *See* Miles Brundage, Shahar Avin, Jasmine Wang, Haydn Belfield, Gretchen Krueger, Gillian Hadfield, Heidy Khlaaf, Jingying Yang, Helen Toner, Ruth Fong, Tegan Maharaj, Pang Wei Koh, Sara Hooker, Jade Leung, Andrew Trask, Emma Bluemke, Jonathan Lebensold, Cullen O'Keefe, Mark Koren, Théo Ryffel, JB Rubinovitz, Tamay Besiroglu, Federica Carugati, Jack Clark, Peter Eckersley, Sarah de Haas, Maritza Johnson, Ben Laurie, Alex Ingerman, Igor Krawczuk, Amanda Askell, Rosario Cammarota, Andrew Lohn, David Krueger, Charlotte Stix, Peter Henderson, Logan Graham, Carina Prunkl, Bianca Martin, Elizabeth Seger, Noa Zilberman, Seán Ó hÉigeartaigh, Frens Kroeger, Girish Sastry, Rebecca Kagan, Adrian Weller, Brian Tse, Elizabeth Barnes, Allan Dafoe, Paul Scharre, Ariel Herbert-Voss, Martijn Rasser, Shagun Sodhani, Carrick Flynn, Thomas Krendl Gilbert, Lisa Dyer, Saif Khan, Yoshua Bengio & Markus Anderljung, *Toward Trustworthy AI Development: Mechanisms for Supporting Verifiable Claims*, ARXIV (Apr. 15, 2020), https: / / arxiv.org /abs /2004.07213.

186. For an overview of proposals for governing AI, see Lawrence Zhang, *Initiatives in AI Governance*, SCHWARTZ REISMAN INSTITUTE FOR TECHNOLOGY AND SOCIETY (Dec. 2020),

trustworthiness of language models will require coordination between multiple stakeholders.

C. COMPOUNDING BIAS

Bias is a major obstacle to building trustworthy language models. The case study provides suggestive evidence that an anti-consumer bias can hinder a model's performance in reading consumer contracts. To further unpack this issue, consider a hypothetical language model trained on consumer contracts that mostly favor companies' interests. Such a model might learn a convenient shortcut to reading consumer contracts. Faced with any contractual question, it may simply provide a pro-company answer to *every* question.[187] If the contracts presented to it generally favor companies (which is likely),[188] then such an anti-consumer bias might, on average, improve performance.

But this hypothetical language model encounters a serious problem: by employing the foregoing anti-consumer heuristic, the model will provide no pro-consumer answers whatsoever. That is, it will fail to identify any contractual provisions that favor consumers.[189] Consumers relying on this model would be systematically misinformed, as the model would conceal from them all provisions that favor their interests. This would, in turn, hinder consumers' ability to understand and exercise their contractual rights.

A related concern—which I call *compounding bias*—stems from the fact that language models not only absorb and reproduce problematic patterns from their training data, but can amplify these patterns.[190] For example, if the hypothetical model described above were used to draft consumer contracts, it may produce contracts that are even more favorable toward companies than the mostly pro-company contracts on which it was trained.[191] The consumer contracts produced by the model (e.g., online terms of service) might then be published on the internet and become included in the training corpora of future models. In other words, the outputs of current models, including the

https://static1.squarespace.com/static/5ef0b24bc96ec4739e7275d3/t/5fb58df18fbd7f2b94b5b5cd/1605733874729/SRI+1+-+Initiatives+in+AI+Governance.pdf

187. Note, however, that language models are not, strictly speaking, classifiers.

188. *See supra* note 152 (discussing the pro-company orientation of consumer contracts).

189. For this reason, when using classifiers on imbalanced datasets it is important to measure recall, not just precision or accuracy. *See* Marina Sokolova & Guy Lapalme, *A Systematic Analysis of Performance Measures for Classification Tasks*, 45 INFO. PROCESSING & MGMT. 427, 429 (2009).

190. *See supra* note 150 (discussing the problem of societal biases in language models).

191. For a comparable issue in the context of code generation, see Chen et al., *supra* note 10, at 27 (finding that a language model trained on code generates more bugs when it is prompted with buggy code).

biases they encode, would pollute the reservoir of data available for training new models.[192] In a dangerous feedback loop, biases could compound with each successive generation of language model.[193]

Fortunately, techniques are being developed to detect and filter out machine-generated content. These techniques could, for example, prevent the outputs of GPT-3 from being included in the training data of GPT-4. However, detecting whether content has been generated by a language model is increasingly difficult.[194] One alternative approach to counteracting model bias involves prompt design. But this too is unlikely to be a panacea.[195] Engineering alone cannot solve the problem. Addressing current biases and preventing a cycle of compounding bias requires a combination of technical and institutional mechanisms.

D. GOVERNANCE

Each stage of a language model's lifecycle, from development through deployment, presents governance challenges. As we have seen, improving a model's reliability, tackling bias, and conducting effective evaluations is vital. But there are other challenges too, some of which are often overlooked.[196] Identifying these challenges is key to understanding the steps that policymakers should take to harness the benefits of language models and address the attendant risks.

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192. *See* Bender et al., *supra* note 20, at 617; Kenton et al., *supra* note 181, at 7. Such compounding bias is a form of data cascade. *See* Nithya Sambasivan, Shivani Kapania, Hannah Highfill, Diana Akrong, Praveen Paritosh & Lora Aroyo., "*Everyone Wants to Do the Model Work, Not the Data Work": Data Cascades in High-Stakes AI*, PROC. 2021 CONF. HUMAN FACTORS IN COMPUTING SYSTEMS (2021) (defining data cascades as "compounding events causing negative, downstream effects from data issues, that result in technical debt over time"). Compounding bias is also somewhat analogous to the issue of bias cascades in human decision-making. *See* DANIEL KAHNEMAN, OLIVER SIBONY & CASS R. SUNSTEIN, NOISE: A FLAW IN HUMAN JUDGMENT 288 (2021) (describing how the initial bias of one decision-maker can replicate and magnify by biasing other decision-makers), citing Itiel E. Dror, *Biases in Forensic Experts*, 360 SCIENCE 243 (2018) (examining the role of bias cascades in forensic investigations).

193. *See* Bender et al., *supra* note 20, at 617 ("[T]he risk is that people disseminate text generated by [language models], meaning more text in the world that reinforces and propagates stereotypes and problematic associations . . . to future [language models] trained on training sets that ingested the previous generation [language model's] output."). For discussion of existing feedback loops and network effects that entrench pro-company contractual drafting, see Boardman, *supra* note 155, at 1112–17.

194. *See* Brown et al., *supra* note 8, at 25–26.

195. *See* Tamkin et al., *supra* note 20, at 5–6.

196. *See generally* Abeba Birhane et al., *supra* note 22 (illustrating that machine learning research continues to neglect issues concerning its societal impact).

(i) *Data protection*. Training language models on vast online corpora raises several concerns with respect to data protection. For example, did the collection of training data infringe upon applicable privacy laws, such as the European Union's General Data Protection Regulation (GDPR) or California's Consumer Privacy Act (CCPA)?[197] Did it violate the federal Computer Fraud and Abuse Act (CFAA)?[198] Did the organization collecting the data have the right to use the data to train a language model?[199] Can personally identifiable information be extracted from the resulting model?[200] In the case of proprietary language models accessed through an API, how is confidential information protected?[201] Researchers have begun to grapple with some of these questions.[202]

(ii) *Environmental impact*. Training language models is energy-intensive.[203] For example, training GPT-3 consumed several thousand petaflop/s-days of

197. CAL. CIV. CODE §§ 1798.100–.199 (2018)

198. 18 U.S.C. § 1030(a)(2) criminalizes "intentionally access[ing] a computer system without authorization" or where doing so "exceeds authorized access." *See also* Van Buren v. United States, 593 U.S. __ (2021) (clarifying which activities amount to unauthorized access).

199. The answer to this question will depend on, among other things, the application of the fair use doctrine. *See* Mark A. Lemley & Bryan Casey, *Fair Learning*, 99 TEX. L. REV. 743, 760–79 (2021) (exploring whether the doctrine of fair use permits machine learning models to be trained on copyrighted data); *see also infra* note 211 (discussing the debate concerning the ownership of the outputs of code generation tools).

200. *See, e.g.*, Carlini et al., *supra* note 158 (demonstrating that an adversary can extract from GPT-2 personally identifiable information contained in the model's training data).

201. This is especially important if lawyers provide client information to the API. *See* Alexander Hudek, *GPT-3 and Prospects for Legal Applications*, KIRA SYSTEMS (Aug. 6, 2020), https: / /kirasystems.com /blog /gpt-3-and-prospects-for-legal-applications /. But arguably this privacy issue is not meaningfully different to the privacy issue arising when lawyers use other online platforms or cloud-based software.

202. *See* Brundage et al., *supra* note 185, at 28–30; Bommasani et al., *supra* note 6, at 145–46; Weidinger et al., *supra* note 20, at 18–21.

203. There have been several attempts to estimate the energy consumption and carbon emissions involved in training large language models. *See* Emma Strubell, Ananya Ganesh & Andrew McCallum, *Energy and Policy Considerations for Deep Learning in NLP*, PROC. 57TH CONF. ASS'N COMPUTATIONAL LINGUISTICS 3645, 3647–48 (2020); Lasse F. Wolff Anthony, Benjamin Kanding & Raghavendra Selvan, *Carbontracker: Tracking and Predicting the Carbon Footprint of Training Deep Learning Models*, 37TH INT'L CONF. MACH. LEARNING WORKSHOP ON CHALLENGES IN DEPLOYING AND MONITORING MACH. LEARNING SYS. At 2–3 (2020); David Patterson, Joseph Gonzalez, Quoc Le, Chen Liang, Lluis-Miquel Munguia, Daniel Rothchild, David So, Maud Texier & Jeff Dean, *Carbon Emissions and Large Neural Network Training*, ARXIV at 2–8 (Apr. 23, 2021), https: / /arxiv.org /abs /2104.10350. However, once trained, language models can operate relatively efficiently. *See, e.g.*, Brown et al., *supra* note 8, at 39. For further discussion of the environmental impact of large language models, see Bender et al., *supra* note 20, at 612–13; Weidinger et al., *supra* note 20, at 32–33; *see also* Bommasani et al., *supra* note 6, at 139–44 (discussing several strategies for measuring and mitigating the

compute,[204] the environmental impact of which can be compared to driving a car several hundred thousand miles.[205] Despite increasingly efficient training techniques, the "parameters race"—in which technology firms compete to build ever-larger language models[206]—suggests that energy consumption in model training may continue to grow. The machine learning community is now turning its attention to these environmental challenges.[207]

(iii) *Intellectual property*. As the capabilities of language models improve, they will produce increasingly valuable outputs, including creative works. Who owns these outputs—the developer of the language model, the user of the language model, the suppliers or owners of the model's training data, or another party?[208] The answer turns on, among other things, whether creative works generated by a machine are eligible for copyright protection,[209] as well

environmental impact of large pretrained models); Borgeaud et al., *supra* note 56, at 16 (equipping a language model with the ability to retrieve information from a database, which improves performance without increasing the computational resources required for training).

204. *See* Brown et al., *supra* note 8, at 39.

205. *See* Heaven, *supra* note 8 ("[T]raining GPT-3 would have had roughly the same carbon footprint as driving a car the distance to the moon and back, if it had been trained in a data center fully powered by fossil fuels."); *see also* Anthony et al., *supra* note 203, at 10 (estimating the energy and carbon footprint of GPT-3).

206. *See* Coco Feng, *US-China Tech War: Beijing-Funded AI Researchers Surpass Google and OpenAI with New Language Processing Model*, SOUTH CHINA MORNING POST (June 2, 2021), https://www.scmp.com/tech/tech-war/article/3135764/us-china-tech-war-beijing-funded-ai-researchers-surpass-google-and; Ali Alvi & Paresh Kharya, *Using DeepSpeed and Megatron to Train Megatron-Turing NLG 530B, the World's Largest and Most Powerful Generative Language Model*, MICROSOFT RESEARCH BLOG (Oct. 11, 2021), https://www.microsoft.com/en-us/research/blog/using-deepspeed-and-megatron-to-train-megatron-turing-nlg-530b-the-worlds-largest-and-most-powerful-generative-language-model /.

207. *See* Roy Schwartz, Jesse Dodge, Noah A. Smith & Oren Etzioni, *Green AI*, 63 COMM. ACM 54 (2020); Peter Henderson, Jieru Hu, Joshua Romoff, Emma Brunskill, Dan Jurafsky & Joelle Pineau, *Towards the Systematic Reporting of the Energy and Carbon Footprints of Machine Learning*, 21 J. MACH. LEARNING RES. 1 (2020); Kadan Lottick, Silvia Susai, Sorelle A. Friedler & Jonathan P. Wilson, *Energy Usage Reports: Environmental Awareness as Part of Algorithmic Accountability*, 33RD CONF. NEURAL INFO. PROCESSING SYS. WORKSHOP ON TACKLING CLIMATE CHANGE WITH MACH. LEARNING (2019); *see also* KATE CRAWFORD, THE ATLAS OF AI: POWER, POLITICS, AND THE PLANETARY COSTS OF ARTIFICIAL INTELLIGENCE ch. 1 (2021) (examining the environmental demands of AI technologies and associated industries).

208. *See* Omri Avrahami & Bar Tamir, *Ownership and Creativity in Generative Models*, ARXIV at 1–2 (Dec. 2, 2021), https://arxiv.org/abs/2112.01516; Jason K. Eshraghian, *Human Ownership of Artificial Creativity*, 2 NATURE MACH. INTELL. 157, 158–59 (2020).

209. *See* Annemarie Bridy, *Coding Creativity: Copyright and the Artificially Intelligent Author*, 2012 STAN. TECH. L. REV. 5; Annemarie Bridy, *The Evolution of Authorship: Work Made by Code*, 39 COLUM. J.L. & ARTS 395 (2016); James Grimmelmann, *There's No Such Thing as a Computer-Authored Work—And It's a Good Thing, Too*, 39 COLUM. J.L. & ARTS 403 (2016); James Grimmelmann, *Copyright for Literate Robots*, 101 IOWA L. REV. 657 (2016); Jane C. Ginsburg &

as the terms of the software license agreement applicable to the model.[210] Different stakeholders are likely to adopt different positions on the issue.[211]

(iv) *Access and misuse*. Historically, open access to the code and weights of language models has enabled researchers and developers to independently use, adapt, and evaluate language models. However, as the capabilities of language models improve, open access has become a double-edged sword.[212] By restricting access to a model, an organization can potentially prevent a

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Luke Ali Budiardjo, *Authors and Machines*, 34 BERKELEY TECH. L.J. 343 (2019); Daniel J. Gervais, *The Machine as Author*, 105 IOWA L. REV 2053 (2020); Daniel J. Gervais, *The Human Cause*, *in* RESEARCH HANDBOOK ON INTELLECTUAL PROPERTY AND ARTIFICIAL INTELLIGENCE (R. Abbott, ed., forthcoming).

210. *See supra* note 183 (discussing the software license applicable to Google's BERT language model).

211. For example, there is a lively debate concerning the ownership of the outputs of code generation tools, such as GitHub Copilot. *See* Chen et al., *supra* note 10, at 13 (suggesting that the doctrine of fair use applies to publicly available code). *Compare* Dave Gershgorn, *GitHub's Automatic Coding Tool Rests on Untested Legal Ground*, THE VERGE (July 7, 2021), https://www.theverge.com/2021/7/7/22561180/github-copilot-legal-copyright-fair-use-public-code; Matthew Sparkes, *GitHub's Programming AI May Be Reusing Code without Permission*, NEW SCIENTIST (July 8, 2021), https://www.newscientist.com/article/2283136-githubs-programming-ai-may-be-reusing-code-without-permission/; Kate Downing, *Analyzing the Legal Implications of GitHub Copilot*, FOSSA (Jul. 12, 2021), https://fossa.com/blog/analyzing-legal-implications-github-copilot/; *see also* Lemley & Casey, *supra* note 199, at 760–79.

212. Discussions concerning the implications of releasing language models (and AI research more generally) include Aviv Ovadya & Jess Whittlestone, *Reducing Malicious Use of Synthetic Media Research: Considerations and Potential Release Practices for Machine Learning*, ARXIV (July 29, 2019), https://arxiv.org/abs/1907.11274; Clément Delangue, *Ethical Analysis of the Open-Sourcing of a State-of-the-Art Conversational AI*, HUGGING FACE (May 9, 2019), https://medium.com/huggingface/ethical-analysis-of-the-open-sourcing-of-a-state-of-the-art-conversational-ai-852113c324b2; Irene Solaiman, Miles Brundage, Jack Clark, Amanda Askell, Ariel Herbert-Voss, Jeff Wu, Alec Radford, Gretchen Krueger, Jong Wook Kim, Sarah Kreps, Miles McCain, Alex Newhouse, Jason Blazakis, Kris McGuffie & Jasmine Wang, *Release Strategies and the Social Impacts of Language Models*, ARXIV (Nov. 13, 2019), https://arxiv.org /abs /1908.09203; Jess Whittlestone & Aviv Ovadya, *The Tension between Openness and Prudence in AI Research*, ARXIV (Jan. 13, 2020), https://arxiv.org /abs/1910.01170; Toby Shevlane & Allan Dafoe, *The Offense-Defense Balance of Scientific Knowledge: Does Publishing AI Research Reduce Misuse?*, PROC. 2020 AAAI /ACM CONF. AI, ETHICS, & SOC'Y 173 (2020); Mark Riedl, *AI Democratization in the Era of GPT-3*, THE GRADIENT (Sept. 25, 2020), https://thegradient.pub /ai-democratization-in-the-era-of-gpt-3 /; *Managing the Risks of AI Research Six Recommendations for Responsible Publication*, PARTNERSHIP ON AI (May 6, 2021), https: / /partnershiponai.org / paper /responsible-publication-recommendations /; *How to Be Responsible in AI Publication*, 3 NATURE MACH. INTELL. 367 (2021); Girish Sastry, *Beyond "Release" vs. "Not Release"*, STANFORD UNIVERSITY CENTER FOR RESEARCH ON FOUNDATION MODELS (Oct. 18, 2021), https://crfm.stanford.edu/commentary/2021/10/18/sastry.html.

powerful language model from being used for nefarious purposes,[213] such as spreading misinformation,[214] writing phishing emails,[215] and generating spam.[216] Organizations can also filter sensitive and unsafe outputs.[217] But this role of gatekeeper is controversial. Restrictions on access can impede valuable research[218] and present additional societal risks.[219]

213. For discussion of the potential misuses of language models, see Weidinger et al., *supra* note 20, at 25–28; Bommasani et al., *supra* note 6, at 135–38. For a broader account of the malicious uses of AI, see Miles Brundage, Shahar Avin, Jack Clark, Helen Toner, Peter Eckersley, Ben Garfinkel, Allan Dafoe, Paul Scharre, Thomas Zeitzoff, Bobby Filar, Hyrum Anderson, Heather Roff, Gregory C. Allen, Jacob Steinhardt, Carrick Flynn, Seán Ó hÉigeartaigh, Simon Beard, Haydn Belfield, Sebastian Farquhar, Clare Lyle, Rebecca Crootof, Owain Evans, Michael Page, Joanna Bryson, Roman Yampolskiy & Dario Amodei, *The Malicious Use of Artificial Intelligence: Forecasting, Prevention, and Mitigation*, ARXIV (Feb. 20, 2018), https://arxiv.org/abs/1802.07228.

214. *See* Ben Buchanan, Andrew Lohn, Micah Musser & Katerina Sedova, *Truth, Lies, and Automation How Language Models Could Change Disinformation*, CENTER FOR SECURITY AND EMERGING TECHNOLOGY at 5–34 (May 2021), https://cset.georgetown.edu/publication/truth-lies-and-automation /; Sharon Levy, Michael Saxon & William Yang Wang, *Investigating Memorization of Conspiracy Theories in Text Generation*, FINDINGS ASS'N COMPUTATIONAL LINGUISTICS 4718 (2021); McGuffie & Newhouse, *supra* note 68; Stephanie Lin, Jacob Hilton & Owain Evans, *TruthfulQA: Measuring How Models Mimic Human Falsehoods*, ARXIV (Sept. 8, 2021), https://arxiv.org/abs/2109.07958. For an overview of the misinformation harms arising from language models, see Weidinger et al., *supra* note 20, at 21–25. The generation of misinformation by language models is especially problematic in the legal domain. *See* Weidinger et al., *supra* note 20, at 24; Bommasani et al., *supra* note 6, at 65.

215. *See* Lily Hay Newman, *AI Wrote Better Phishing Emails Than Humans in a Recent Test*, WIRED (Jul. 8, 2021), https://www.wired.com/story/ai-phishing-emails/.

216. *See* Brown et al., *supra* note 8, at 35.

217. *See Content Filter*, OPENAI, https://beta.openai.com/docs/engines/content-filter (last visited Aug. 8, 2022). OpenAI researchers also proposed a method for fine-tuning GPT-3 to reduce toxicity. *See* Irene Solaiman & Christy Dennison, *Process for Adapting Language Models to Society (PALMS) with Values-Targeted Datasets*, PROC. 35TH CONF. NEURAL INFO. PROCESSING SYS. (2021).

218. *See* Bommasani et al., *supra* note 6, at 10–11, 157 (describing academia's incremental loss of access to state-of-the-art models). One possible solution is for researchers to use open-source alternatives instead of proprietary models. For example, EleutherAI, an open-source software group, has attempted to reproduce language models comparable to GPT-3. These models, however, are currently much smaller than GPT-3. *See* Sid Black, Leo Gao, Phil Wang, Connor Leahy & Stella Biderman, *GPT-Neo: Large Scale Autoregressive Language Modeling with Mesh-Tensorflow*; https://github.com/EleutherAI/gpt-neo (last visited Aug. 8, 2022); EleutherAI, *GPT-NeoX*, GITHUB, https://github.com/EleutherAI/gpt-neox (last visited Aug. 8, 2022).

219. For example, content filters can exclude valuable outputs and introduce new biases. *See* Kenton et al., *supra* note 181, at 6 ("[T]here may be a tension between de-biasing language and associations, and the ability of the language agent to converse with people in a way that mirrors their own language use. Efforts to create a more ethical language output also embody value judgments that could be mistaken or illegitimate without appropriate processes in

(v) *Unequal performance*. Despite improvements in their capabilities, language models continue to perform better for certain groups of people than others.[220] One source of this problem is that language models are developed primarily for only a small fraction of human languages.[221] However, even multilingual models, which are designed to serve multiple languages, perform better in some languages than in other languages.[222] While efforts are underway to better include underrepresented groups in language modeling,[223] significant inequalities persist.[224]

(vi) *Regulation*. Finally, the type of legal application explored in this Article—using a language model to provide legal advice directly to consumers—faces a distinct regulatory barrier. Generally speaking, non-lawyers, including developers and operators of AI systems, are prohibited from

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place."); *see also* Tamkin et al., *supra* note 20, at 9 ("[S]teering a model with human feedback still raises the question of who the human labelers are or how they should be chosen, and content filters can sometimes undermine the agency of the very groups that they are intended to protect.").

220. *See* Bender et al., *supra* note 20, at 611–12; Bommasani et al., *supra* note 6, at 130; Weidinger et al., *supra* note 20, at 16–18.

221. *See* Pratik Joshi, Sebastin Santy, Amar Budhiraja, Kalika Bali & Monojit Choudhury, *The State and Fate of Linguistic Diversity and Inclusion in the NLP World*, PROC. 58TH ANN. MEETING ASS'N COMPUTATIONAL LINGUISTICS 6282 (2020) (studying the relative inclusion of different languages in NLP conferences); *see also* Weidinger et al., *supra* note 20, at 34–35 (discussing the issue of disparate access to language models due to hardware, software, and skill constraints).

222. *See* Shijie Wu & Mark Dredze, *Are All Languages Created Equal in Multilingual BERT?*, PROC. 5TH WORKSHOP ON REPRESENTATION LEARNING FOR NLP 120, 128 (2020) ("While mBERT covers 104 languages, the 30% languages with least pretraining resources perform worse than using no pretrained language model at all.").

223. *See Mission,* WIDENING NATURAL LANGUAGE PROCESSING, https://www.winlp.org/mission/ (last visited Aug. 8, 2022) (describing the organization's mission to improve the representation of women and underrepresented groups in NLP).

224. *See, e.g.,* Isaac Caswell, Isaac Caswell, Lisa Wang, Ahsan Wahab, Daan van Esch, Nasanbayar Ulzii-Orshikh, Allahsera Tapo, Nishant Subramani, Artem Sokolov, Claytone Sikasote, Monang Setyawan, Supheakmungkol Sarin, Sokhar Samb, Benoît Sagot, Clara Rivera, Annette Rios, Isabel Papadimitriou, Salomey Osei, Pedro Ortiz Suárez, Iroro Orife, Kelechi Ogueji, Andre Niyongabo Rubungo, Toan Q. Nguyen, Mathias Müller, André Müller, Shamsuddeen Hassan Muhammad, Nanda Muhammad, Ayanda Mnyakeni, Jamshidbek Mirzakhalov, Tapiwanashe Matangira, Colin Leong, Nze Lawson, Sneha Kudugunta, Yacine Jernite, Mathias Jenny, Orhan Firat, Bonaventure F. P. Dossou, Sakhile Dlamini, Nisansa de Silva, Sakine Çabuk Ballı, Stella Biderman, Alessia Battisti, Ahmed Baruwa, Ankur Bapna, Pallavi Baljekar, Israel Abebe Azime, Ayodele Awokoya, Duygu Ataman, Orevaoghene Ahia, Oghenefego Ahia, Sweta Agrawal & Mofetoluwa Adeyemi, *Quality at a Glance: An Audit of Web-Crawled Multilingual Datasets*, ARXIV (Apr. 23, 2021), https://arxiv.org/abs/2103.12028 (finding that low resource language corpora face a host of systemic issues).

providing legal services.[225] Modifying this rule would require regulatory reform.[226] In contemplating such reform, it is important to ask what legal services (if any) are ordinarily available to consumers.[227] For many consumers, the answer is none, which arguably weighs in favor of removing regulatory barriers to using AI systems in the legal domain.[228] To promote consumer

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225. *See* MODEL RULES OF PROF'L CONDUCT r. 5.4 (AM. BAR ASS'N 2019) (prohibiting nonlawyer ownership of law firms and fee sharing with nonlawyers); *State Changes of Model Rules*, AM. BAR ASS'N, http://legalinnovationregulatorysurvey.info/state-changes-of-model-rules/ (last visited Aug. 8, 2022) (overviewing state-level unauthorized practice rules); *see also* Deborah L. Rhode, *Policing the Professional Monopoly: A Constitutional and Empirical Analysis of Unauthorized Practice Prohibitions*, 34 STAN. L. REV. 1, 11–44 (1981) (presenting the seminal empirical study on the enforcement of unauthorized practice rules); Cyphert, *supra* note 16, at 433–34 (arguing that nonlawyers' use of GPT-3 to perform legal tasks may amount to unauthorized practice).

226. There have been many proposals to alter the unauthorized practice rules and overhaul the regulation of legal services. *See* Gillian K. Hadfield & Deborah L. Rhode, *How to Regulate Legal Services to Promote Access, Innovation, and the Quality of Lawyering*, 67 HASTINGS L.J. 1191, 1214–23 (2016); BENJAMIN H. BARTON & STEPHANOS BIBAS, REBOOTING JUSTICE: MORE TECHNOLOGY, FEWER LAWYERS, AND THE FUTURE OF LAW chs. 8–10 (2017); HADFIELD, RULES FOR A FLAT WORLD, *supra* note 181, at ch. 9; Benjamin H. Barton & Deborah L. Rhode, *Access to Justice and Routine Legal Services: New Technologies Meet Bar Regulators*, 70 HASTINGS L.J. 955, 978–87 (2019); Rebecca L. Sandefur, *Legal Advice from Nonlawyers: Consumer Demand, Provider Quality, and Public Harms*, 16 STAN. J. C.R. & C.L. 283, 312–13 (2020). Notably, in 2020, the Utah Supreme Court created a regulatory sandbox to facilitate testing new methods for delivering legal services, including by nonlawyers. *See* Utah Supreme Court Standing Order No. 15 (effective Aug. 14, 2020) ("[E]stablish[ing] a pilot legal regulatory sandbox and an Office of Legal Services Innovation to assist the Utah Supreme Court with overseeing and regulating the practice of law by nontraditional legal service providers or by traditional providers offering nontraditional legal services."); UTAH RULES OF PROF'L CONDUCT rr. 5.4A–5.4B (effective Aug. 14, 2020) (relaxing certain unauthorized practice rules); Deno G. Himonas & Tyler J. Hubbard, *Democratizing the Rule of Law*, 16 STAN. J. C.R. & C.L. 261, 273–78 (2020) (detailing the goals and features of Utah's regulatory sandbox); Rebecca L. Sandefur, Thomas M. Clarke & James Teufel, *Seconds to Impact?: Regulatory Reform, New Kinds of Legal Services, and Increased Access to Justice*, 84 LAW & CONTEMP. PROBS. 69, 74–76 (2021) (describing the activities permitted by Utah's regulatory sandbox).

227. *See* Utah Supreme Court Standing Order No. 15 at 8 (effective Aug. 14, 2020) (providing that the regulation of legal services should "be based on the evaluation of risk to the consumer," which "should be evaluated relative to the current legal services options available").

228. *See* Tanina Rostain, *Robots versus Lawyers: A User-Centered Approach*, 30 GEO. J. LEGAL ETHICS 559, 569 (2017) ("For most individuals, the choice is not between a technology and a lawyer. It is the choice between relying on legal technologies or nothing at all."); *see also supra* note 90 (examining how the cost of legal services impedes access to justice).

welfare, policymakers will need to balance this consideration against the risks posed by language models.[229]

Some of these issues are of immediate concern. Others will become more salient as the capabilities of language models improve further. The purpose of flagging these issues is not to exhaustively describe the challenges facing language models in the legal domain. Instead, this brief account aims to illustrate that the safe and beneficial deployment of language models in legal contexts requires governance. While technological solutions are necessary, they are not sufficient. Regulation and policy also have important roles to play.

VI. CONCLUSION

Using computational language models to read consumer contracts is simple in principle but complex in practice. The case study presented in this Article explores some of these complexities by examining the degree to which GPT-3—the world's first commercial language model—can understand online terms of service. The results paint a nuanced picture. On the one hand, the generally strong performance of GPT-3 suggests that language models have the potential to assist consumers in discovering and exercising their contractual rights. On the other hand, the case study casts doubt on GPT-3's ability to understand consumer contracts. It suggests that the model is highly sensitive to the wording of questions and might contain an anti-consumer bias.

Due to the case study's limitations, however, its findings are not definitive. To be sure, the purpose of this Article is not to draw firm conclusions about a particular language model, but to begin a broader inquiry. As GPT-3 has taught us, scale matters. Larger-scale and more diverse testing is needed to evaluate the opportunities and challenges of using language models to read consumer contracts and perform other legal tasks. If we are to integrate language models into our legal toolkit, we will need to further investigate the safety and reliability of using these prediction machines in practice. The better we understand how language models interact with providers and consumers of legal services, and vice versa, the better positioned we will be to leverage the benefits of language models and confront the associated risks.

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229. *See* Remus & Levy, *supra* note 15, at 546–48 (discussing the need for consumer protection in the context of automated legal services). *Compare* Rostain, *supra* note 228, at 564–71 (distinguishing between the protections that should be afforded to individual users of automated legal services and the protections that should be afforded to corporate users of automated legal services).

APPENDIX

A. TEST CONDITIONS

1. *Prompt Design*

The case study used the following priming text:[230]

> I am a highly intelligent legal question answering bot. If you ask me a question, I will give you a "yes" or "no" answer.
>
> [*Company Name*]'s [*Terms of Service, or equivalent document name*] include[*s*] the following: "[*contract excerpt*]"
>
> Question: [*text of question*]
>
> Answer: [*response provided by GPT-3*]

The model's response length was restricted to two tokens, which is roughly equivalent to eight characters of normal English text.

2. *Contract Text*

Due to limits on the length of text that GPT-3 can process, the case study could not present the model with the entire terms of service for each website.[231] Instead, for each question the model was presented with an excerpt from the applicable terms of service, ranging between approximately 100 words and 1,350 words, with an average length of approximately 450 words.

3. *Model Hyperparameters*

Table 6 lists the hyperparameters used in the case study.[232]

230. This priming text is similar to the priming text in a template available in the OpenAI API at the time of the case study. *See Q&A*, OPENAI, https://beta.openai.com/examples/default-qa (last visited Aug. 8, 2022). More specialized guides have subsequently been released in the API. *See Question Answering*, OPENAI, https://beta.openai.com/docs/guides/answers (last visited Aug. 8, 2022). However, these were not available when the case study was conducted.

231. The model's context window is 2,048 tokens. Notably, because this context window cannot accommodate a single full contract, let alone several contracts accompanied by corresponding questions and answers, the case study could not employ few-shot learning.

232. These hyperparameters are similar to the hyperparameters in a template available in the OpenAI API at the time of the case study. *See Q&A*, OPENAI, https://beta.openai.com/examples/default-qa (last visited Aug. 8, 2022). Descriptions in Table 6 are adapted from descriptions in the OpenAI API documentation.

Table 6: Hyperparameters

Hyperparameter	Description	Case Study
Engine	Choice of model from the GPT-3 family of models.	Davinci (175b parameters)
Response Length	Maximum number of tokens that can be generated. One token is equivalent to approximately four characters of normal English text.	2
Temperature	Controls the degree of randomness in sampling. Higher values cause the model to take more risks. As the temperature approaches zero the model will be increasingly deterministic.	0
Top P	Controls diversity of sampling via nuclear sampling, such that the model considers only the results of the tokens with Top P probability mass. For example, where Top P is 0.1 only the tokens comprising the top 10% probability mass will be considered.	1
Frequency Penalty	Penalizes new tokens based on their existing frequency in the text so far. Decreases the model's likelihood to repeat the same line verbatim.	0
Presence Penalty	Penalizes new tokens based on whether they appear in the text so far. Increases the model's likelihood to introduce new topics.	0
Best Of	Generates multiple outputs server-side and displays only the best output (i.e., the output with the lowest log probability per token).	1
Stop Sequences	Sequences where the API will stop generating further tokens.	⏎
Inject Start Text	Text appended after the user's input.	⏎ "Answer:"
Inject Restart Text	Text appended after the model's output.	-

4. *Question Readability*

Table 7 lists the readability scores of the original and alternative wordings of the questions in the case study. Because readability scores are unreliable for short texts (such as individual questions),[233] the 200 originally worded questions were combined in one document, and readability scores were

233. *See* Oakland & Lane, *supra* note 156.

calculated in respect of that entire document. The same was done for the 200 alternatively worded questions. The higher the Flesch Reading Ease score, the more readable the text.[234] For all other scores (which aim to approximate a school grade reading level), the lower the score, the more readable the text.

Table 7: Comparing readability of the original wording and the alternative wording of the questions

	Original Wording	Alternative Wording
Flesch Reading Ease	61.70	39.51
Flesch-Kincaid Grade Level	8.02	12.12
Gunning Fog Index	9.50	13.94
Coleman-Liau Index	8.65	13.08
SMOG Index	11.08	13.96
Automated Readability Index	6.68	11.85
FORCAST Grade Level	10.46	12.22

B. OVERALL PERFORMANCE

The three measures of overall performance in Tables 8A, 8B, and 8C correspond to the three measures of confidence described in Part III.B, namely (i) the probability assigned to the output; (ii) the difference between the probability assigned to the output and the probability assigned to the alternative answer; and (iii) the ratio between the probability assigned to the output and the probability assigned to the alternative answer, respectively.

Table 8A: Comparing test accuracy and overall performance with the contract withheld baseline

	Test	Contract Withheld
Accuracy	77% [154/200]	60.5% [121/200]
Performance (Measure 1)	20.35	7.90
Performance (Measure 2)	13.55	3.08
Performance (Measure 3)	2.50	0.37

234. *Supra* note 144.

Table 8B: Comparing accuracy and overall performance on the pro-company, pro-consumer, and neutral questions

	Pro-Company	Pro-Consumer	Neutral
Accuracy	83.64% [35/45]	60.00% [27/45]	77.78% [92/110]
Performance (Measure 1)	24.99	6.64	22.72
Performance (Measure 2)	16.30	3.94	16.44
Performance (Measure 3)	2.57	0.70	4.15

Table 8C: Comparing accuracy and overall performance on the original wording and the alternative wording of the questions

	Original Wording (More Readable)	Alternative Wording (Less Readable)
Accuracy	77% [154/200]	68.5% [137/200]
Performance (Measure 1)	20.35	14.08
Performance (Measure 2)	13.55	8.97
Performance (Measure 3)	2.50	1.81

C. CALIBRATION PLOTS

The confidence scores for the 200 test questions were sorted in ascending order and split into 10 bins (comprised of 20 questions each). The average confidence score and accuracy were calculated for each bin and plotted in Figures 4A, 4B, and 4C (each plot is for a different measure of confidence). A linear or logarithmic line of best fit is shown. The stronger the upward trend, the stronger the positive correlation between accuracy and confidence, i.e., the higher the calibration.

Figure 4A: Binned scatter plot showing the relationship between (i) accuracy and (ii) the probability assigned to the output (Measure 1)

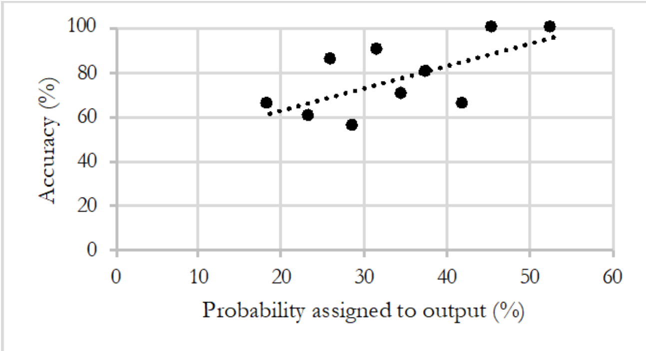


Figure 4B: Binned scatter plot showing the relationship between (i) accuracy and (ii) the difference between the probability assigned to the output and the probability assigned to the alternative answer (Measure 2)

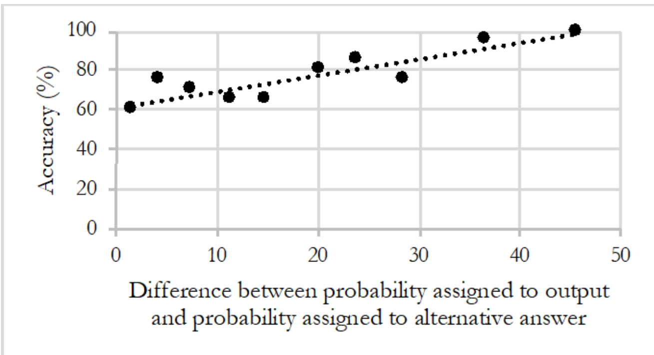
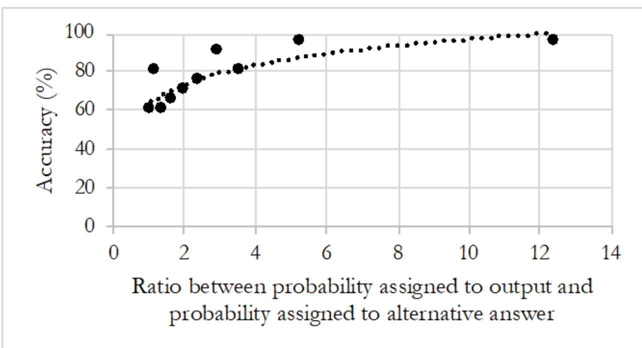


Figure 4C: Binned scatter plot showing the relationship between (i) accuracy and (ii) the ratio between the probability assigned to the output and the probability assigned to the alternative answer (Measure 3)



POST-GRANT ADJUDICATION OF DRUG PATENTS: AGENCY AND/OR COURT?

Arti K. Rai†*, Saurabh Vishnubhakat*††*, Jorge Lemus*†††*, & Erik Hovenkamp*‡

ABSTRACT

The America Invents Act of 2011 (AIA) created a robust administrative system—the Patent Trial and Appeal Board (PTAB)—that provides a route for challenging the validity of granted patents outside of district courts. Congress determined that administrative adjudication of the validity of initial patent grants could be cheaper and more scientifically accurate than district court adjudication of such validity.

For private economic value per patent, few areas of technology can match the biopharmaceutical industry. This is particularly true for small-molecule drugs. A billion-dollar drug monopoly may be protected from competition by a relatively small number of patents. Accordingly, the social cost of invalid patents—and, by extension, the potential benefit of PTAB review—is particularly acute for small molecule drugs. Conversely, if the PTAB is overly assertive and improperly targets high-quality patents, we may observe problematic reductions in innovation incentives. Thus, empirical research on how PTAB review is functioning in the area of drug patents is important.

To investigate PTAB review of drug patents empirically, this Article uses several novel datasets, which are made publicly available, to study the respective roles of the PTAB and the district courts. Our empirical findings indicate that the PTAB's role in adjudicating small-molecule patents has been substantially more modest than for other types of patents. Moreover, there is little evidence that the PTAB targets categories of small-molecule patents

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that are generally considered high quality. There is also no evidence that the PTAB targets small-molecule patents held by small entities. However, PTAB challenges may not differentiate as finely among different categories of patents as district court challenges. The Article concludes by discussing legal reforms policymakers could implement if they were interested in encouraging a more active role for the PTAB in policing the validity of small-molecule drug patents. The case for these reforms is bolstered by data showing that the PTAB is used more frequently for biologics patents, where litigation currently operates differently than for small molecule drugs. The Article also discusses how ex post determination of drug patent validity at the PTAB could be structured in comparison to more rigorous ex ante patent application examination.

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I. INTRODUCTION

The America Invents Act of 2011 (AIA) created a robust administrative system—the Patent Trial and Appeal Board (PTAB)—that provides a route for challenging the validity of granted patents outside of district courts.[1] Congress determined that administrative adjudication of the validity of the initial patent grant could be cheaper and more scientifically accurate than district court adjudication of such validity.[2]

1. Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284–341 (codified as amended in scattered sections of 35 U.S.C.).

2. *See generally* Saurabh Vishnubhakat, Arti K. Rai & Jay P. Kesan, *Strategic Decision Making in Dual PTAB and District Court Proceedings*, 31 BERKELEY TECH. L.J. 45, 51–55 (2016) (discussing this standard "substitution" justification for implementing administrative post-grant review). The substitution justification generally requires that the district court stay Article III litigation pending the outcome of the PTAB proceeding. When district courts do not issue stays, the benefits of substitution can be thwarted by duplication and inconsistency. Senators Patrick Leahy and John Cornyn have introduced legislation that attempts to prescribe more district

However, as demonstrated by the six U.S. Supreme Court cases it has already generated,[3] the PTAB has proved quite provocative. As it happens, the creation of the PTAB coincided with what some analysts argue has been a rise of "anti-administrativism" at the Supreme Court.[4] In the case of the PTAB, specific reasons for controversy have ranged from disputes over whether patents represent the types of public rights amenable to administrative adjudication,[5] to questions regarding the extent to which Congress has precluded Article III review of administrative determinations.[6]

At least in part, the high-dollar value associated with patent cases provides the fuel for this legal fire. As Justice Brett Kavanaugh noted at oral argument in the most recent of the Supreme Court challenges, Arthrex, billions of dollars may turn on the PTAB's decisions.[7]

Although Justice Kavanaugh's remarks did not single out the biopharmaceutical industry, in terms of private economic value per patent, few areas of technology can match it. Particularly for small-molecule drugs that are generally taken orally (as contrasted with large-molecule biologic proteins, which generally must be injected), a billion-dollar drug monopoly may be protected from competition by a relatively small number of patents.[8]

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court stays by codifying a standard four-part test. Restoring the America Invents Act, S. 2891, 117th Cong. (2021). This test was codified in the context of the now-expired post-grant review of covered business method (CBM) patents, and the data show that it strongly counseled in favor of stays. *See* Joel Sayres & Julie Wahlstrand, *To Stay or Not to Stay Pending IPR? That Should be a Simpler Question*, 17 CHI.-KENT J. INTELL. PROP. 52, 63 (2018) (discussing the four-part CBM test).

3. Cuozzo Speed Techs., LLC v. Lee, 136 S. Ct. 2131 (2016); Oil States Energy Servs., LLC v. Greene's Energy Grp., LLC, 138 S. Ct. 1365 (2018); SAS Inst., Inc. v. Iancu, 138 S. Ct. 1348 (2018); Return Mail, Inc. v. U.S. Postal Serv., 139 S. Ct. 1853 (2019); Thryv, Inc. v. Click-To-Call Techs. LP, 140 S. Ct. 1367 (2020); United States v. Arthrex, Inc., 141 S. Ct. 1970 (2021).

4. *See, e.g.*, Gillian Metzger, *1930's Redux: The Administrative State Under Siege*, 131 HARV. L. REV. 1 (2017).

5. *See Oil States*, 138 S. Ct. at 1373.

6. *See Cuozzo*, 136 S. Ct. at 2141–42.

7. Transcript of Oral Argument at 22, *Arthrex*, 141 S. Ct. 1970 (Nos. 19-1434, -1452, -1458).

8. To be sure, issues of patent quantity are also salient as well. The number of patents per approved branded small-molecule drug has increased noticeably over the years. A study by C. Scott Hemphill and Bhaven N. Sampat, *When Do Generics Challenge Drug Patents?*, 8 J. EMPIRICAL LEGAL STUD. 613 (2011), computed mean and median patent numbers for each three-year FDA approval cohort between 1985 and 2002. Between the first cohort (1985–87) and the last (2000–02), the average number of patents per drug increased from 1.9 to 3.9, and the median number of patents increased from 1.5 to 2.5. *Id.* at 619–20. A commercial firm that extended the Hemphill and Sampat analysis through 2014 determined that the average number of patents per drug in the 2012–14 cohort was 6.1, and the median number of patents was 4.0. *Patent Proliferation: A 30-Year Increase in the Number of Patents Per Drug*, ONPOINT ANALYTICS

Accordingly, the social costs of invalid patents—and, by extension, the potential benefits of PTAB review—are particularly acute in the biopharmaceutical industry. Conversely, if the PTAB is overly assertive and improperly targets high-quality patents, we may observe problematic reductions in innovation incentives.[9]

To investigate PTAB review of drug patents empirically, this Article uses several novel datasets to study the respective roles of the PTAB and the district courts in patent invalidity proceedings. Analysis of contemporaneous district court litigation is particularly important because, prior to the AIA, Congress set up court-centric mechanisms for testing therapeutic patent validity. These court-centric mechanisms appear in the Hatch-Waxman Act of 1984 ("Hatch-Waxman"),[10] and the Biologics Price Competition and Innovation Act of 2010 (BPCIA), which was eventually passed as a portion of the Affordable Care Act.[11]

Indeed, some biopharmaceutical patentees argue that the PTAB improperly disturbs these court-centric mechanisms. Critics have sought legislation that exempts biopharmaceutical patents from PTAB review.[12] Critics have also lauded the PTAB's increased refusal to institute proceedings,[13]

(Sept. 12, 2016), https://onpointanalytics.com/pharma/patent-proliferation; *see also* Robin Feldman, *May Your Drug Price Be Evergreen*, J.L. & BIOSCIENCES 590, 631 (2018) (documenting increase in quantity of "added" patents per drug between 2005 and 2015). These single digit figures are nonetheless several orders of magnitude smaller than those found for products in the information and communications technology industries. Indeed, the number of patents per small-molecule drug can be more than an order of magnitude smaller than the number of patents per large-molecule biologic, particularly for blockbuster biologics. *See, e.g.*, Victor L. van de Wiele, Aaron S. Kesselheim & Ameet Sarpatwari, *Barriers to US Biosimilar Market Growth: Lessons from Biosimilar Patent Litigation*, 40 HEALTH AFFS. 1198, 1201 (2021) (identifying 80 to over 100 patents covering biologics like Roche/Genentech's bevacizumab (Avastin), rituximab (Rituxan), trastuzumab (Herceptin) and Abbvie's adalimumab (Humira)).

9. For present purposes, we assume that accurate application of existing patent validity standards will generally incentivize socially desirable innovation.

10. Drug Price Competition and Patent Term Restoration Act, Pub. L. No. 98-417, 98 Stat. 1585 (codified as amended in 21 U.S.C. §§ 301, 355, 360cc).

11. Pub. L. No. 111-148, 124 Stat. 119–1025 (codified as amended in scattered sections of 42 U.S.C.).

12. In 2018, Senator Orrin Hatch, one of the namesakes of Hatch-Waxman, proposed legislation that exempted biopharmaceutical patents from generic or biosimilar challenge by barring those firms from challenging patents at the PTAB. *See* Ryan Davis, *PTAB's Doors Would Be Closed to Generics Under Hatch Bill*, LAW360 (June 20, 2018), https://www.law360.com/ip/articles/1054276/ptab-s-doors-would-be-closed-to-generics-under-hatch-bill (discussing proposed Hatch-Waxman Integrity Act of 2018, S. 3738, 115th Cong. (2018)).

13. *See* Christina Schwarz & Laura Fishwick, *PTAB Trends: More Orange Book Patents are Surviving the "Death Squad*,*"* IP WATCHDOG (Jan. 23, 2019), www.ipwatchdog.com/2019/01/23/ptab-trends-orange-book-patents-surviving-death-squad (discussing the positive reaction of patent owners to this development).

assuming (erroneously, as it happens)[14] that this development also applies to biopharmaceutical patents.

Conversely, generic firms and consumer advocates argue that district courts lack expertise in evaluating biopharmaceutical patents. In this view, an expert body, such as the PTAB, that polices erroneously issued biopharmaceutical patents is necessary to ensure that the exclusivity duration provides commensurate innovation-benefit to the public.[15] These groups express alarm at the possibility of a diminished role for the PTAB. Indeed, the Second Look at Drug Patents Act of 2020,[16] a bipartisan bill co-sponsored by Senators Patty Murray and John Cornyn, would require the Federal Drug Administration (FDA) and the U.S. Patent and Trademark Office (USPTO) to work together, notifying the public about small-molecule patents blocking generic entry that could be challenged through PTAB review.

These arguments have, however, often played out in a relative absence of data regarding the PTAB's involvement in biopharmaceutical patents, particularly relative to the district courts and to other types of patents. As one step in addressing the data gap, this Article focuses on patents that cover FDA-approved small molecules. Because the majority of these small-molecule patents are listed on the transparent, publicly accessible, central repository known as the Orange Book (OB),[17] these patents represent a more tractable empirical target than biologics patents.[18] Even for OB patents, however, much

14. In ongoing work, one of the Article's authors (SV) found that the PTAB's emerging framework of discretionary denials under the so-called *NHK-Fintiv* doctrine has *not* been applied to small-molecule patents to any meaningful degree. *See generally* NHK Spring Co. Ltd. v. Intri-Plex Techs. Inc., No. IPR2018-00752, 2018 WL 4373643 (P.T.A.B. Sept. 12, 2018) (precedential); Apple Inc. v. Fintiv Inc., No. IPR2020-00019, 2020 WL 2126495 (P.T.A.B. Mar. 20, 2020) (precedential). Specifically, in the total population of institution decisions decided under the *NHK-Fintiv* framework, just under 3.5% (16 out of 461) involved a patent on an FDA-approved small molecule, and only 0.65% (3/461) both involved this type of small-molecule patent *and* resulted in a discretionary *denial* under *NHK-Fintiv*. Instead, as this Article discusses, the roots of the PTAB's modest role lie elsewhere. Saurabh Vishnubhakat, *Patent Office Discretion and Agency Underreach* (working paper on file with author).

15. *See, e.g.*, Brief of the Coalition Against Patent Abuse as Amicus Curiae in Support of No Party 8–21,United States v. Arthrex, Inc., 141 S. Ct. 1970 (2021) (Nos. 19-1434, -1452, -1458) (arguing that the case studies presented show that PTAB decisions are more scientifically expert than district court decisions and are also correlated with generic entry and reduced prices).

16. S. 4253, 116th Cong. (2020).

17. The OB does not, however, list patents on non-FDA approved uses of metabolites, intermediates, and "process[es]" (i.e., manufacturing processes). 21 C.F.R. § 314.53(b)(1) (2019).

18. Although this Article focuses on small molecules, Part V, *infra*, does compare and contrast the Hatch-Waxman regime with the biologics regime, bringing in empirical findings on litigated biologics patents.

of the empirical discussion thus far has focused on litigation outcomes at the PTAB or the overlap in PTAB and district court litigation.[19]

This Article uses a somewhat different lens, assessing OB patents as a whole. The primary lens focuses further upstream than litigation outcomes and is somewhat less subject to selection effects. Specifically, this Article identifies all relevant OB-listed patents and can therefore drill down on parties' ex ante decisions to litigate OB patents and to litigate different types of OB patents in different fora.[20]

In general, this Article finds that, although OB patents are highly litigated, there are significant[21] differences in OB and non-OB patent litigation at the PTAB and in district court. For example, although most OB and non-OB patents challenged at the PTAB are also litigated in district court, the percentage of patents litigated solely at the PTAB is significantly lower for OB patents than for non-OB patents. The rate of PTAB challenge for OB patents with a parallel challenge in district court is significantly lower than for non-OB patents with a parallel district court challenge.

This Article discusses the extent to which these differences may reflect the influence of the Hatch-Waxman incentive scheme for challenging patents. This scheme provides both challengers and patentees incentives to stay in district court, even if administrative proceedings are cheaper and more accurate from a societal perspective.[22]

In addition, the literature has organized OB patents by scientific categories. This Article follows other scholars in differentiating between "primary" patents on active ingredients and "secondary" patents on methods of use,

19. *See, e.g.*, Michelle Ankenbrand & Jason Repko, *Orange Book Patent/Biologic Patent Study and District Court Pharma Litigation Study*, U.S. PAT. AND TRADEMARK OFF. (July 18, 2019), https://www.uspto.gov/sites/default/files/documents/Boardside%20Chat%20-%20Orange%20Book%20and%20Biologics%20%282019-07-11%29-IQ_807521-Final.pdf.

20. This Article takes the patent as its unit of analysis. A companion paper, Erik Hovenkamp, Jorge Lemus, Arti Rai, & Saurabh Vishnubhakat, *Drug Settlements and Generic Entry: Has the PTAB Made a Difference*, __ NATURE BIOTECHNOLOGY __ (forthcoming) examines what effect, if any, the PTAB is having at the drug level—specifically, on the timing of generic entry relative to originator product launch. That paper builds on prior work done by two of the authors (EH and JL) on the role of settlements at the PTAB. *See* Erik Hovenkamp & Jorge Lemus, *Delayed Entry Settlements at the Patent Office*, 54 INT'L REV. L. & ECON. 30 (2018) (investigating whether monopolist-patentees and their prospective rivals are using the PTAB as a platform for striking settlements that delay the rivals' entry).

21. By "significant" we mean statistically significant at the $p < 0.05$ level. *See infra* Part IV.

22. *See infra* Section II.A.

formulations, or other ancillary features.[23] Because secondary patents may be filed after the primary patent, they can extend a drug's patent life.[24] Moreover, secondary patents may extend patent life unduly because they are may be less scientifically innovative, and hence more likely to be invalid under conventional standards of patent law,[25] compared to primary patents. Critics also charge that even when secondary patents don't extend patent life,[26] they expand the roster of patents that potential generic entrants have to address.

Past analyses of the PTAB's role that differentiate by category of OB patent have either not reported their methodology for categorization, or have relied on patentees' self-reported categorization necessary to comply with FDA regulations. In contrast, we perform our own categorization and compare it to patentees' self-reported categorization. We then use our categorization to determine relative rates of litigation at the PTAB and the district court for different scientific categories of OB patents.

The calculations reveal that active-ingredient patents are significantly less likely to be challenged, whether at the PTAB or in district court, than secondary patents. Additionally, we do not find any significant difference between challenge rates of different types of patents at the PTAB compared to district court.

Furthermore, unlike the prior literature on the PTAB, this Article codes patents not only by scientific category but also by whether they represent an original-patent filing or a continuation. Specifically, the Article separates out continuations because such patents do not, at least in principle, extend a patent's life beyond the term allowed by the parent patent application. Critics argue, however, that continuations can be used to undermine the notice

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23. *See, e.g.*, Amy Kapczynski, Chan Park, & Bhaven Sampat, *Polymorphs and Prodrugs and Salts (Oh My!): An Empirical Analysis of "Secondary" Pharmaceutical Patents*, 7 PLOS ONE 1 (2012); C. Scott Hemphill & Bhaven N. Sampat, *Evergreening, Patent Challenges, and Effective Market Life in Pharmaceuticals*, 31 J. HEALTH ECON. 327, 329–30 (2012) (using the terminology of patent with at least one "active ingredient" claim to denote what this Article calls a primary patent).

24. Kapczynski et al., *supra* note 23, at 2.

25. Particularly at the international level, there is vigorous debate on whether patent law should treat secondary patents as a different class from other patents. *See generally* Christopher Holman, Timo Minssen, & Eric M. Solovy, *Patentability Standards for Follow-on Pharmaceutical Innovation*, 37 BIOTECHNOLOGY L. REPT. 131 (2018) (arguing that because secondary patents can often be innovative, they should not be treated differently). Because the Article assumes the application of conventional legal standards, this issue is not addressed. In other work, one of the authors (AKR) endorsed nonobvious secondary patents that meet conventional patent law standards. *See* Arti K. Rai & Grant Rice, *Use Patents Can be Useful*, 6 SCI. TRANSLATIONAL MED. 248 (2014).

26. As discussed herein, see *infra* Section III.C, when secondary patents are filed as continuations, they do not extend patent life.

function of the parent patent by extending patent scope beyond that of the parent.[27] Continuations also increase search costs for generic entrants by adding to the total roster of patents.

This Article finds that continuations make up a substantial proportion of secondary OB patents. And continuation patents on non-active ingredients are significantly more likely to be challenged than either non-continuations or continuations on active-ingredient patents.

Finally, the regression framework, which examines correlations between litigation frequency and scientific category, continuation status, and small-entity status, is generally consistent with the results achieved through descriptive statistics. For example, even controlling for potential confounding factors such as examiner art unit and issue year, method-of-use patents and continuation patents are more likely to be challenged in district court. However, the regression does not find these effects at the PTAB.

Notably, small-entity status is negatively correlated with likelihood of challenge, both at the PTAB and in district court. To the extent that policymakers are concerned about small-entity patent owners being particularly vulnerable to PTAB challenge, this Article indicates that such concern may be misplaced—small-entity status is correlated with a reduced likelihood of challenge.

In sum, this Article shows that the PTAB's role in adjudicating OB patents has been substantially more modest than for non-OB patents. Moreover, there is little evidence that the PTAB targets active-ingredient patents disproportionately. However, our regression framework does indicate that, while method-of-use and continuation patents are more likely to be challenged in district court than active-ingredient patents, this is not the case at the PTAB.

Relying on this data, the Article concludes by discussing paths policymakers could take if they were interested in a more active role for the PTAB in policing the validity of OB patents. The Article also discusses policy choices between ex post review by the PTAB or the courts, and more rigorous ex ante review.

Part II of the Article provides the statutory and regulatory background for the strategic positioning adopted by originators and generic entrants. It also discusses the existing literature. Part III presents data collection, classification, and empirical strategy. Part IV presents results. Part V provides a discussion and some conclusions.

27. *See generally* Mark A. Lemley & Kimberly A. Moore, *Ending Abuse of Patent Continuations*, 84 BOSTON U. L. REV. 63 (2004) (examining efforts undertaken to control the problems associated with continuation patents).

II. BACKGROUND

A. STATUTORY AND REGULATORY

The AIA, whose relevant provisions came into force on September 16, 2012, implemented several new mechanisms to conduct post-grant administrative review of patents. As noted, *supra* Part I, Congress determined that post-grant administrative review had the potential to correct errors more cheaply and accurately than district court litigation.

Moreover, absent a relatively cheap forum for challenging validity, even infringing defendants that thought a patent was weak might not expend resources to challenge it. This is because Supreme Court case law builds asymmetric incentives to litigate validity into patent doctrine. Under estoppel doctrine in patent law, a challenger that successfully invalidates a patent provides a public good: the challenger not only benefits, but so do all other potential competitors, who can free ride off the challenger's efforts.[28] Conversely, the challenger who loses is uniquely estopped from challenging the patent again, while the patent remains in force.[29] The result is fewer patent validity challenges than might be socially optimal, just as any public good is likely to be undersupplied. Although some of this public good problem may also exist in the administrative context,[30] the possibility of collective action through joinder and the reduced cost of administrative proceedings likely reduces its scale.[31]

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28. *See* Blonder Tongue Laby's, Inc. v. Univ. of Ill. Found., 402 U.S. 313, 350 (1971) (holding that a finding of patent invalidity creates nonmutual-defensive collateral estoppel, such that a patent that is invalid against one party is invalid against the world).

29. A separate statutory change created by the AIA arguably exacerbates this problem by restricting lawsuits against individual accused infringers, thereby making it harder to form joint defense agreements. *See* 35 U.S.C. § 299. The ability to form such joint defense agreements is contested even where accused infringers are, indeed, joined as co-defendants. *See* Joseph Scott Miller, *Joint Defense or Research Joint Venture? Reassessing the Patent-Challenge-Bloc's Antitrust Status*, 2011 STAN. TECH. L. REV. 5, 16–19 (2011) (arguing that such agreements are proper under antitrust law). The reduced likelihood of such co-defendant joinder under the AIA makes joint-defense agreements even harder to justify and less likely to arise.

30. *See* John R. Thomas, *Collusion and Collective Action in the Patent System: A Proposal for Patent Bounties*, 2001 U. ILL. L. REV. 305, 308–09 (2001). *But see* Stuart M. Benjamin & Arti K. Rai, *Who's Afraid of the APA? What the Patent System Can Learn from Administrative Law*, 95 GEO. L.J. 269, 323–27 (2007) (noting that administrative review relying on *Chevron* deference by the courts, rather than estoppel against the patent challenger, could substantially reduce collective-action problems).

31. *See* Vishnubhakat et al., *supra* note 2, at 74–75, 102–03 (discussing the incentives and empirically observed patterns of strategic joinder between previously sued and non-sued parties and across technology sectors).

This Article focuses on inter partes review (IPR), which has proved, by far, to be the most popular type of post-grant administrative review. A petition for IPR can be filed at any time nine months after patent issue and is also available retrospectively against patents issued prior to the AIA. To be granted institution, the petition must establish "a reasonable likelihood that the requester would prevail with respect to at least 1 of the claims challenged in the request."[32] The PTAB decides on institution within six months of the petition filing[33] and makes a final decision on validity no more than one year after initiation of post-grant review.[34]

Notably, IPRs have no standing requirement. Accordingly, they are available to anyone other than the patent holder, so long as the challenger meets two conditions: 1) it has not previously challenged the patent in a civil action;[35] and 2) if the challenger has been sued in district court, it files an IPR within one year of being served with the district court complaint.[36]

As these limits on petitioning indicate, Congress intended the IPR process to interact efficiently with district court litigation. District courts, meanwhile, have the discretion to stay existing infringement litigation pending the outcome of an IPR.[37] In determining whether to issue a stay, courts generally consider three factors: 1) the potential for prejudice or tactical disadvantage against the nonmoving party; 2) how far along the district court litigation is; and 3) the likelihood a stay could simplify the pending litigation.[38]

The AIA also intersects with two specific statutory schemes challenging the validity of biopharmaceutical patents in district court—Hatch-Waxman and the BPCIA. Hatch-Waxman, enacted in 1984, covers small molecules, while the BPCIA, enacted in 2010, governs large-molecule biologics, which are more scientifically complex.[39]

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32. 35 U.S.C. § 314(a).

33. *See* U.S. PAT. & TRADEMARK OFF., AIA TRIALS 7 (2019),https://www.uspto.gov/sites/default/files/documents/What%20are%20AIA%20trials%20for%20website%2010.24.19.pdf.

34. 35 U.S.C. § 316(a)(11).

35. *Id.* § 315(a)(1). A counterclaim does not count as a civil action. *Id.* § 315(a)(3).

36. *Id.* § 315(b).

37. *See, e.g.*, Nichea Corp. v. Vizio, Inc., 2018 WL 2448098, at *3 (C.D. Cal. May 21, 2018).

38. *See id.* at *1. However, one of the authors of the AIA recently concluded that district courts need to be more aggressive in granting stays, otherwise efficiencies will not be realized to the extent originally contemplated. *See* Restoring the America Invents Act, S. 2891, 117th Cong. (2021).

39. *See generally* W. Nicholson Price II & Arti K. Rai, *Manufacturing Barriers to Biologics Competition and Innovation*, 101 IOWA L. REV. 1023 (2016) (examining the problem of secret biologics manufacturing processes).

Both Hatch-Waxman and the BPCIA allow competitors to rely on clinical trial data generated by a branded-originator firm. Hatch-Waxman also requires that the branded-drug manufacturer seeking FDA approval submit to the agency a list of all patents claiming the drug or a method of using such drug "with respect to which a claim of patent infringement could reasonably be asserted" if an unlicensed person manufactured, used, or sold the drug.[40] These patents are then listed on the OB.

The FDA has interpreted Hatch-Waxman to mean that branded firms must list the following categories of patents on the OB: active-ingredient patents (which it calls "drug substance" patents); formulation and composition patents (which it calls "drug product" patents); and method-of-use patents.[41] The OB annual edition contains all patents active as of December 31 of the preceding year that branded firms assert cover their marketed drugs. For example, the 2012 annual edition contains all patents active as of December 31, 2011.

To market its drug, a generic firm must file a so-called Paragraph IV certification, stating that all relevant OB patents are invalid or not infringed.[42] Because this certification creates an act of constructive infringement, the originator is entitled to sue in district court within forty-five days. The first generic entity that files a Paragraph IV certification is entitled to a 180-day period of exclusive marketing.[43] Notably, this 180-day period is intended to incentivize generic firms to challenge an invalid patent, providing a public good.[44] As currently construed, however, the 180-day period remains with the challenger even if the challenger decides to settle, thereby blocking generic entry until 180 days after another generic firm invalidates the patent.[45]

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40. 21 U.S.C. § 355 note (Any Information or Documentary Material that May Have Been Filed Pursuant to The Pharmaceutical Agreement Notification). Patents on manufacturing, packaging, intermediates, and metabolites are not supposed to be submitted. The FDA does not, however, audit any OB listings. To the contrary, in the more than thirty-five years since the enactment of Hatch-Waxman, the FDA has disavowed performing anything other than a ministerial role with respect to patents. For a recent statement of this disavowal, see Listing of Patent Information in the Orange Book, 85 Fed. Reg. 33169, 33170 (2020).

41. 21 C.F.R. § 314.53 (2019).

42. *See Paragraph IV Drug Product Applications: Generic Drug Patent Challenge Notifications*, FDA (Apr. 20, 2021), https://www.fda.gov/drugs/abbreviated-new-drug-application-anda/paragraph-iv-drug-product-applications-generic-drug-patent-challenge-notifications.

43. *Id.*

44. Thomas, *supra* note 30, at 336–37.

45. For this reason, critics argue that the 180-day incentive does not currently promote competition. *See* C. Scott Hemphill & Mark A. Lemley, *Earning Exclusivity: Generic Drug Incentives and the Hatch-Waxman Act*, 77 ANTITRUST L.J. 947, 953–55 (2011).

Moreover, challenging an OB patent solely through the IPR procedure does not confer any exclusivity on the challenger.

Once the generic manufacturer files a Paragraph IV certification, the patent owner can not only to sue for patent infringement but also receives an automatic 30-month stay of the generic drug's FDA approval process, pending district court consideration of the suit.[46] The stay can be terminated only if the district court enters judgment saying the patent claims at issue in the suit are invalid or not infringed.[47]

The automatic 30-month stay creates a challenge for would-be generic entrants that hope to use the PTAB's relatively expedited procedures. A PTAB determination of invalidity lifts a stay only if the district court chooses to enter judgment for the defendant.[48] Moreover, under current case law, the district court is only required to enter judgment if PTAB determinations are affirmed by the Court of Appeals for the Federal Circuit, the court with exclusive appellate jurisdiction over patent claims.[49] Likewise, the 180-day marketing-exclusivity incentive attaches only if the patent challenger makes itself vulnerable to a district court infringement suit via a Paragraph IV certification.[50]

B. EXISTING LITERATURE

The existing OB-patent literature that examines choice of litigation forum focuses on PTAB outcomes and whether OB patents are also being litigated in district court. Studies find that OB patents challenged at the PTAB generally fare better than non-OB patents. A USPTO 2019 study, examining PTAB litigation from September 16, 2012 to November 30, 2018, found that the agency instituted review of petitioner challenges at a rate of 64% for OB patents, relative to an overall institution rate of 66%.[51] The study also found that, in cases that made it to a final written decision, 52% of instituted claims were held to be patentable—i.e., were vindicated.[52] This compared with only 19% of instituted claims held patentable overall.[53] Similarly, a 2018 Ropes & Gray study analyzing from September 16, 2012, to May 1, 2018, determined

46. FDA, *supra* note 42.
47. 21 U.S.C. § 355(j)(5)(B)(iii)(I).
48. *Id.*
49. *See* Fresenius USA, Inc. v. Baxter Int'l, Inc., 721 F.3d 1330, 1334 (Fed. Cir. 2013) (holding that Federal Circuit affirmance of USPTO claim cancellation "extinguishes the underlying basis for suits based on the patent").
50. 21 U.S.C. § 355(j)(5)(B)(iv).
51. Ankenbrand & Repko, *supra* note 19, at 18.
52. *Id.* at 20.
53. *Id.*

that, for OB patents, at least one challenged claim in the patent survived in 51% of final written decisions.[54] In contrast, for non-OB patents, at least one challenged claim survived in only 35% of final written decisions.[55] A 2019 study from September 16, 2012, and April 24, 2017, determined that, of the 198 OB patents challenged, only 25 patents had all challenged claims invalidated.[56]

Analysts also find that OB patents litigated at the PTAB are generally also litigated in district court. For example, the 2021 USPTO study of OB patents determined that of 91% of OB patents challenged at the PTAB were also challenged in district court.[57]

Some analyses also look at different categories of patents. For example, one study determined that, of the twenty-five patents for which all challenged claims were invalidated at the PTAB, only two were listed by the branded firm as active-ingredient patents on the OB.[58] The Ropes & Gray analysis found that at least one challenged claim in active-ingredient patents generally survived, whether they were challenged at the PTAB or in district court.[59] Meanwhile, formulation and method-of-treatment claims were less likely to survive, though somewhat more likely at the PTAB than in district court.[60] The Ropes & Gray study did not, however, discuss its methodology for classifying patents.

Finally, although the PTAB is still a relatively young institution, analysts have looked at litigation trends over time. According to USPTO data, both absolute numbers and percentages of petitions challenging OB patents peaked in fiscal years 2015 and 2016 (at 133 and 127, or 7% and 7.5% of total AIA petitions). The 2015–16 period was arguably a one-time blip, however, as certain hedge funds thought at the time (incorrectly, as it happened) that simply filing a challenge at the PTAB might result in stock price drops that they could exploit by shorting the stock.[61] Both before and after that time

54. Filko Prugo, Scott McKeown & Jon Tanaka, *Insight: Orange, Purple Book Patentees Hone PTAB Survival Skills*,17 BNA PAT. TRADEMARK & COPYRIGHT J. 0, 2 (2018).

55. *Id.*

56. Jonathan J. Darrow, Reed F. Beall, & Aaron S. Kesselheim, *The Generic Drug Industry Embraces a Faster, Cheaper Pathway for Challenging Patents*, 17 APPLIED HEALTH ECON. & HEALTH POL'Y 47, 51 (2019).

57. Ankenbrand & Repko, *supra* note 19, at 11.

58. Darrow et al., *supra* note 56, at 51.

59. Prugo et al., *supra* note 54, at 2.

60. *Id.*

61. *See* Joseph Walker & Rob Copeland, *New Hedge Fund Strategy: Dispute the Patent, Short the Stock*, WALL ST. J. (Apr. 7, 2015, 7:24 PM), https://www.wsj.com/articles/hedge-fund-manager-kyle-bass-challenges-jazz-pharmaceuticals-patent-1428417408 (discussing practice

period, PTAB use has been substantially more modest, covering only about 2–4% of all AIA petitions.[62]

III. SOURCES OF DATA AND DATA COLLECTION

A. COLLECTION AND CLASSIFICATION

We began by establishing a dataset of all patents listed on the OB during any of the ten annual editions published between January 2010 and January 2019.[63] From 2010 to 2016, we relied on OB data extracted by Professor Heidi Williams and made publicly available on the National Bureau of Economic Research's (NBER) website.[64] From 2017 to 2019, we used Professor Williams's procedure to extract relevant information from PDFs of OB editions generously provided to us by Professor Erika Lietzan.

This resulted in a dataset of 5,842 unique patents, which we compared to classifications for OB patents that we purchased from a third-party vendor (PharmaIntelligence/Medtrack). For two reasons, one involving data limitations and the other involving limitations of the vendor's approach, we substantially reworked the vendor's approach.[65]

Our approach[66] first looks at all of the claims in a patent. If at least one claim is directed to[67] the two-dimensional structure of a chemical that was not

of filing and publicizing patent challenges against pharmaceutical companies while also betting against their shares).

62. U.S. PAT. & TRADEMARK OFF., PTAB ORANGE BOOK PATENT/BIOLOGIC PATENT STUDY 3 (2021), https://www.uspto.gov/sites/default/files/documents/PTABOBbiologicpatentstudy8.10.2021draftupdatedthruJune2021.pdf.

63. As we discuss below, for analyses that involved a comparison of PTAB litigation with district court litigation, we needed only a subset of this data.

64. *Orange Book Patent and Exclusivity Data—1985–2016*, NAT'L BUREAU ECON. RSCH., https://www.nber.org/research/data/orange-book-patent-and-exclusivity-data-1985-2016 (last visited Nov. 11, 2021).

65. For example, at the outset, we determined that about 555 (10%) of patents in our OB patent dataset had not been classified by the vendor. Further, our detailed quality check of the vendor classifications determined that, although the classifications generally appeared sound for product and method-of-use patents, the vendor's distinctions drawn to create other classes were far less clear. Accordingly, one of the authors (AKR) and several research assistants with advanced degrees in the biochemical sciences iterated over multiple samples of the 5,842 unique patents. Through such iteration, we were able to identify a relatively straightforward approach that produces replicable classifications. We used this approach to classify the 555 unclassified patents and to reformulate the vendor's classifications.

66. Our approach is based on an approach taken, and validated, by C. Scott Hemphill and Bhaven N. Sampat in several articles on secondary patenting. *See, e.g.*, *supra* note 23.

67. By "directed to," we mean the claim is to the product. Claims to methods of use or formulation can sometimes include chemical structure. This chemical structure is, however, not the invention to which the claim is "directed."

disclosed in prior non-provisional applications, then we classify the patent as being directed to an active ingredient. We categorize such patents as product patents even if the patent also includes claims not directed to a product. The benefit of this approach to product patent classification is that it results in a bright-line rule with a clear application. Our approach is also consistent with the conventional understanding that patents containing active-ingredient claims may include claims drawn to other features.[68] Conversely, when a patent does not include any claim directed to a chemical compound, it cannot reasonably be viewed as anything other than secondary.

For secondary patents, one specific category of interest was new method-of-use patents. Method-of-use patents differ from other patent categories because Congress has permitted generic firms to use a limited drug label (colloquially known as a "skinny label") to avoid infringing patents on new uses found by originators. Skinny labeling is available as a path to generic entry so long as the drug has already been approved by the FDA for one use, and the patent that is blocking generic entry is the additional method-of-use patent with a later expiration date.[69] Accordingly, such patents have not always, at least historically,[70] blocked generic entry like other types of patents. If the patent did not contain any product claims, and the majority of claims were directed to a method of use, then we classified it as a method-of-use patent.

Finally, the literature discusses a variety of other types of secondary patent claims, including: claims directed to dosage forms or other formulations; salts; enantiomers; esters; and polymorphs or other crystalline structures. These types of patents can extend patent life on a drug. Additionally, in cases where the patent covers a variation on a prior approved drug that requires the filing of an additional "new drug application" (NDA) at the FDA, a secondary patent can undergird the practice of "product hopping."[71]

68. Hemphill & Sampat, *supra* note 23, at 329 ("[A] patent with both active ingredient and non-active ingredient claims counts as an AI patent.").

69. *See* Arti K. Rai, *Use Patents, Carve-Outs, and Incentives: A New Battle in the Drug-Patent Wars*, 367 NEW ENG. J. MED. 491, 491 (2012) (discussing FDA carve-outs for patented uses from the generic label). Skinny labeling is not possible if the use patent covers the only FDA-approved use for the drug.

70. Recent Federal Circuit decisions have called into question the viability of skinny labeling. *See, e.g.*, GlaxoSmithKline LLC v. Teva Pharms. USA, Inc., 7 F.4th 1320 (Fed. Cir. 2021) (rehearing).

71. A firm engages in product hopping when it moves its customers from one branded drug that will shortly face generic entry due to patent expiry to a branded variation that has additional remaining patent life. *See generally* Michael A. Carrier & Steve D. Shadowen, *Product Hopping: A New Framework*, 92 NOTRE DAME L. REV. 167, 171 (2016) (describing benefits of product hopping).

However, we determined that these "other" claims were often found together in patents. Further, we were not particularly concerned with these distinctions among the various categories. Accordingly, we classified patents that predominantly contained these claims, and did not contain a product claim, as "secondary-other."

In contrast to our study, some of the existing analyses rely on patentees' self-reported OB classifications. To compare our analyses to those existing analyses, we compared our classifications against the OB classifications. As noted earlier, the FDA instructs applicants to classify their OB patents into one or more of three categories: "drug substance" (DS); "drug product" (DP); or "method-of-use" (UC). Somewhat confusingly for present purposes, the FDA states that the DS label denotes patents on active ingredients (what we are calling "product" patents).[72] Meanwhile, the DP label denotes a finished dosage form, such as a tablet, capsule, or solution (what we are calling "secondary-other" patents).[73]

Accordingly, the OB allows eight potential permutations for a given patent.[74] Moreover, as shown in Table 1, OB patent owners avail themselves of all available permutations, including the "uninformative" permutation of DS=0, DP=0, and UC=0. To some extent, this phenomenon arises because patents contain claims directed to different types of subject matter. But a casual approach to patent identification may also be encouraged by the FDA's longstanding position that it does not audit in any way the information that is put on the OB.[75]

Our investigation further determined that a given patent was sometimes classified in the OB not simply into one of the eight permutations but into several conflicting permutations. Once we limited ourselves to unique permutations, we were left with 5,495 patents. We could match all but eleven of these patents with our classifications. Table 1 shows the comparison for the 5,484 remaining patents.

72. 21 C.F.R. § 314.3(b) (2016).

73. *Id.*

74. *See infra* Table 1.

75. Rebecca S. Eisenberg & Daniel A. Crane, *Patent Punting: How FDA and Antitrust Courts Undermine the Hatch-Waxman Act to Avoid Dealing with Patents*, 21 MICH. TELECOMM. & TECH. L. REV. 197, 211 (2015).

Table 1. Comparison of Our Classification with OB Classifications

alt	product	method-of-use	other	Total
DS=1 & DP=1 & UC=1	254	21	91	366
DS=1 & DP=1 & UC=0	212	2	155	369
DS=1 & DP=0 & UC=1	20	9	10	39
DS=1 & DP=0 & UC=0	105	1	85	191
DS=0 & DP=1 & UC=1	10	121	625	756
DS=0 & DP=1 & UC=0	17	37	1,571	1,625
DS=0 & DP=0 & UC=1	38	1,558	228	1,824
DS=0 & DP=0 & UC=0	46	20	248	314
Total	702	1,769	3,013	5,484

In general, the heavy use of multiple classifications by OB-patent owners meant that our approach yielded a smaller number of patents in each category. For active-ingredient patents, one additional reason for the smaller number may be that FDA regulations suggest that patents on polymorphs of the active ingredient are also "drug substance" patents.[76] In contrast, our approach counts patent claims drawn to polymorphs as "secondary-other."

As Table 1 shows, 39.8% (374/965) of patents with a DS=1 classification in the OB are not classified as active-ingredient patents under our approach. Meanwhile, only 15.8% (111/702) of patents classified as active-ingredient patents fail to secure a DS=1 label. The overlap between the two approaches, constituting 591 patents, is substantial but far from complete.

Most of the patents (88.1%) (1,558/1,769) that we classified as method-of-use patents were designated as only method-of-use in the OB. On the other hand, the OB encompassed a much larger total number of patents (2,985) in the method-of-use category.

With DP=1, the numbers tended to be most similar between the categorizations. A total of 3,116 patents were listed as DP=1, and a total of 3,013 we classified as "secondary-other." Moreover, 2,442 patents are classified as both DP=1 in the OB and "secondary-other."

In general, our approach errs conservatively as to what constitutes an active-ingredient patent. By contrast, self-categorization by patentees on the

76. *See* 21 C.F.R. § 314.53 (2019) (indicating that a polymorph may be "the same active ingredient"); *see also* Listing of Patent Information in the Orange Book, 85 Fed. Reg. 33169, 33170–71 (discussing "drug substance patents that claim only a polymorph of the active ingredient").

OB listings may be overinclusive, particularly if the goal is to divide to conform to patent practice—that is, the first patent filed by the originator typically claims the active ingredient, though it may also contain claims to methods of use and perhaps even formulations. Additionally, in at least one circumstance, the FDA's regulations encourage overinclusion by suggesting that patents on polymorphs should be classified as active-ingredient patents.

B. LITIGATION DATA

We drew our data on PTAB litigation from Unified Patents and our data on district court case resolution from Lex Machina. The Unified Patents data[77] are publicly available and the Lex Machina data[78] are generally accessible upon request to academics. Additionally, all replication data and code for the Article are available at Harvard Dataverse.[79] Accordingly, our results are amenable to replication.

In the remainder of the Article, we focus on patents litigated either at the PTAB, in district court, or both. Because defendants could file a PTAB challenge only after the AIA went into effect, we focus on district court cases in Lex Machina filed on or after September 16, 2011, and through December 31, 2019. We similarly restrict our PTAB data to petitions filed since the PTAB began functioning on September 16, 2012, and through December 31, 2019.

Although our litigation data are highly granular with respect to date, our OB data are collected on an annual basis. Accordingly, we have a mismatch: we must either start with an OB edition (2011) that includes patents that expired before September 16, 2011, or with an annual edition (2012) that omits patents that expired between September 16, 2011, and December 31, 2011. Because the 2012 edition hews more closely to our desired time period, we run our litigation analyses starting with that edition. By dropping the 2010 and 2011 editions, we reduce the number of OB patents analyzed to 4,718.

77. *Free Patent Dispute Updates*, UNIFIED PATS., https://www.unifiedpatents.com/docket (last visited Nov. 17, 2021).

78. *Public Interest*, LEX MACHINA, https://lexmachina.com/public-interest (last visited Nov. 17, 2021).

79. Arti K. Rai, Saurabh Vishnubhakat, Jorge Lemus, & Erik Hovenkamp, *Replication Data for: Post-Grant Adjudication of Drug Patents: Agency and/or Court?*, HARV. DATAVERSE, https://doi.org/10.7910/DVN/YCMKVU (last visited Nov. 17, 2021).

C. CONTINUATION CLASSIFICATION

We also divided patents by whether they issued from a continuation application.[80] The USPTO prosecution history of each application contains its continuity record, including any earlier-filed ("parent") applications to which it claims priority as well as any later-filed ("child") applications that themselves claim priority to it.[81] Although continuation applications do not, at least in principle, extend the effective life of a patent beyond the parent patent application's term. Critics argue that continuations can be used to undermine the notice function of the parent patent by improperly extending patent scope beyond that of the parent.[82] Continuations also add to the total roster of patents with which a potential generic entrant must contend.

The use of continuations is part of a broader set of practices built around tradeoffs in patent priority, term, and breadth/scope. There is a tradeoff between the pursuit of priority by being first in time and the desire to maximize both the scope of patent claims and the patent's term. In general, the USPTO allocates priority from the patent application's filing date,[83] starting the 20-year clock to when the patent, if it is issued, will eventually expire.[84]

Meanwhile, patent scope is supposed to be limited by the application's disclosure, which adequately enables and describes all subject matter covered by the claims.[85] Thus, even if an applicant makes broadening amendments to claims, the claims cannot, at least in principle, exceed what can be properly supported by the disclosure, which is fixed at the filing date and cannot be amended.

Continuation practice relies on this dynamic by allowing an application to enjoy the same priority as the parent application. Because the continuation application is legally assigned the same "effective" filing date as the parent

80. We did not count divisional applications as continuations. Unlike true continuations, divisional applications arise when the USPTO determines that more than one invention is claimed in a given application. 35 U.S.C. § 121.

81. The prosecution history for a patent can be obtained by visiting *Public Patent Application Information Retrieval (PAIR)*, U.S PAT. & TRADEMARK OFF., https://portal.uspto.gov/pair/PublicPair (last visited Nov. 17, 2021).

82. *See*, *e.g.*, Lemley & Moore, *supra* note 27 (examining efforts undertaken to control the problems associated with continuation patents); Mark A. Lemley, *Ten Things to Do About Patent Holdup of Standards (And One* Not *To)*, 48 B.C. L. REV. 149 (2007) (same as applied to standard patents); Gary C. Ganzi, *Patent Continuation Practice and Public Notice: Can They Coexist?*, 89 J. PAT. & TRADEMARK OFF. SOC'Y 545 (2007) (discussing reasons supplied by patent owners on why continuations should be issued and the effect of those reasons on public notice).

83. *See* 35 U.S.C. § 119.

84. *Id.* § 154(a)(2).

85. *Id.* § 112(a).

application,[86] the later-filed application avoids intervening technological developments that might otherwise defeat patentability.

In principle, this legal fiction is permitted only because the later-filed application must also contain the same disclosure—and, hence, the same outer limit on patent scope—as the parent application. However, if the USPTO does not sufficiently enforce the statutory disclosure requirements of enablement[87] and written description,[88] an applicant can enjoy the benefit of earlier priority, claiming more than the earlier disclosure supports, to the detriment of public notice and the public domain.[89]

We include in our analysis not only full continuations but also continuations-in-part (CIPs), which can add new material, though that material is not given the same priority date as the parent application. We choose to treat CIPs in the same category as ordinary continuations for two reasons. First, because CIPs represent a small percentage of our OB patent total (2.1%), breaking them out separately would not be fruitful. Second, CIPs can raise at least some of the same notice concerns as ordinary continuations.

IV. RESULTS

As noted, 4,718 unique patents were listed on the OB during the annual editions published from 2012 to 2019. Of these 4,718 patents, 42.2% were litigated at the PTAB, in district court ("DCT"), or both, while 57.8% were not. Against the backdrop of approximately 1% of patents litigated during their lifetime, this figure indicates that OB patents are very highly litigated.

Table 2 shows the litigation venue for the 1,989 patents that were litigated at least once.[90] Table 2 reaffirms the USPTO's analysis:[91] over 90% of OB patents litigated at the PTAB (in our case, 252 of 269 patents, or 93.7%) are in litigation in district court. Going beyond the USPTO's analysis, we show that

86. Only certain parties in specific circumstances can claim priority in this way. *See id.* §§ 119, 120, 121.

87. *See id.* § 112(a). (requiring that the patent specification must "enable any person skilled in the art to which it pertains . . . to make and use" the invention). An adequately enabling disclosure must teach the person skilled in theart well enough to practice the invention "without undue experimentation." *In re* Wands, 858 F.2d 731, 736–40 (Fed. Cir. 1988).

88. *See* 35 U.S.C. § 112(a) (requiring that the patent specification must "contain a written description of the invention, and of the manner and process of making and using it"). An adequate written description must convey "to those skilled in the art that the inventor had possession of the claimed subject matter as of the filing date." Ariad Pharms v. Eli Lilly & Co., 598 F.3d 1336, 1351 (Fed. Cir. 2010) (en banc).

89. *See* Lemley & Moore, *supra* note 27, at 100.

90. "0" denotes no litigation, and "1" denotes litigation.

91. Ankenbrand & Repko, *supra* note 19, at 11.

12.8% of OB patents litigated in district court are challenged at the PTAB. This is significantly[92] lower than the 20% of non-OB patents litigated in district court that were challenged at the PTAB during the same time period.[93] Meanwhile, whereas 0.8% of OB patents were challenged at the PTAB only, a significantly higher percentage (3.1%) of non-OB patents were challenged at the PTAB only.[94]

Table 2: Litigation Venue for OB Patents

	DCT		
PTAB	**0**	**1**	**Total**
0	0	1,720	1,720
1	17	252	269
Total	17	1,972	1,989

Table 3: Litigation Venue for Non-OB Patents

	DCT		
PTAB	**0**	**1**	**Total**
0	0	22,241	22,241
1	890	5,561	6,451
Total	890	27,802	28,692

Relative to PTAB challenges against non-OB patents, the structure of Hatch-Waxman makes PTAB challenges to OB patents substantially less attractive. In particular, Hatch-Waxman's 30-month automatic stay of FDA approval cannot be lifted until after the PTAB challenger succeeds on appeal and secures an entry of judgment from the district court.[95] Moreover, only those challengers that file a Paragraph IV certification, making themselves available for district court suit, can secure a 180-day marketing exclusivity.[96]

Table 4 analyzes litigation at either the PTAB or the district court by scientific category of patent. Active-ingredient patents represent a small percentage (11.5%) of all OB patents. Moreover, even within this small

92. A simple comparison of proportions yields a p-value of less than 0.00001.
93. *See infra* Table 3.
94. A simple comparison of proportions yields a p-value of less than 0.00001.
95. 21 U.S.C. § 355(j)(5)(B)(iii)(1).
96. *Id.* § 355(j)(5)(B)(iv).

percentage, they are significantly underrepresented (relative to secondary patents) in the population of litigated patents.[97]

Table 4: Number of Patents Litigated by Scientific Category

Classification	PTAB or DCT Not Litigated	Litigated	Total
product	383 [14.09]	159 [8.00]	542 [11.51]
method-of-use	794 [29.20]	756 [38.03]	1,550 [32.93]
other	1,542 [56.71]	1,073 [53.97]	2,615 [55.56]
	2,719 [100.00]	1,988 [100.00]	4,707 [100.00]

Our initial-challenge data analysis thus indicates that, even after the advent of the PTAB, active-ingredient patents are perceived as less vulnerable to challenge than other types of patents.[98] When combined with analyses by other commentators showing favorable litigation outcomes for active-ingredient patents,[99] this result regarding ex ante litigation risk underscores the resiliency of these patents.

A perhaps puzzling result is the apparently high-likelihood of challenge to method-of-use patents. Method-of-use patents that claim additional molecule use have traditionally been susceptible to so-called skinny labeling by the generic drug maker. Under this approach, which is allowed under Hatch-Waxman, the generic drug maker doesn't put the subsequent use "on label" and can enter the market through a noninfringing path.[100]

97. A χ^2 analysis yields a p-value of less than 0.00001.

98. Indeed, some commentators have argued that firms are unlikely to pursue later stage research and development on molecules that cannot be the subject of strong active-ingredient patents. *See* Benjamin N. Roin, *Unpatentable Drugs and the Standards of Patentability*, 87 TEX. L. REV. 503, 545–48 (2009). If that is the case, these empirical results should come as no surprise.

99. *See, e.g.*, C. Scott Hemphill & Bhaven Sampat, *Drug Patents at the Supreme Court*, 339 SCI. 1386, 1387 (2013); *see also* Prugo et al., *supra* note 54, at 2 (finding that active-ingredient patents have the lowest PTAB institution-rate).

100. *See supra* Section III.A.

That said, skinny labeling may be seen as a risky strategy that opens up the possibility of an induced infringement charge if the drug is prescribed off-label for the patented use. Method-of-use patent challenges may increase even further, on the theory that the generic is inducing physicians to prescribe for the off-label use. The Federal Circuit makes users of skinny labeling more vulnerable to charges of induced infringement.[101]

Table 5 shows the distribution of litigation between the PTAB and the district court by type of patent. The percentage of product patents litigated at the PTAB is slightly higher than in the district court (10.78% vs. 7.97%). Meanwhile the percentage of "other" patents litigated at the PTAB is slightly lower than in the district court (49.81% vs. 53.93%). However, perhaps because of the low numbers of OB patents litigated at the PTAB generally, these small differences are not statistically significant.[102]

Table 5: Venue of Litigated Patents by Scientific Category

Classification	**PTAB**	**DCT**
product	29 [10.78]	157 [7.97]
method-of-use	106 [39.41]	751 [38.10]
other	134 [49.81]	1,063 [53.93]
Total	269 [100.00]	1,971 [100.00]

Table 6 shows how these issues play out when we classify patents according to whether or not they represent a continuation. Continuations are significantly more likely to be litigated than patents than non-continuations.[103] Even though continuations do not prolong patent life, they may be vulnerable to litigation challenges for reasons of scope.

101. *See* GlaxoSmithKline LLC v. Teva Pharms. USA, Inc., 7 F.4th 1320, 1334 (Fed. Cir. 2021) (rehearing) (holding that, based on the entire trial record, there was substantial evidence to support the jury's finding that Teva induced infringement throughout the term of the patent-at-issue, including during its "skinny label" period).

102. A χ^2 goodness-of-fit analysis indicates that the distribution of PTAB challenges is not significantly different from the distribution of district court challenges (p-value of 0.14).

103. A χ^2 analysis yields a p-value of less than 0.00001.

Table 6: Comparison Between Non-Continuation and Continuation Patents

	PTAB or DCT		
Continuation Type	**Not Litigated**	**Litigated**	**Total**
	1,199	740	1,939
Non-continuations	[44.10]	[37.22]	[41.19]
Continuation or CIP	1,520	1,248	2,768
	[55.90]	[62.78]	[58.81]
Total	2,719	1,988	4,707

Table 7 shows the distribution between PTAB and district court litigation by whether the patent is a continuation. The raw numbers indicate that district court challenges appear to have a slightly greater focus on continuations than do PTAB challenges. However, this small difference is not statistically significant.[104]

Table 7: Venue of Patent by Non-Continuation or Continuation Patent

Continuation Type	**PTAB**	**DCT**
Non-continuations	112 [41.6%]	732 [37.1%]
Continuation or CIP	157 [58.4%]	1239 [62.9%]
Total	269 [100.00]	1,971 [100.00]

Table 8 shows that litigation propensity differs by the scientific category of continuation patent. Not only are continuation product patents relatively smaller in number than non-continuation product patents, but they are also no more likely to be litigated than non-continuations.[105] This perhaps counterintuitive result may arise because continuations of product patents can have claims to a specific species, while the parent claimed a group of related chemicals in genus form. In that case, the species patent is narrower, and arguably stronger, than the genus claim. Meanwhile, not only are method-of-use continuations more numerous than non-continuations (a 2:1 ratio), but

104. A χ^2 goodness-of-fit analysis yields a p-value of 0.13004.
105. A χ^2 test yields a p-value of 0.678.

they are somewhat more likely to be litigated than non-continuations in that category.[106] As for continuations in the "other" category, they are significantly more likely to be litigated than non-continuations.[107]

Table 8: PTAB or DCT

Continuation Type	Not Litigated	Litigated	Total
Panel A: Product Patents			
Non-continuations	219 [57.18]	94 [59.12]	313 [57.75]
Continuation or CIP	164 [42.82]	65 [40.88]	229 [42.25]
Total	383	159	542
Panel B: Method-of-Use Patents			
Non-continuations	278 [35.01]	234 [30.95]	512 [33.03]
Continuation or CIP	516 [64.99]	522 [69.05]	1,038 [66.97]
Total	794	756	1,550
Panel C: Other types of Patents			
Non-continuations	702 [45.53]	412 [38.40]	1,114 [42.60]
Continuation or CIP	840 [54.47]	661 [61.60]	1,501 [57.40]
Total	1,542	1,073	2,615

The basic statistical analysis thus indicates that there are large differences in overall litigation propensity between OB non-OB patents, and also with respect to category of OB patent. However, the extent to which there is any difference in characteristics of patents litigated at the PTAB relative to the district court is much less clear.

To examine the latter issue further, we conducted an analysis regressing litigation at the PTAB or in district court with the patent's scientific category

106. A χ^2 test yields a p-value of 0.089.
107. A χ^2 test yields a p-value of less than 0.0003.

and continuation status. Additionally, our regression framework investigated the role that small-entity status plays in litigation.[108] This investigation is important because some commentors (including one of the Article's authors) have expressed concern that patents owned by small entities may be disproportionately subject to PTAB challenges.[109]

Table 9 shows the results of a linear regression that examines correlations between small size (relative to large size), scientific category (relative to the product category), and continuation status (relative to non-continuations). The results in columns 3 and 6, which control for both the patent examiner's art unit and the patent's issue year, are of particular interest. Controls for art unit and issue year are useful because studies show that both variables can affect the quality of the granted patent.[110]

The regression takes the form:

$$Yi=\alpha Smalli+\beta methodi+\gamma otheri+\delta CiP\_Conti+Exam\_Art\_Uniti+Issue\_Yeari+\varepsilon i$$

In columns 1–3, Y_i corresponds to the number of district court cases in which the patent was involved since September 16, 2011. In columns 4–6, Y_i corresponds to the number of PTAB challenges in which the patent was involved.[111]

108. The USPTO defines small entities as including the following: independent inventors; firms with fewer than 500 employees; and nonprofit institutions. 37 C.F.R. § 1.27 (2020).

109. *See, e.g.*, Saurabh Vishnubhakat, *The Mixed Case for a PTAB Off-Ramp*, 18 CHI.-KENT J. INTELL. PROP. L. 514, 517−18 (2019).

110. *See, e.g.*, Michael Frakes & Melissa Wasserman, *Do Patent Lawsuits Target Invalid Patents*, *in* SELECTION AND DECISION IN THE JUDICIAL PROCESS AROUND THE WORLD 6, 14–15 (Yun-chien Chang ed., 2019).

111. Using the number of times in which the patent was asserted (district court) or challenged (PTAB) as the dependent variable allows us to account for concerns that the PTAB might be used to harass patent owners through repetitive challenges. However, a logistic regression that uses a dichotomous dependent variable (litigation/no litigation) yields qualitatively similar results.

Table 9: Results of Regression

	(1) DCT	(2) DCT	(3) DCT	(4) PTAB	(5) PTAB	(6) PTAB
Small	-1.589***	-1.512***	-1.574***	-0.102***	-0.103***	-0.102***
	(0.107)	(0.110)	(0.123)	(0.012)	(0.012)	(0.0151)
Method-of-use	1.096***	1.123***	0.924***	0.0576*	0.0512	-0.0301
	(0.212)	(0.213)	(0.242)	(0.028)	(0.028)	(0.028)
Other	0.279	0.310	0.625**	-0.0052	-0.0130	-0.0596*
	(0.186)	(0.187)	(0.234)	(0.024)	(0.024)	(0.027)
Continuation or CIP	0.274*	0.237	0.283*	-0.0002	-0.0071	-0.0071
	(0.124)	(0.126)	(0.133)	(0.016)	(0.016)	(0.016)
Observations	4707	4707	4707	4707	4707	4707
Adjusted R^2	0.021	0.049	0.076	0.005	0.011	0.059
Examiner Art Unit	No	No	Yes	No	No	Yes
Issue Year	No	Yes	Yes	No	Yes	Yes

Robust standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The negative, and significant, coefficients in columns 3 and 6 indicate that patents issued to small entities are less likely to be litigated, both at the PTAB and in district court. Column 3 also shows that, relative to product patents, method-of-use and "other" patents are more likely to be litigated in district court. In contrast, at the PTAB, we see slightly lower rates of litigation relative to product patents, although the magnitude of the coefficients is small and the significance is weaker. Continuations are more likely than non-continuations to be litigated in district court. In contrast, there is no significant difference at the PTAB.[112]

In general, the weak statistical impact of patent characteristics, such as scientific category, on PTAB litigation may reflect the small number of challenges at the PTAB. But to the extent that Congress chooses to fortify the PTAB option for OB patents, the distribution of patent categories challenged

112. Note that we are using our regression model not to predict outcomes but instead to understand correlations. Because our main interest is in the sign and significance of the estimated coefficients, we view our results as useful despite the low adjusted R^2 values.

at the PTAB relative to the district court will be an important metric to monitor.

V. DISCUSSION AND CONCLUSION

This Article uses a novel dataset to provide a comprehensive quantitative analysis of an understudied question: parties' decisions to litigate OB patents relative to non-OB patents in district courts and the PTAB and to litigate different types of OB patents in these different fora.

The percentage of patents litigated solely at the PTAB is significantly lower for OB patents than for non-OB patents. Moreover, the rate of PTAB challenge for OB patents challenged in district court is significantly lower than for non-OB patents challenged in district court.

Breaking down by type of OB patent, active-ingredient patents are significantly less likely to be litigated, whether at the PTAB or in district court, than secondary patents. Additionally, whether at the PTAB or in district court, continuation patents on non-active ingredients are significantly more likely to be litigated than are non-continuations or continuations on active-ingredient patents.

The regression framework, which examines correlations between litigation frequency and scientific category, continuation status, and small-entity status, yields results that are generally consistent with the more basic statistical tests. For instance, the regression shows that method-of-use patents, secondary "other" patents, continuation patents are more likely than product patents to be challenged in district court. Notably, however, this difference does not emerge at the PTAB. Although weak statistical impact may reflect the small number of PTAB challenges, the regression does suggest a potential difference in PTAB functioning vis a vis the district courts that will be important to watch, particularly if Congress fortifies the PTAB pathway.

This Article's analysis also indicates that policymakers' concern about small entities may be misplaced: at both the PTAB and in district courts, small-entity status is correlated with a reduced likelihood of challenge. Interestingly, this result emerges even though the basic descriptive data show that small firms filed proportionally fewer product patents than large firms.[113]

Overall, the empirical findings show that the PTAB's role in adjudicating OB patents has been modest, both as an absolute matter and relative to its role for non-OB patents. That said, while district court litigation differentially targets patents that are generally considered low quality, PTAB litigation may

113. Unreported results, on file with authors.

not do so with the same force, at least based on the small amount of PTAB litigation that has occurred thus far.

In contrast with Hatch-Waxman, the BPCIA does not provide incentives to remain in district court only. Data from biologics litigation therefore provide some insight into what the PTAB's use might look like absent those incentives. According to the USPTO, during the period between September 16, 2012, and November 30, 2018, only 47% (46/98) of biologics patents challenged at the PTAB had any ongoing patent litigation.[114] This number contrasts starkly with the >90% figure for OB patents.[115] Biologics-patent owners are relatively, and notably, more likely to avail themselves of AIA proceedings irrespective of whether the patent is being challenged in district court.

The contrasting experience with biologics patents is important not only on its own terms (biologics play almost as large a role in U.S. biopharmaceutical spending as small molecules) but also because it suggests paths for restructuring small molecule patent litigation. Specifically, to expand the role of the PTAB with respect to OB patents, and perhaps particularly for secondary OB patents, Congress might reconsider multiple features unique to Hatch-Waxman. These include, for example, the 30-month stay of FDA approval granted to OB patent owners who sue in district court. The lifting of a Hatch-Waxman stay rests on a district court's entry of judgment in favor of the defendant,[116] and a district court is required to enter judgment only if the Federal Circuit affirms a PTAB invalidation.[117] Therefore, the PTAB route is unlikely to be faster than the district court route, and may even be slower.

At a minimum, Congress could amend Hatch-Waxman to allow the 30-month stay to be lifted by a PTAB decision invalidating all relevant patent claims. Even this modest change would let challengers more effectively use the PTAB's expertise, improving the status quo. Policymakers could also consider changing the mechanism by which the Hatch-Waxman awards its 180-day marketing exclusivity. This marketing exclusivity currently provides little incentive to use the PTAB. Under the Hatch-Waxman framework, the exclusivity is awarded only to entities that file a Paragraph IV certification and are thereby deemed to have committed an artificial act of infringement sufficient to create Article III standing for a branded firm's infringement suit.

114. Ankenbrand & Repko, *supra* note 19, at 22.

115. *Id.* at 11.

116. 35 U.S.C. § 355(j)(5)(B)(iii)(I).

117. *See* Fresenius USA, Inc. v. Baxter Int'l, Inc., 721 F.3d 1330 (Fed. Cir. 2013).

Symmetry between the PTAB and district courts with respect to incentive would more fully realize the AIA's substitution goals.[118]

Finally, incentivizing greater use of the PTAB might be coupled with additional ex ante efforts to improve OB patent validity. More specifically, the data indicate that OB patents come from a relatively small number of art units. For example, Art Units 1611–19 (collectively, Group 1610) all examine applications on the same subject matter: "Organic Compounds: Bio-affecting, Body Treating, Drug Delivery, Steroids, Herbicides, Pesticides, Cosmetics, and Drugs."[119] Meanwhile, Art Units 1621–29 (collectively, Group 1620) all examine applications related to "Organic Chemistry."[120] Groups 1610 and 1620 combined account for 78.0% of the OB patents in our dataset. Five other art unit groups examine 1–5% of the OB patents apiece, bringing the total up to 93.9%. Table 10 summarizes these tabulations.

Table 10: Art Unit Groups of Orange Book Patents

Group	OB Patents	Share
1620	1,846	39.2%
1610	1,824	38.8%
3760	200	4.2%
1650	196	4.2%
1670	164	3.5%
1640	104	2.2%
3770	85	1.8%
Other	288	6.1%
Total	**4,707**	**100.0%**

93.9%

118. More generally, the 180-day exclusivity period likely needs reform. As currently structured, the period provides little incentive for any type of *successful* challenge. To the contrary, if the first Paragraph IV filer settles a patent infringement lawsuit, then a successful challenger must wait 180 days after it has invalidated the patent before it can enter. Some follow-on generic challengers may be using the PTAB precisely for purposes of invalidating patents on which the first Paragraph IV-filer has settled (and thereby achieving generic entry, perhaps even earlier than the settling challenger). *See* Prugo et al., *supra* note 54, at 4. We explore that issue further in a companion paper on which we are currently working. *See* Hovenkamp et al., *supra* note 20.

119. *TC 1600 Management Roster*, U.S. PAT. & TRADEMARK OFF., https://www.uspto.gov/patents/contact-patents/tc-1600-management-roster (last visited Nov. 17, 2021). The individual art units within these groups are distinct from each other as an administrative matter—e.g., each is led by its own supervisory patent examiner—but all art units within the same group focus on the same subject matter of inventions.

120. *Id.*

The data are therefore consistent with recent suggestions in the literature[121] that it may be cost-effective to target additional examination resources at patents that have a substantial likelihood of being placed on the OB. As the data show, these patents can be identified ex ante. Such resources should include lessons learned from PTAB review of OB patents. Although PTAB review is less frequent than is likely optimal, the USPTO should reuse lessons learned from its own highly expert ex post review, IPRs, in its patent examinations.

121. *See, e.g.*, Dmitry Karshtedt, *Pharmaceutical Patents and Adversarial Examination*, 91 Geo. Wash. L. Rev. (forthcoming 2023); S. Sean Tu & Mark A. Lemley, *What Litigators Can Teach the Patent Office About Pharmaceutical Patents* 43–44 (W. Va. Univ. Sch. L., Working Paper No. 2021-015, 2021); Michael D. Frakes & Melissa F. Wasserman, *Investing in Ex Ante Regulation: Evidence from Pharmaceutical Patent Examination* (Nat'l Bureau Econ. Rsch., Working Paper No. 27579, 2020).

CONTRACTUAL BUNDLES FOR INNOVATION

Taorui Guan†

ABSTRACT

The question of how contracts promote innovation has long attracted scholars' attention. This Article tackles this question by studying one contractual mechanism — bundling arrangements — that innovators frequently use to transfer other assets along with a patent license. It examines 400 patent licensing transactions that public companies filed with the Securities and Exchange Commission, and finds that 42.25% of them included bundling arrangements. In general, these arrangements enhance innovation, as the assets in the bundle can help the licensee deploy the licensed technology. It also finds that ex ante patent licensing transactions involved bundled asset transfers more frequently than ex post transactions did.

The findings have two important implications for law and policy. First, the efficiency-enhancing effect of these arrangements should serve as a justification for their use in the innovation marketplace. However, both the law of patent misuse and antitrust case law might find bundling arrangements illegal before their efficiency-enhancing effect have been fully assessed. This Article suggests that lawmakers incorporate an analysis of this effect into these laws, reducing patentees' concern about legal liabilities when they enter bundling arrangements that promote innovation. Second, for certain technology users, only ex ante patent licensing transactions can lead to efficient outcomes. The high transaction costs of detecting licensing opportunities can impede ex ante transactions. This Article suggests policymakers lower these costs by making relevant patent documents easier to locate and read, and link them to a platform that allows patentees to present information about the complementary assets that they are willing to transfer.

This Article then provides a detailed empirical account of the contractual bundles in patent licensing transactions. It also demonstrates how contracts can promote innovation by overcoming the limitations of the patent system.

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I. INTRODUCTION

For over a generation, scholars have studied the question of how law promotes innovation.[1] They have explored the ways that different areas of law

1. Matthew Jennejohn, *The Private Order of Innovation Networks*, 68 STAN. L. REV. 281, 284 (2016).

– including intellectual property law,[2] tax law,[3] antitrust law,[4] labor law,[5] insurance law,[6] and tort law[7] – foster it. Scholars have also examined how various areas of law and policy work together to provide innovation incentives to producers of knowledge goods and how they allocate the access to these goods among consumers.[8]

Contracts' role in promoting innovation has long attracted scholarly attention. The existing scholarship has revealed three important interrelated functions through which contracts do this. First, contracts facilitate collaborative innovation. By entering alliance contracts, technology firms "partially integrate [their] development capabilities" to pursue innovation

2. *See, e.g.*, Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265 (1977); Robert P. Merges, *One Hundred Years of Solicitude: Intellectual Property Law, 1900-2000*, 88 CALIF. L. REV. 2187, 2190 (2000) (stating that "intellectual property law has generally adapted quite well to each successive wave of technological innovation").

3. *See, e.g.*, David Hasen, *Taxation and Innovation—A Sectorial Approach*, 2017 U. ILL. L. REV. 1043, 1044 (2017) ("The taxation of innovation generally, and of intellectual property specifically, has received a great deal of scholarly attention over the last twenty years."); Michael J. Graetz & Rachael Doud, *Technological Innovation, International Competition, and the Challenges of International Income Taxation*, 113 COLUM. L. REV. 347, 434 (2013) (noting that tax rules can provide "incentives both [domestic] and abroad for R&D expenditures, innovation, and manufacturing").

4. *See, e.g.*, Jonathan B. Baker, *Beyond Schumpeter vs. Arrows: How Antitrust Fosters Innovation*, 74 ANTITRUST L.J. 575, 576 (2007) (noting that antitrust law "can systematically promote innovation competition and pre-innovation product market competition, which will encourage innovation"). *But see* Daniel F. Spulber, *Unlocking Technology: Antitrust and Innovation*, 4 J. COMP. L. & ECON. 915, 966 (2008) (identifying certain antitrust policies that damage innovation incentives).

5. *See, e.g.*, Viral V. Acharya, Ramin P. Baghai & Krishnamurthy V. Subramanian, *Labor Laws and Innovation*, 56 J.L. & ECON. 997, 998 (2013) (examining how labor laws can enhance an employee's innovative efforts and increase investment in innovation); Rachel Griffith & Gareth Macartney, *Employment Protection Legislation, Multinational Firms, and Innovation*, 96 REV. ECON. & STAT. 135, 135 (2014) (stating that the "optimal level of investment in incremental innovation increases with [employment protection legislation]").

6. *See, e.g.*, Rachel E. Sachs, *Prizing Insurance: Prescription Drug Insurance as Innovation Incentive*, 30 HARV. J. L. & TECH. 153, 208 (2016) (demonstrating that "prescription drug insurance can operate much like a prize in promoting incentives to innovate in many of the lacunae left behind by the structure of our existing patent law and FDA exclusivity systems").

7. *See, e.g.*, Benjamin H. Barton, *Tort Reform, Innovation, and Playground Design*, 58 FLA. L. REV. 265, 270-71 (2006) (claiming that tort liability can inspire manufacturers to take innovative efforts to produce safer and better products). *But see* Gideon Parchomovsky & Alex Stein, *Torts and Innovation*, 107 MICH. L. REV. 285, 285 (2008) (pointing out that tort liability for negligence, defective products, and medical malpractice can chill innovation and proposing two ways to reform tort law in order to facilitate it).

8. *See* Daniel J. Hemel & Lisa Larrimore Ouellette, *Innovation Policy Pluralism*, 128 YALE L. J. 544, 549-50 (2019) (discussing how to combine IP and non-IP mechanisms, including prizes, grants and tax preferences, in incentivizing the creation and distribution of knowledge products).

jointly.[9] They establish contractual mechanisms that govern their collaboration and mitigate the potential hazards of collaboration.[10] Second, contracts create collective right organizations, such as patent pools, that help economize the transaction costs of high-volume licensing of rights to technology.[11] Third and most fundamental, contracts realize the transfer of resources from the owners to the users who need those resources for innovation. Patent licensing is one typical example of this kind of contract. Patentees who are not "ideally situated to develop an invention" might license their patent to other firms.[12]

Conventional wisdom holds that a patent license agreement is merely an exchange of a monetary payment with "a promise by the licensor not to sue

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9. Jennejohn, *supra* note 1, at 284-85; *see also* Ronald J. Gilson, Charles F. Sabel & Robert E. Scott, *Braiding: The Interaction of Formal and Informal Contracting in Theory, Practice, and Doctrine*, 110 COLUM. L. REV. 1377, 1382-83 (2010) (noting that technology firms use contracts to realize "collaborative innovation").

10. *See* Ronald J. Gilson, Charles F. Sabel & Robert E. Scott, *Contracting for Innovation: Vertical Disintegration and Interfirm Collaboration*, 109 COLUM. L. REV. 431, 437 (2009) ("Collaborative innovation is not just a shift from hierarchy—the organization of transactions within firms—to contract. Rather, the unavoidable mutual vulnerabilities among collaborators motivate corresponding innovations in contractual governance to support the new transactional structure."); Jennejohn, *supra* note 1, at 292-93 (finding that the firms designed a "management committee" through alliance contracts to address multiple hazards that might arise when they collaborate); D. Gordon Smith, *The Exit Structure of Strategic Alliances*, 2005 U. ILL. L. REV. 303, 303-05 (2005) (finding that the "management committee" that many alliance contracts create can mitigate opportunistic behaviors that might arise when firms collaborate).

11. *See* Robert P. Merges, *Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations*, 84 CALIF L. REV. 1293, 1295-97 (1996); Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting*, 1 INNOVATION POL'Y & ECON. 119, 144 (2000); Jonathan M. Barnett, *The 'License As Tax' Fallacy* 14 (USC Law Legal Studies Paper No. 19-35), https://ssrn.com/abstract=3503148 (noting that parties in the innovation marketplace "typically engineer transactional structures . . . while mitigating the IP-specific transaction costs").

12. *See* Peter Lee, *Transcending the Tacit Dimension: Patents, Relationships, and Organizational Integration in Technology Transfer*, 100 CALIF. L. REV. 1503, 1515 (2012); *see also* Kitch, *supra* note 2, at 278 (noting that licensing could be "the most efficient and hence patent-value-optimizing way to exploit the invention"); ASHISH ARORA, ANDREA FOSFURI & ALFONSO GAMBARDELLA, MARKETS FOR TECHNOLOGY: THE ECONOMICS OF INNOVATION AND CORPORATE STRATEGY 96 (2002) ("The producer of the knowledge may not have the necessary downstream assets to exploit it commercially. The producer may therefore find it profitable to license the technology or enter into cooperative agreements with other firms."); *id.* at 175 (noting that a large successful company might prefer to license its technology to others when "the technology has application in markets in which the innovator does not typically operate"); Colleen V. Chien, *Software Patents as a Currency, Not Tax, on Innovation*, 31 BERKELEY TECH. L.J. 1669, 1675 (2016) ("A startup company's ability to license or sell, rather than develop their technology, reduces its market risks and enhances innovation through its transfer of technology.").

the licensee."[13] In actual licensing transactions, however, the agreement can be more complicated. Licensees might not only contract for a right to the patented technology but also for other assets, such as know-how, that facilitate the implementation of the technology.[14] In other words, patent licensing transactions in the innovation marketplace might exchange a bundle of assets for monetary payment and/or other considerations.[15]

For example, in 2003, Applied Micro Circuits Corporation (AMCC), a supplier of integrated circuit products, obtained technology related to switch fabric devices from International Business Machines Corporation (IBM) to complement its existing portfolio.[16] AMCC supplied these devices to big telecommunication firms such as Alcatel, Fujitsu, Huawei, Lucent, Mitsubishi, Motorola, and Siemens, who used them to "switch the information in the proper priority and to the proper destinations."[17] In its transaction with IBM, AMCC not only obtained a patent license to IBM's technology, but also purchased a relevant product line, consisting of know-how, computer codes, copyright, and other assets.[18] The asset bundle cost AMCC approximately $50 million in total.[19] AMCC believed that its practice of acquiring bundled assets allowed it to "reduce the time required to develop and bring to market new technologies and products."[20]

Empirical evidence suggests that bundled asset transfers occur relatively frequently in patent licensing transactions. According to Colleen Chien, most

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13. Spindelfabrik Suessen-Schurr, Stahlecker & Grill GmbH v. Schubert & Salzer Maschinenfabrik Aktiengesellschaft, 829 F.2d 1075, 1081 (Fed. Cir. 1987); *cf.* Robin Feldman, *Patent Demands & Startup Companies: The View from the Venture Capital Community*, 16 YALE J.L. & TECH. 236, 247 (2014) ("A license, after all, is merely an agreement not to sue in return for a monetary payment, and the threat of a lawsuit is what drives companies to pay the licensing fee.").

14. Mark A. Lemley & Robin Feldman, *Patent Licensing, Technology Transfer, and Innovation*, 106 AM. ECON. REV. 188, 188 (2016) [hereinafter Lemley & Feldman, *Patent Licensing*].

15. *See* U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, ANTITRUST ENFORCEMENT AND INTELLECTUAL PROPERTY RIGHTS: PROMOTING INNOVATION AND COMPETITION 114 (2007) (noting that bundling arrangements in patent licensing transactions are "ubiquitous").

16. Applied Micro Circuits Corp., Annual Report (Form 10-K) 7 (Jun. 10, 2004), https://www.sec.gov/Archives/edgar/data/711065/000119312504101745/d10k.htm.

17. *Id.*

18. Applied Micro Circuits Corp., *supra* note 16, at 5; Applied Micro Circuits Corp. & Int'l Bus. Mach. Corp., License Agreement, 2003 WL 27353724; Applied Micro Circuits Corp., Asset Purchase Agreement (Form 10-Q, Exhibit-10.41) (Nov. 14, 2003), https://www.sec.gov/Archives/edgar/data/711065/000119312503081530/dex1041.htm; Applied Micro Circuits Corp., Intellectual Property Agreement (Form 10-Q, Exhibit-10.43) (Nov. 14, 2003), https://www.sec.gov/Archives/edgar/data/711065/000119312503081530/dex1043.htm.

19. Applied Micro Circuits Corp., *supra* note 16, at 5.

20. *Id.*

software patent licensing contracts bundle a patent license with know-how, trade secrets or code.[21] The 2008 Berkeley Patent Survey showed that the majority of startups in the biotechnology and software industries expected to gain technical knowledge from the patentee when they took a patent license.[22] Deepak Hegde found 41% of patent licenses in the pharmaceutical, biotechnology, and medical instrument and device industries were bundled with proprietary information; 18.6%, also included technical services.[23] In addition to know-how and services, Ashish Arora also found that firms acquire equipment along with patent licenses.[24] The frequent occurrence of bundling arrangements suggests that this contractual mechanism plays an important role in technology transfers.

Scholars have a favorable view of bundled asset transfers in patent licensing transactions. They are inclined to believe that these are efficiency-enhancing arrangements because bundling facilitates the implementation of technology. As Mark Lemley and Robin Feldman state, "in order to transfer ideas in a way that leads to commercialization, reading a patent alone is not enough. In general, one must also transfer things like know-how, complementary assets, and other peripheral disclosures."[25] According to Michael Risch, the transfer of sufficient know-how along with the patent allows the licensees to "maximize [the patented technology's] potential."[26] In David Teece's view, commercializing knowledge assets "frequently involves identifying and combining the relevant complementary assets"[27] because they can turn knowledge assets "into products or services to yield value."[28]

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21. Chien, *supra* note 12, at 1679.

22. Stuart J. H. Graham, Robert P. Merges, Pam Samuelson & Ted Sichelman, *High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey*, 24 BERKELEY TECH. L.J. 1255, 1317-18 (2009).

23. Deepak Hegde, *Tacit Knowledge And The Structure of License Contracts: Evidence from The Biomedical Industry*, 23 J. ECON. & MGMT. STRATEGY 568, 578-79 (2014).

24. Ashish Arora, *Contracting for Tacit Knowledge: The Provision of Technical Services in Technology Licensing Contracts*, 50 J. DEV. ECON. 233, 247 (1996) [hereinafter Arora, *Contracting for Tacit Knowledge*].

25. Lemley & Feldman, *Patent Licensing*, *supra* note 14, at 188.

26. Michael Risch, *Licensing Acquired Patents*, 21 GEO. MASON L. REV. 979, 983 (2014); *see also* MARK S. HOLMES, PATENT LICENSING AND SELLING: STRATEGY, NEGOTIATION, FORMS § 1:5.8 (2d ed. 2013) ("While the enablement and best mode requirements of the patent statute obligate the inventor to adequately teach how to make and use the invention, the complexity of the licensed technology may require further information from the licensor in order to optimally exploit the licensed rights.").

27. DAVID J. TEECE, MANAGING INTELLECTUAL CAPITAL: ORGANIZATIONAL, STRATEGIC, AND POLICY DIMENSIONS 8 (2000).

28. *Id.* at 25.

Nevertheless, Congress and the courts regard these bundling arrangements skeptically,[29] concerned that bundling a patent license with other assets might have "anticompetitive consequences" on the markets for these assets.[30] In their view, bundling a patent license with unpatented assets used in conjunction with the technology might be an attempt to expand the "patent monopoly" that the Patent Act authorizes.[31] If a court deems a bundling arrangement illegal under the law of patent misuse[32] or antitrust law,[33] it can hold the patent at issue unenforceable under the law of patent misuse,[34] or impose federal antitrust liabilities on the patentee, including fines and imprisonment.[35] Lawyers in the innovation marketplace raise the concern that these laws are "potentially applicable to an enormous range" of bundling arrangements, including those that result from "harmless commercial decisions."[36]

These divergent views reflect the fact that the nature of bundling arrangements in patent licensing transactions is not yet well understood. Given the frequent occurrence of bundling arrangements in patent licensing transactions, it is worth knowing why these bundles exist, what they consist of, and whether they are, by their nature, efficiency-enhancing or anticompetitive. Although previous studies offer valuable empirical evidence indicating that licensing parties bundle patent licenses with other assets, they do not address these basic questions. They focus instead on whether parties transfer knowledge along with patent licenses,[37] and on the means by which

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29. Barnett, *supra* note 11, at 3.

30. *See* Ill. Tool Works Inc. v. Indep. Ink, Inc., 547 U.S. 28, 37 (2006); *see also* Morton Salt Co. v. G. S. Suppiger Co., 314 U.S. 488, 491 (1942) (holding a bundling arrangement of patent license and unpatented supplies illegal because it allows the patentee to use "its patent monopoly to restrain competition in the marketing of unpatented articles").

31. *See* Motion Pictures Patents Co. v. Universal Film Mfg. Co., 243 U.S. 502, 517 (1917) (regarding the bundling arrangement of a patented projector and unpatented films as an attempt to extend the patentee's power "wholly without the scope of the patent monopoly"); Carbice Corp. of Am. v. Am. Patents Dev. Corp., 283 U.S. 27, 33 (1931) (regarding that bundling patented technology with unpatented materials is "beyond the scope of the patentee's monopoly"); *see also* Herbert Hovenkamp, *The Intellectual Property-Antitrust Interface*, in 3 ISSUES IN COMPETITION LAW AND POLICY 1979, 1987 (2008).

32. 35 U.S.C. § 271 (d) (2012); *Morton Salt*, 314 U.S. at 491.

33. 15 U.S.C. § 1 (2012); *Ill. Tool Works*, 547 U.S. at 37.

34. 35 U.S.C. § 271 (d) (2012).

35. 15 U.S.C. § 1 (2012).

36. *See* U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, *supra* note 15, at 111-12 (internal quotation marks omitted).

37. *See* Chien, *supra* note 12, at 1679; Graham et al., *supra* note 22, at 1316; Robin C. Feldman & Mark A. Lemley, *Do Patent Licensing Demands Mean Innovation*, 101 IOWA L. REV. 137, 155 (2015) [hereinafter Feldman & Lemley, *Patent Licensing Demands*]; Robin C. Feldman

independent parties transfer knowledge through contracts.[38] Even when these studies find a transfer of non-informational assets, such as equipment, along with a patent license, they treat it as a means of knowledge transfer.[39] A study that reveals the nature of the bundling arrangements is absent in the existing scholarship.

This Article takes the first step toward revealing the nature of these bundling arrangements with regard to innovation and competition. In Part II, this Article explains why bundled asset transfers exist in patent licensing transactions by associating the bundle of assets with the disclosure function of the patent system. One important function of the patent system is disclosing technology to the public to facilitate innovation. Yet the information a patent discloses might not be detailed enough to allow potential users to grasp the relevant technology. And when they do disclose detailed information, users might still not be able to implement the patent due to the lack of other assets, such as facilities. To move beyond this impasse, the technology users acquire the assets — informational or non-informational — that they need for innovation from patentees, along with a patent license. This makes the patent licensing transaction an exchange of a bundle of assets for considerations.

To understand what kind of assets are in the bundles and their relationship to the patented technology, Part III provides an empirical study of the contracts in 400 patent licensing transactions[40] of public companies. These

& Mark A. Lemley, *The Sound and Fury of Patent Activity*, 103 MINN. L. REV. 1793, 1837 (2019) [hereinafter Feldman & Lemley, *Sound and Fury*].

38. *See* Ashish Arora, *Licensing Tacit Knowledge: Intellectual Property Rights and The Market for Know-How*, 4 ECON. INNOVATION & NEW TECH. 41, 42 (1995) [hereinafter Arora, *Licensing Tacit Knowledge*] ("Thus simple contracts involving patents can accomplish the transfer of know-how."); Arora, *Contracting for Tacit Knowledge*, *supra* note 24, at 237 (noting that "if the licensor can tie the transfer and payment for know-how to a complementary input (whose transfer is easy to monitor) the transfer of know-how can be accomplished"); Hegde, *supra* note 23, at 569.

39. *See* Arora, *Contracting for Tacit Knowledge*, *supra* note 24, at 252-53; Hegde, *supra* note 23, at 579.

40. Each of the transactions consists of at least one contract. Parties might sign a single contract to finish patent licensing and the transfer of other assets. *See, e.g.*, Annamed, Inc. & Dermin Sp. zo.o., Patent and Technology Development and License Agreement 2-3, 2016 WL 01469341. Sometimes, they use several contracts to finish the transaction. In this situation, they might sign other agreements, such as know-how transfer agreements, consulting service agreements, and research and development agreements, along with their patent licensing agreement. *See, e.g.*, Pioneer Hi-Bred Int'l, Inc. & S&W Seed Co., Patent License Agreement §§ 1.3, 1.4 & 1.7, 2015 WL 6623061; S&W Seed Co., Know-How Transfer Agreement (Form 8-K, Exhibit 10.13) § 2 (Jan. 17, 2015), https://www.sec.gov/Archives/edgar/data/1477246/000113626115000008/swexh10-13.htm.

companies regard these contracts as "material contracts"[41] upon which their businesses substantially depend. The companies attach the contracts to their annual, quarterly, or current reports as exhibits and file them with the U.S. Securities and Exchange Commission (SEC) to inform the public. The contracts reveal what kind of assets are transferred with the patent licenses. Since public companies' business substantially depend on these contracts, they generally disclose the transactional background of the contracts in their reports in detail. This background information is important for readers to understand the content of the contracts, as sometimes the contracts do not contain the information necessary to understand the meaning of the key terms therein and the contracting parties' intent behind these terms. Part III examines the contracts and the SEC reports together.

To be clear, this dataset represents only the material contracts of public firms; in general these contracts are substantial and are reported by relatively large companies. Hence the dataset might not represent the overall population of contracts in patent licensing transactions,[42] especially contracts licensing trivial patents or contracts between small firms. Further, the dataset only contains 400 patent licensing transactions, which might be a small sample for all such transactions in the economy. Although it might be risky to draw statistical inferences based on this dataset, it still allows us to gain deeper understanding about the nature of bundling arrangements as well as the complementary relationship between patented technology and other assets and the relationship between patents and contracts.

Part III carefully examines the 400 patent licensing transactions and finds that 42.25% of them involve bundled asset transfer. Broadly, the assets in the bundles can be classified into three categories: intellectual property, property, and labor. The findings suggest that the licensees sought these assets to refine technologies, develop products, manufacture products, and facilitate the distribution of products in the marketplace. In general, the bundling arrangements in these transactions enhance efficiency because they transfer complementary assets to licensees in ways that help them more effectively implement the technology.

Part III also finds that the parties entered some of these patent licensing transactions in the context of patent litigations. We might deem these "ex post patent licensing transactions," and those that did not involve litigation, "ex

41. Under 17 C.F.R. § 229.601(b)(10) (2018), "material contracts" are the contracts that are not made in the ordinary course of business and are material to the registrant.

42. *See* Chien, *supra* note 12, at 1696 (discussing the potential bias of using the material contracts filed with the SEC to infer the general characteristics of the overall population of the patent licensing transactions).

ante patent licensing transactions." Only 5.88% of the ex post transactions involved bundled asset transfers; but of the ex ante ones, 47.56%. This finding confirms the proposition of existing literature that licensees are unlikely to obtain other assets in ex post patent licensing transactions but tend to obtain them in ex ante ones.[43] This Article claims that two factors explain the divergence of ex ante and ex post licensing transactions – the degree of the licensee's dependence on the patentee, and the extent to which the licensee has completed its innovation process.

Part IV discusses two implications that the findings have for current law and policy. The first addresses the test that courts apply to determine whether a bundling arrangement is illegal. Antitrust case law and the law of patent misuse hold bundling arrangements illegal when the patentee conditions the patent license on the purchase of other assets, and when the patentee has market power in the relevant market for the patent. This Article demonstrates that, doctrinally, the bundling arrangements in this study are unlikely to be illegal because they do not include restrictive terms and seem to be based on the licensees' efficiency concerns rather than on the patentees' coercion. Normatively, the efficiency-enhancing effect of these arrangements should serve as a justification for their use in the innovation marketplace. Currently, courts only examine contested bundling arrangements for evidence of coercion and the patentee's market power, but they do not weigh the efficiency-enhancing effect of the bundling arrangements against their potential anticompetitive effect. The lack of this third factor might make patentees reluctant to enter bundling arrangements that promote innovation because of the risk that a court might deem them illegal.[44]

This Article recommends that Congress and the Supreme Court adopt a *rule of reason* approach to these bundling arrangements, incorporating this analysis into both bodies of law. This change would mitigate the risk of using these bundling arrangements to facilitate innovation.

The second implication is about the transaction costs of finding relevant assets. Ex ante patent licensing transactions can help users obtain patentees' assets promptly when those are the most effective means by which to deploy the patented technology. If the users are unable to enter the transactions ex ante, they might suffer efficiency loss by having to rely on their own less effective assets to exploit the technology or they might have to abandon the technology altogether. The fact that ex post bundled asset transfers exist

43. *See* Feldman & Lemley, *Patent Licensing Demands*, *supra* note 37, at 139; Feldman & Lemley, *Sound and Fury*, *supra* note 37, at 1795, 1799.

44. *See* U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, *supra* note 15, at 111-12 (internal quotation marks omitted).

indicates the high transaction costs impeding ex ante transactions, leading to efficiency loss. To avoid efficiency loss, this Article suggests that policymakers reduce transaction costs by making it easier for potential users to detect both the transaction opportunities in a given technology and the associated complementary assets. Policymakers can make patent documents easier to read and locate, and link them to a platform that allows patentees to present information about the complementary assets they are willing to transfer with a patent license.

The Article concludes by pointing out that there are two complementary relationships imbedded in the innovation marketplace. In terms of *assets*, intellectual property, property, and labor are complementary to patented technology as they can help the licensee deploy that technology. In terms of *legal institutions*, contracts allow the patent system to achieve its ultimate goal — promoting innovation — by bundling complementary assets with the patent license and transferring them as a package to technology users. This facilitates the development and implementation of the technology that the patent system discloses.

II. CONTRACTUAL BUNDLES AS A COMPLEMENT TO PATENT DISCLOSURE

A. PATENT DISCLOSURE AND ITS LIMITATIONS

Section 8 of the U.S. Constitution set the primary goal of the patent system by granting Congress the power "[t]o promote the progress of science and useful arts."[45] The patent system achieves this goal by (1) providing incentives to inventors to create inventions and (2) disclosing technology to the public.[46] According to the *incentive theory*, the patent system encourages inventors to innovate by granting them exclusive rights over their inventions.[47] This exclusive right allows inventors to prevent others from appropriating their

45. U.S. CONST. art. I, § 8, cl. 8; Motion Picture Patents Co. v. Universal Film Mfg. Co., 243 U.S. 502, 511 (1917) (holding that "the primary purpose of our patent laws . . . is to promote the progress of science and useful arts" (internal quotation marks omitted)).

46. *See* Lisa Larrimore Ouellette, *Do Patents Disclose Useful Information*, 25 HARV. J. L. & TECH. 545, 554-57 (2012); Jeanne C. Fromer, *Patent Disclosure*, 94 IOWA L. REV. 539, 541 (2009) ("Patent law encourages this cumulative innovation, both by dangling the patent right before the inventor as an incentive to invent in the first instance and by requiring him to disclose his invention to the public so that science can progress by building on the divulged knowledge.").

47. *See* Ouellette, *supra* note 46, at 554-55; Benjamin N. Roin, *The Disclosure Function of the Patent System (Or Lack Thereof)*, 118 HARV. L. REV. 2007, 2007 (2005) [hereinafter *Disclosure Function*] ("The most commonly offered economic justification for the patent system is that it preserves the incentive for inventors to create, develop, and commercialize new technologies and innovations.").

invention.[48] It lets inventors choose whether to deploy an invention themselves to earn profits, or whether to license the patent rights to others in return for royalties or other considerations. The financial and/or non-financial gains that a patent brings about encourage innovators to create inventions, which drives innovation.

Under the *disclosure theory*, the patent system promotes innovation by requiring inventors to fully disclose their inventions to the public through patent documents when they apply for a patent to protect their inventions.[49] The Supreme Court regards this as a quid pro quo — the patent system grants inventors an exclusive right in exchange for the disclosure of how their technology works.[50] The disclosure "is assumed [to] stimulate ideas and the *eventual development* of further significant advances in the art."[51] In the Supreme Court's view, the technical information that the patent disclosures disseminate will foster productive effort, which in turn will have "a positive effect on society through the introduction of new products and processes of manufacture into the economy."[52]

To this end, Section 112 of the Patent Act specifies three disclosure requirements that patent applicants must satisfy – written description,

48. *See* Ouellette, *supra* note 46, at 554 ("Under innovation incentive theories, patents encourage new in- ventions by preventing appropriation by competitors …").

49. *See* Brenner v. Manson, 383 U.S. 519, 533 (1966) (holding "one of the purposes of the patent system is to encourage dissemination of information concerning discoveries and inventions"); Bonito Boats, Inc. v. Thunder Craft Boats, Inc., 489 U.S. 141, 151 (1989) (stating that "the ultimate goal of the patent system is to bring new designs and technologies into the public domain through disclosure").

50. Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 535 U.S. 722, 736 (2002) ("[E]xclusive patent rights are given in exchange for disclosing the invention to the public."); Kewanee Oil Co. v. Bicron Corp., 416 U.S. 470, 480-81 (1974) ("In return for the right of exclusion—this 'reward for inventions'—the patent laws impose upon the inventor a requirement of disclosure. To insure adequate and full disclosure so that upon the expiration of the 17-year period 'the knowledge of the invention enures to the people, who are thus enabled without restriction to practice it and profit by its use,' the patent laws require that the patent application shall include a full and clear description of the invention and 'of the manner and process of making and using it' so that any person skilled in the art may make and use the invention." (citations omitted)); Pfaff v. Wells Elecs., Inc., 525 U.S. 55, 63 (1998) ("[T]he patent system represents a carefully crafted bargain that encourages both the creation and the public disclosure of new and useful advances in technology, in return for an exclusive monopoly for a limited period of time."); J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred Int'l, Inc., 534 U.S. 124, 142 (2001) ("The disclosure required by the Patent Act is 'the quid pro quo of the right to exclude.'" (quoting *Kewanee Oil*, 416 U.S. at 484)); Jason Rantanen, *Peripheral Disclosure*, 74 U. PITT. L. REV. 1, 4 (2012) (noting that "the patent system has long been justified on the ground that it encourages the disclosure of information by requiring inventors to provide in the patent document, [sic] information about how their invention works").

51. *Kewanee Oil*, 416 U.S. at 481 (emphasis added).

52. *Id.* at 480.

enablement, and best mode. First, patent applicants must provide a written description of the invention, presenting "the manner and process of making and using it, in such full, clear, concise, and exact terms."[53] Second, the description should "enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same."[54] Third, the disclosure "shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention."[55] Ideally, the technical information that the patent document discloses will allow potential users to "gain full possession of the invention."[56] Users should be able to "use it fruitfully"[57] and "build upon [it]"[58] when the patent expires[59] or during the patent term with a license from the patentee.

Yet patent disclosure might fail to lead to the actual implementation and development of the technology due to two impediments. The first is that the patent documents disclose inadequate information.[60] This can happen because "applicants have an incentive to provide information that meets [only] the minimum thresholds of patentability."[61] Many applicants deliberately withhold the information that is necessary to make and use the invention efficiently; they keep crucial bits of technical information secret.[62] As Jason Rantanen has

53. 35 U.S.C. § 112 (2012).

54. *Id.*

55. *Id.*

56. Sean B. Seymore, *Symposium: The Disclosure Function of the Patent System: Introduction*, 69 VAND. L. REV. 1455, 1456 (2016).

57. *See* Fromer, *supra* note 46, at 541; *see also Disclosure Function*, *supra* note 47, at 2009.

58. *See Disclosure Function*, *supra* note 47, at 2010; Rantanen, *supra* note 50, at 5.

59. Aronson v. Quick Point Pencil Co., 440 U.S. 257, 262 (1979) (stating that patent law "seeks to foster and reward invention" with the hope that patent disclosure will "stimulate further innovation and . . . permit the public to practice the invention once the patent expires").

60. *See* Robert P. Merges, *A Transactional View of Property Rights*, 20 BERKELEY TECH. L.J. 1477, 1501 (2005) ("An issued patent usually does not disclose everything of value about an invention and the surrounding technology."); Lee, *supra* note 12, at 1556 ("Patents do not disclose and licenses do not convey tacit knowledge of great value to licensees.").

61. Rantanen, *supra* note 50, at 6.

62. *Id.* (noting that patent applicants "may disclose information about some aspects of their invention, but elect to maintain others as secrets"); *id.* at 13 (noting that patent applicants might "hold[] back crucial bits of technical information necessary to efficiently practice the invention"); Fromer, *supra* note 46, at 563 (noting that a patent document "does not contain some of the most pertinent technical information"); *Disclosure Function*, *supra* note 47, at 2023-24 (stating that "despite the statutory enablement requirements, many applicants deliberately fail to disclose the trade secrets and know-how necessary to recreate or use the invention efficiently"); Colleen V. Chien, *Contextualizing Patent Disclosure*, 69 VAND. L. REV. 1849, 1851 (2016) (noting that patent applicants tend to "withhold[] key information from patent applications"); Feldman & Lemley, *Sound and Fury*, *supra* note 37, at 1800 (noting that "technology often includes trade secrets and know-how beyond the to-be-patented technology

pointed out, disclosure tends to be "incomplete and opaque."[63] Further, patent disclosure often "occurs . . . early in the process of innovation, at the time a patent is filed."[64] Current patent law does not mandate follow-up disclosure. As a result, patent documents often do not include valuable information about the subsequent development of the technology.[65] As Jeanne Fromer notes, patent disclosure tends to be "early and static."[66] Due to the inadequacy of the technical information that it discloses, some scholars criticize the patent system for "not achiev[ing] its objective of stimulating innovation."[67]

Some scholars' believe that raising the disclosure requirements might remove this impediment.[68] Sean B. Seymore suggests that the Patent and Trademark Office (PTO) should require patent applicants to provide working examples of their inventions.[69] Lisa Larrimore Ouellette recommends that the PTO make patent documents subject to the peer review of scientists or require patentees to respond to questions from scientists concerning how the documents enable users to implement the invention[70] Jeanne Fromer proposes broadening the scope of disclosure to cover important information generated

itself"); *see, e.g.*, Anpath Group, Inc., Annual Report (Form 10-K) 12 (July, 15, 2014), https://www.sec.gov/Archives/edgar/data/1310527/000101041214000124/f10kdraft7clean71414.htm ("We do not believe that our business is dependent upon obtaining patents on our technology due to the existence of nondisclosure agreements and our maintenance of trade secrets. However, having patents on our technology would provide an addition level of protection in this regard.").

63. Rantanen, *supra* note 50, at 6.

64. Jeanne C. Fromer, *Dynamic Patent Disclosure*, 69 VAND. L. REV. 1715, 1715-16 (2016); *see* Chien, *supra* note 62, at 1851-52 (pointing out that "the patents that are filed are often relatively poor tools of teaching. The patent system incents early disclosure by awarding those who are first to file their applications . . . as a result, disfavors mature, complete disclosure, as the invention is often still at the preliminary, pre-commercial stage at the time of filing").

65. *See* Fromer, *supra* note 64, at 1716 ("Yet the law does not require disclosure of so much of this valuable information related to a patented invention.").

66. *Id.* at 1715-16. (stating that "[s]o much of the innovation process, from refinement to prototyping to market research to mass production, has yet to occur at the moment of patent filing").

67. *Id.*; *see also* Mark A. Lemley, *The Myth of the Sole Inventor*, 110 MICH. L. REV. 709, 747 (2012) (contending that "[t]he theory that patents are valuable for the information they disclose, then, doesn't seem to describe the real world-at least, not enough so to stand alone as a justification for having a patent system").

68. *See* Chien, *supra* note 62, at 1852 ("Academic proposals have centered, accordingly, on improving the patent document.").

69. Sean B. Seymore, *The Teaching Function of Patents*, 85 NOTRE DAME L. REV. 621, 627 (2010) (proposing "that raising the standard of disclosure, by allowing the U.S. Patent and Trademark Office (Patent Office) to request working examples, will improve the teaching function of patents").

70. *See* Ouellette, *supra* note 46, at 601.

after the filing of patent application, such as data concerning the commercialized products that they or their licensees make.[71]

Even when the patent document discloses adequate information for potential users to grasp the technology, the users might still be unable to implement it due to the second impediment – the lack of non-informational assets. As economics literature shows, to commercialize a technology successfully, users need not only the technical information concerning the technology but also "other capabilities or assets."[72] For example, the potential user of an automobile technology might be unable to commercialize the technology if it cannot gain access to relevant manufacturing and distribution facilities.[73] The lack of non-informational assets is an exogenous limitation to the patent system, one that changes to the patent system will not address. Another legal institution – contracts – can provide a solution to this impediment. In the innovation marketplace, contracts allow technology users to obtain non-informational assets from technology owners or third parties.[74]

B. CONTRACTUAL SOLUTION: BUNDLED ASSET TRANSFERS

Conventional wisdom holds that a patent license agreement is an exchange of a monetary payment for the patentee's promise not to sue the licensee.[75] In practice, this is not necessarily the case. As Peter Lee pointed out, "obtaining the bare legal right to practice some invention is rather empty unless the licensee actually understands the technology and can practice it."[76] In actual licensing transactions, technology users obtain informational and non-

71. *See* Fromer, *supra* note 64, at 1716.

72. David J. Teece, *Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy*, 15 RES. POL'Y 285, 288 (1986) ("In almost all cases, the successful commercialization of an innovation requires that the know-how in question be utilized in conjunction with other capabilities or assets.").

73. *See* TEECE, *supra* note 27, at 25 ("For instance, the design for a new automobile is of little value absent access to manufacturing and distribution facilities on competitive terms.").

74. *See infra* Sections II.B, III.A; *cf.* Lemley & Feldman, *Patent Licensing*, *supra* note 14, at 188 (pointing out that in general technology owners "must also transfer things like know-how, complementary assets, and other peripheral disclosures" along with a patent license to make a technology transfer lead to commercialization).

75. Spindelfabrik Suessen-Schurr, Stahlecker & Grill GmbH v. Schubert & Salzer Maschinenfabrik Aktiengesellschaft, 829 F.2d 1075, 1081 (Fed. Cir. 1987) ("As a threshold matter, a patent license agreement is in essence nothing more than a promise by the licensor not to sue the licensee."); *cf.* Feldman, *supra* note 13, at 247 ("A license, after all, is merely an agreement not to sue in return for a monetary payment, and the threat of a lawsuit is what drives companies to pay the licensing fee.").

76. Lee, *supra* note 12, at 1516; *see also* Lemley & Feldman, *Patent Licensing*, *supra* note 14, at 188 (claiming that "if patents actually drive innovation by third parties, we would expect to see not just the transfer of a patent license, but also the transfer of other types of information assets").

informational assets along with the right to patented technology by contracting with the owners. That is to say, contracts complement the patent system as they enable users to overcome the impediments that hinder the development and implementation of the technology that the patent system discloses.

Legal scholars and economists have found that in many patent licensing transactions, patent holders bundle patent licenses with informational assets such as know-how and trade secrets. Colleen Chien studied a dataset of 245 software patent licensing contracts and determined that "in most cases, when patents were licensed, so were know-how, trade secrets or code." [77] When Stuart Graham *et al.* conducted the 2008 Berkeley Patent Survey, they found that the majority of startups in the biotechnology and software industries stated that when they acquired patent licenses, they intended to gain technical knowledge as well.[78] Deepak Hegde examined 505 patent licenses in the pharmaceutical, biotechnology, and medical instruments and devices industries.[79] He determined that 41% of the licenses required the patentee to transfer data, information, materials, and the like to the licensees.[80]

In some studies, economists have found that licensees acquired non-informational assets from patentees. Hegde determined that 18.6% of the 505 patent licenses that he studied obligated the licensor to provide technical assistance to licensee.[81] Ashish Arora examined a set of 144 technology agreements of Indian companies, which included 69 patent licenses.[82] According to his findings, 81.2% of the patent licensing transactions included a transfer of technical training services while other technical services were transferred less frequently.[83] His findings also show that around 40% of the patent licensing transactions involved a transfer of equipment.[84] Arora believed that equipment is transferred as a "complementary input[]" to know-how.[85]

Previous studies have also suggested that the timing of patent licensing transactions seems to affect the formation of bundling arrangements. Mark

77. Chien, *supra* note 12, at 1679.

78. Graham et al., *supra* note 22, at 1317-18.

79. Hegde, *supra* note 23, at 574.

80. *Id.* at 578.

81. *Id.* at 579.

82. Arora, *Contracting for Tacit Knowledge*, *supra* note 24, at 239, 245.

83. *Id.* at 235, 239, 241-42 (showing that among the 69 patent licensing contracts, 23 (33.3%) included services to set up plants; 20 (29%) included services to set up research and development unit; 26 (37.7%) included quality control services).

84. *Id.* at 247 (showing that 26 (37.7%) of the 69 patent licensing transactions involved a transfer of equipment).

85. *Id.* at 252.

Lemley and Robin Feldman conducted two surveys of patent licensing transactions that resulted from patent litigation and licensing demands. These transactions tended to occur after the defendant-licensees developed and implemented the technology, which are regarded as ex post patent licensing transactions.[86] In both surveys, a high percentage of the firms responded that they are unlikely to acquire knowledge in ex post licensing transactions.[87] Nevertheless, Lemley and Feldman believe that the bundling arrangement of knowledge and patent license can happen "in the ex ante context,"[88] i.e., before the invention has been widely commercialized and before the occurrence of any patent litigation demands.[89] However, they did not provide empirical evidence concerning bundled asset transfers in ex ante patent licensing transactions like they did for the ex post ones.

Previous studies have provided valuable evidence concerning bundled asset transfers in patent licensing transactions, yet a more comprehensive study is needed to clarify what the bundles consist of and the effect that they have on innovation. Though legal scholars have recognized there might be different kinds of assets in a bundle,[90] they have primarily focused on one type of asset – knowledge. In their view, patent licensing transactions involving knowledge

86. Chien, *supra* note 12, at 1685 ("Patent licenses signed as the result of patent litigation are a highly selected part of the patent market, and because they are formed ex post, they also tend to take place after technology has been transferred or copied, or independently invented."); Feldman & Lemley, *Sound and Fury*, *supra* note 37, at 1800 ("Patent litigation and licensing demands for existing patents, by contrast, tend to occur well after the defendant has developed and implemented the technology.").

87. *See* Feldman & Lemley, *Patent Licensing Demands*, *supra* note 38, at 161-62 (showing that no less than 88% of the firms that patent license due to patent licensing demands reported that the frequency of obtaining knowledge in addition to the right to use the patented technology is 0%-10%); Feldman & Lemley, *Sound and Fury*, *supra* note 37, at 1837 (showing that 70% of the firms that take patent license due to patent licensing demands reported that such licenses "almost never" transfer any sort of knowledge); Risch, *supra* note 26, at 987 ("Post-implementation licensing merely allows commercial 'innovators' to continue using inventions that they were already using in the first place, but only after bearing the added cost of a licensing fee.").

88. Feldman & Lemley, *Sound and Fury*, *supra* note 37, at 1799 (contending that "actual technology transfer happens within the patent system in the ex ante context"); *see also* Risch, *supra* note 26, at 983.

89. Feldman & Lemley, *Patent Licensing Demands*, *supra* note 37, at 177 (noting that an ex ante license "occurs when a product company initiates the approach to a patent holder seeking new technology").

90. *See* Lemley & Feldman, *Patent Licensing*, *supra* note 14, at 188 ("Thus, if patents actually drive innovation by third parties, we would expect to see not just the transfer of a patent license, but also the transfer of other types of information assets.").

transfer to the licensee are likely to promote innovation,[91] while those not related to knowledge transfer are less likely to do so.[92] The research has paid less attention to non-informational assets. Economists do examine both informational and non-informational assets in the bundles, but their focus is on the contractual design that firms use to transfer knowledge through arm's length contracts.[93] They tend to treat the transfer of non-informational assets as an indicator of knowledge transfer[94] or as a means to facilitate knowledge transfer.[95]

This Article adds empirical evidence to the previous research by examining 400 patent licensing transactions that publicly traded companies filed with the SEC. As Part III will show, the assets that licensees obtain in these transactions are diverse, but, in general, they promote innovation by helping the licensee to deploy the licensed technology. Transmitting knowledge to the licensee is not the only way that these assets serve to promote innovation. As the findings show, assets that do not transfer knowledge to the licensee might still play an important role in innovation. Typical examples are trademark and maintenance support services that the patentee directly performs for end-users. The former does not by itself transfer knowledge to the licensee but can help promote the distribution of the patented products.[96] The latter might involve knowledge

91. *See* Chien, *supra* note 12, at 1678-79; Graham et al., *supra* note 22, at 1316; Risch, *supra* note 26, at 983 (claiming that the transfer of sufficient know-how is a way to "maximize [the patented technology's] potential"); *cf.* Barnett, *supra* note 11, at 1 (noting that IP licensing transactions facilitate "value-creating exchanges of knowledge assets," which "support a robust innovation ecosystem").

92. *See* Feldman & Lemley, *Patent Licensing Demands*, *supra* note 37, at 176; *see also* Robert P. Merges, *The Trouble with Trolls: Innovation, Rent-Seeking, and Patent Law Reform*, 24 BERKELEY TECH. L.J. 1583, 1583 (2009) (distinguishing the "legitimate secondary market, in which patent rights are bought and sold in ways that compensate real innovators (and also often involve the transfer of information and/or technology, in addition to the legal right)" from "the more questionable market for the settlement of lawsuits involving weak, outdated or irrelevant patents").

93. *See, e.g.*, Arora, *Licensing Tacit Knowledge*, *supra* note 38, at 42 ("Thus simple contracts involving patents can accomplish the transfer of know-how."); Arora, *Contracting for Tacit Knowledge*, *supra* note 24, at 237 (noting that "if the licensor can tie the transfer and payment for know-how to a complementary input (whose transfer is easy to monitor) the transfer of know-how can be accomplished"); Hegde, *supra* note 23, at 569.

94. *See, e.g.*, Hegde, *supra* note 23, at 579 (regarding technical assistance as an indicator of the transfer of "tacit or noncontractible knowledge"); Arora, *Contracting for Tacit Knowledge*, *supra* note 24, at 239 (treating the transfer of services as an indicator of the transfer of know-how).

95. *See, e.g.*, Hegde*, supra* note 23, at 252 (demonstrating that bundling know-how with equipment as it complementary input together in arm-length contract can mitigate the moral hazards in the process of know-how transfer).

96. *See infra* Section III.A.1.d.

transfer but the receivers are the end-users – the licensee's customers – rather than the licensee itself.[97]

Part III also adds evidence to the literature concerning the timing of patent licensing transactions and bundled asset transfers. It distinguishes ex ante and ex post patent licensing transactions by whether they result from patent litigation. The findings show that only 5.88% of the ex post licensing transactions involved bundled asset transfer; ex ante licensing, 47.56%. These findings confirm the theory that bundled asset transfers are more likely to happen in an ex ante licensing context than in an ex post one. They also suggest that although ex ante licensing transactions can involve bundled asset transfers, the majority of them (52.44%) are merely an exchange of the patentee's promise not to sue the licensee for monetary payment and/or other considerations.

III. CASE STUDY: 400 MATERIAL PATENT LICENSING TRANSACTIONS OF PUBLIC COMPANIES

To understand what kind of assets are in the bundle and the relationship between the assets and the patented technology, this Section presents an analysis of 400 patent licensing transactions of public companies that filed with the SEC. It examines not only the four corners of each patent licensing agreement, but also the associated agreements that the companies signed, along with the licensing agreement, in the same transaction. It explores the background of each transaction by reviewing the annual, quarterly, and current reports to which the agreements were attached. However, the conclusions made in this Section might not be applicable to the overall population of the contracts that innovators sign in patent licensing transactions because the agreements this Article examines are material contracts on which public companies' business depends: they are substantial, and are reported by relatively large companies.

A. THE ASSETS IN THE BUNDLES

Among the 400 patent licensing transactions, 169 involve bundled asset transfers (accounting for 42.25% of the total). We can classify the transferred assets into three groups — intellectual property, property, and labor. The licensees use the assets to deploy the licensed technologies at different stages of innovation — refinement of the technologies, development and manufacture of products, and distribution of the products in the marketplace. The findings confirm the idea that to commercialize a patented technology,

97. *See infra* note 186 and accompanying text.

reading the patent document alone might be not enough; other assets might be necessary in order to deploy it.[98] In general, the bundling arrangements in these transactions are efficiency-enhancing arrangements.[99]

1. *Intellectual Property*

a) Proprietary Information

Of the relevant dataset, 144 of the transactions (or 36%) involve proprietary information, including know-how and trade secrets. In patent licensing transactions, the licensee might want proprietary information from patentees in order to maximize the value of the technology.[100] Occasionally, the licensees obtain commercial information, such as business processes and customer lists.[101] This kind of information facilitates the commercialization of the licensed technology.[102] In most cases, however, the information is technical and related directly to the implementation of the technology. Technical information can keep licensees from having to put money and effort into recreating the patentee's research and diminishes licensees' risk of technical failures.[103]

Take the patent licensing transactions in the pharmaceutical industry for example. Firms here face a high risk of technical failure in the process of drug

98. Lemley & Feldman, *Patent Licensing*, *supra* note 14, at 188.

99. *See* U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, *supra* note 15, at 114 (noting that bundling arrangements in patent licensing transactions can often lead to efficiencies).

100. *See* HOLMES, *supra* note 26, § 1:5.8 (noting that "the complexity of the licensed technology may require further information from the licensor in order to optimally exploit the licensed rights"); Risch, *supra* note 26, at 983 (stating that the transfer of sufficient know-how is to "maximize [the patented technology's] potential"); 3 ROGER M. MILGRIM & ERIC E. BENSE, MILGRIM ON LICENSING § 19.00 (2006) ("If industrial or intellectual property is viewed as the bricks of successful licensing, then surely technical information and assistance are the mortar.").

101. *See, e.g.*, Dexcom Inc. & SM Tech., LLC, Exclusive Patent License Agreement §§ 1.1.7, 2, 2005 WL 8063058 (transferring information concerning business processes); Visual Mgmt. Sys., Inc. & IDS Patent Holding, LLC, Exclusive Patent and Trade Secret License Agreement § 1.04 & Definition Appendix, 2008 WL 11104830 (transferring business data, customer lists, price lists); Hansen Med., Inc. & Koninklijke Philips Elecs. N.V., Patent and Technology License and Purchase Agreement §§ 1.21 & 2.1, 2011 WL 13022426 (transferring customer lists and supplier lists).

102. *Cf.* Merges, *supra* note 60, at 1501 (noting that "information about the business setting in which the technology may be employed, potential customers and their needs, and the like" is related to the implementation of patent).

103. *Cf.* Mycalex Corp. of Am. v. Pemco Corp., 64 F. Supp. 420, 425 (D. Md. 1946), *aff'd*, 159 F.2d 907 (4th Cir. 1947) (defining "know-how" as factual knowledge "acquired as the result of trial and error, gives to the one acquiring it an ability to produce something which he otherwise would not have known how to produce with the same accuracy or precision found necessary for commercial success").

development.[104] Licensees of a patented drug must pass the U.S. Food and Drug Administration's (FDA) regulatory hurdles before receiving approval to enter the market.[105] This process costs hundreds of millions to billions of U.S. dollars and takes approximately 7.5 years.[106] But only 9.6% of drugs pass the clinical trials and receive approval to enter the market.[107] Given that the stakes in commercializing a new drug are high, it is critical for licensees to have access to any data that will help them achieve technical success,[108] even though the access fees to the data can be high.[109] Proprietary information from the patentee can accelerate the speed of drug development, providing the licensee with a lead in the race to bring a drug to the market.[110]

Here is a typical pharmaceutical patent licensing transaction: Cerecor Inc. (Cerecor), a clinical-stage biopharmaceutical company, desired to develop and commercialize the compounds that Merck & Co., Inc. (Merck) had developed and patented to treat depression.[111] After Merck granted the license, Cerecor would need to develop the compounds in order to pass clinical trials that FDA

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104. *See* Aimo Kannt & Thomas Wieland, *Managing Risks in Drug Discovery: Reproducibility of Published Findings*, 389 NAUNYN-SCHMIEDEBERG'S ARCHIVES PHARMACOLOGY 353, 355 (2016) (noting that "more than 99% of all drug discovery projects will not result in an approved product").

105. U.S. Food & Drug Admin., *Development & Approval Process | Drugs*, https://www.fda.gov/drugs/development-approval-process-drugs (last visited July 17, 2020).

106. Aylin Sertkaya, Anna Birkenbach, Ayesha Berlind & John Eyraud, EXAMINATION OF CLINICAL TRIAL COSTS AND BARRIERS FOR DRUG DEVELOPMENT §§ E3.1, E3.2 (2014) (showing that the total costs of bringing a new drug to market are somewhere between $161 million and $2 billion and the average length of time from the starting date of the clinical trial to the date of marketing the drug is 90.3 months—or approximately 7.5 years).

107. David W. Thomas, Justin Burns, John Audette, Adam Carroll, Corey Dow-Hygelund & Michael Hay, *Clinical Development Success Rates 2006–2015*, 1 BIO INDUS. ANALYSIS 1, 7 (2016).

108. *See Licensing Your 'Know-How' Holds Revenue Potential, But Seller Beware*, TECH TRANSFER CENTRAL, https://techtransfercentral.com/reprints/ttt/1207-licensing-your-know-how/ (last visited July 30, 2020) (noting that in the biopharmaceutical industry, licensees are not only paying for a patent license but also for a body of knowledge and important details that leads to technical success).

109. *See* John P. Walsh, Ashish Arora & Wesley M. Cohen, *Effects of Research Tool Patents and Licensing on Biomedical Innovation*, *in* PATENTS IN THE KNOWLEDGE-BASED ECONOMY 285, 300-01 (Wesley M. Cohen & Stephen A. Merrill eds., 2003) (showing that biopharmaceutical firms pay tens of millions to hundreds of millions of U.S. dollars to gain access to proprietary data).

110. *See* Jeffrey P. Somers, *Biotech Patent Licensing: Key Considerations in Deal Negotiations*, 6 J. BIOLAW BUS. 11, 16-18 (2003).

111. Essex Chemie AG & Cerecor Inc., Exclusive Patent and Know-How License Agreement, 2015 WL 6606686; Cerecor Inc., Registration Statement (Form S-1) 95 (June 12, 2015), https://www.sec.gov/Archives/edgar/data/1534120/000104746915005421/a2224996zs-1.htm#bm12006_prospectus_summary.

requires for marketing approval.[112] Recognizing a risk of failure in the drug's development,[113] Cerecor obtained, along with the patent license, the right to use "Merck Know-How," including medicinal chemistry data, medical data, pre-clinical data, toxicological data, and other documents.[114] It acquired 127 data documents from Merck[115] and used the data to obtain the FDA's marketing approval.[116]

Licensees in other technology fields also seek proprietary information from patentees to support the implementation of the licensed technology. This phenomenon not only occurs in high-tech industries such as pharmaceuticals and computer programming,[117] but also in industries that we usually consider to be less technologically advanced, such as furniture manufacturing.[118] Since the way in which the patented technology operates in each industry is specific, technical information that the licensee obtains from the patentee to complement the patented technology also appears to be specific[119] For example, in the wind turbine industry, licensees obtain materials that relate to prototypes of turbine.[120] In the medical device industry, manufacturers acquire the licensed substance's stability and safety data,[121] which is subject to the review by the FDA.

112. Cerecor Inc. Registration Statement, *supra* note 111, at 95-96.

113. *Id.* at 18.

114. Essex Chemie AG & Cerecor Inc., *supra* note 111, §§ 1.31, 2.01.

115. *Id.* at Schedule 1.31.

116. Cerecor Inc. Registration Statement, *supra* note 111, at F-22.

117. *See, e.g.*, Face2face Animation, Inc. & InMotion Biometrics, Inc., Patent and Technology License Agreement §§ 1.14 & 2.1, 2005 WL 8125156 (acquiring engineering notebooks, drawings, blueprints, flow charts, and diagrams from patentees); *see* Noela Jemutai Kipyegen & William P K Korir, *Importance of Software Documentation*, 10 INT'L J. COMPUTER SCI. ISSUES 223, 227 (2013) (discussing the importance of software documentation in computer programming); Isaac Nassi & Ben Shneiderman, *Flowchart Techniques for Structured Programming*, 8 ACM SIGPLAN NOTICES 12 (1973) (discussing the use of flowchart in computer programing).

118. *See, e.g.*, Li Jinliang & Shandong Caopu Arts & Crafts Co., Ltd., Exclusive Patent License Agreement § 4, 2010 WL 11346858.

119. For example, in the wind turbine industry, licensees obtained materials that relate to prototypes of turbine.

120. *See, e.g.*, The Ariz. Bd. of Regents on Behalf of the U. of Ariz. & Wildcap Energy, Inc., Exclusive Patent License Agreement § 1.11 (a), 2011 WL 13039236.

121. *See, e.g.*, Quick-Med Tech., Inc. & Biosara Corp., Patent and Technology License Agreement §§ 1.16, 1.31, 2.1, 2012 WL 12408967; *NIMBUS*®, QUICK-MED TECHNOLOGIES, INC., https://www.quickmedtech.com/technology/nimbus (last visited Jan. 20, 2019).

b) Software

As computer technology advances, more industries seek to automate the production of products and services.[122] This trend has influenced patent licensing practices. Patent licensees often need a software license if the patented technology integrates with the software.[123] Among the 400 patent licensing transactions in this Article's dataset, 54 (or 13.5%) involved a software license. Generally speaking, there are three situations in which a licensee would obtain a software license from the patentee.

In the first situation, the licensed technology is itself a piece of patented software. A piece of software consists of three primary elements – source codes, object codes, and design documentation. Three areas of laws – patent, trade secret, and copyright – can simultaneously protect it.[124] A patent license only allows the licensees to implement the method that the software realizes. This does not mean that the licensee can gain access to the codes, which are the core of a piece of software.[125] A software license gives the licensee the access to codes, as well as the design documentation.[126]

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122. *See generally* Edward P. Ambinder, *A History of the Shift Toward Full Computerization of Medicine*, 1 J. ONCOLOGY PRAC. 54, 54-56 (2005) (noting that the medical industry began its shift toward full computerization starting in the 1960s); John Markoff, *Armies of Expensive Lawyers, Replaced by Cheaper Software*, N.Y. TIMES, Mar. 5, 2011, at A1 (noting that computer software is used to finish some tasks that conventionally are done by lawyers); Jamshed Iqbal, Zeashan Hameed Khan & Azfar Khalid, *Prospects of Robotics in Food Industry*, 37 FOOD SCI. TECH. 159, 159-64 (2017) (discussing how computers are used in the food processing industry).

123. *See* B. G. BRUNSVOLD, D. P. O'REILLEY & D. B. KACEDON, DRAFTING PATENT LICENSE AGREEMENTS 346 (2008).

124. A piece of software consists of three primary elements: source codes, object codes, and design documentation. Source code is the collection of codes that are written using human-readable language. Object code is a sequence of instructions to the computer in a computer language, usually in binary form. Trade secret is an important way to protect software. Section III.A.1.c will discuss the copyright protection of software.

125. Access to source code is necessary because it would allow licensees to program the licensed software by reading the source code. With source codes, licensees can enter the market earlier with the software. *See Licensing Your 'Know-How' Holds Revenue Potential, But Seller Beware*, TECH TRANSFER CENTRAL, https://techtransfercentral.com/reprints/ttt/1207-licensing-your-know-how/ (last visited Oct. 30, 2018); *see also* Don Gilbert, *Bioinformatics Software Resources*, 5 BRIEFINGS BIOINFORMATICS 300, 300 (2004) (noting that, in the biotechnical industry, source codes of old bioinformatics software are widely read and referred to by bioinformaticians to develop new software).

126. *See, e.g.*, Lenovo (Beijing) Ltd., Legend Holdings Ltd., Yu Bing & Wang Zheng, Patent, Copyright and Technology License Agreement §§ 2.1, Schedule 1.1, Schedule 2.1.3, 2004 WL 7297504; Face2face Animation, Inc. & InMotion Biometrics, Inc., Patent and Technology License Agreement §§ 1.14, 2.1, 2005 WL 8125156 (the licensed technology includes "software (in object and source code)"); Document Security Sys., Inc. & Ergonomic

In the second situation, licensees install the software in the patented product to realize particular functionalities. For example, certain medical software is intended for use in medical devices to help doctors diagnose diseases and determine treatment methods.[127] Licensees of the patented medical device might also obtain a license for the software that the device implements.[128] Products such as navigation devices and autopilot systems often require a piece of software that processes mapping data, performs route calculations, navigates a calculated route, and controls direction.[129]

In the third situation, licensees might use software for research and development. Typically, software patent licensees sometimes obtain another piece of software — the software developers' tool — that will allow them to develop the patented software.[130] A licensee of a patented wind turbine

Group, Inc., Limited Exclusive Patent License Agreement §§ 1.17, 2.1, 2007 WL 9540382 (licensed intellectual property includes "computer software and programs, and related flow charts, programmer notes, documentation, updates, and data, whether in object or source code form").

127. *The Increasing Importance of Software in Medical Devices*, ORTHOGONAL, http://orthogonal.io/medical-softtware/the-increasing-importance-of-software-in-medical-devices-html/ (last visited Dec. 11, 2018).

128. For example, Nomos Corporation, a medical instruments manufacturer, obtained a patent license concerning a device and method for delivering radiation therapy, and it also obtained a license for software relating to the patented device and method, because the software element of the device "is deemed an essential element of the functionality of the product." *See* N. Am. Sci., Inc., Annual Report (Form 10-K) 80 (Mar. 11, 2005), https://www.sec.gov/Archives/edgar/data/949876/000110465905010671/a05-2506_110k.htm; The Bd. of Regents of the U. of Tex. Sys. & Nomos Corp., Patent License Agreement, 2004 WL 7254648.

129. *See*, *e.g.*, Tele Atlas N. Am., Inc. & Cobra Electronics Corp., Technology and Patent License Agreement §§ 2.1, 2.3, 2006 WL 8378719; Cobra Electronics Corp., Annual Report (Form 10-K) 1 (Mar. 30, 2007), https://www.sec.gov/Archives/edgar/data/30828/000119312507070237/d10k.htm#toc95660_1; Cobra Electronics Corp., Press Release (Form 8-K, Exhibit-99.1) 2 (Apr. 28, 2006), https://www.sec.gov/Archives/edgar/data/30828/000119312506092094/dex991.htm (portable mobile navigation device); *see also, e.g.*, Drone Aviation Holding Corp. & Adaptive Flight, Inc., Non-Exclusive, Perpetual Intellectual Property and Patent License Agreement § 2.4, 3.1, 2015 WL 6602036; Drone Aviation Holding Corp., Annual Report (Form 10-K) 5 (Mar. 4, 2016), https://www.sec.gov/Archives/edgar/data/1178727/000101376216001358/f10k2015_droneaviation.htm (certain "flight simulation and fault tolerant flight control algorithms" for an autopilot system).

130. *E.g.*, Avistar Systems Corp. is a videoconferencing solution provider. It delivers a suite of video, audio, and collaboration software to desktops in hundreds of locations. The software can facilitate interactive video calling, interactive broadcasts and presentations, the retrieval stored videos, and data sharing. *See* Avistar Comms. Corp., Annual Report (Form 10-K) 3, 6-9, F-27 (Mar. 31, 2008), https://www.sec.gov/Archives/edgar/data/1111632/000111163208000010/form10-k.htm#item1_business. Radvision grants Avistar a license to use its 3G-324M Toolkit. *See*, Avistar Sys. UK Ltd., Avistar Comms. Corp. & Radvision Ltd., Patent License Agreement § 1.12, 6.2, 2007 WL 9522911. The toolkit is a piece of software

technology might obtain software from the patentee allowing it to analyze the data of wind characteristics in different sites so as to install efficient turbines in the promising locations.[131] Pharmaceutical patent licensees might seek proprietary bioinformatics software from patentees[132] to help them analyze and manage biodata.[133] Although free bioinformatics software programs are available on the internet, "it is not always easy to find the relevant ones."[134]

c) Copyright

In 26 (or 6.5%) of the 400 patent licensing transactions, licensees also obtained a copyright license from patentees. The need for a copyright license can arise when licensees acquire patentees' proprietary information or software, both of which are copyrightable subject matters.[135] If licensees make copies or derivative works of proprietary information or software without authorization, they are subject to copyright infringement lawsuits, by which copyright holders (patentees) can seek either actual damages or statutory damages.[136] Licensees can avoid the risk of these lawsuits by obtaining a copyright license.

To illustrate, copyright law automatically protects proprietary information if the information constitutes an original work of authorship and is fixed in a

for developers that includes a set of application programming interfaces to develop multimedia communication solutions for 3G servers and handsets. *See 3G-324M Toolkit*, SOFTIL, https://www.softil.com/solutions/protocol-stacks-frameworks/3g-324m-toolkit/ (last visited Dec. 11, 2018).

131. *See, e.g.*, The Ariz. Bd. of Regents on Behalf of the U. of Ariz. & Wildcap Energy, Inc., Exclusive Patent License Agreement, 2011 WL 13039236; Wildcap Energy Inc., Registration Statement (Form S-1/A) 24-25 (Mar. 9, 2011), https://www.sec.gov/Archives/edgar/data/1499027/000143774911001397/wildcap_s1a2-030711.htm; *see also* SATHYAJITH MATHEW, WIND ENERGY: FUNDAMENTALS, RESOURCE ANALYSIS AND ECONOMICS VII (2006) (noting that in the wind energy industry software is an analysis tool for wind energy exploiters to "assess[] the energy potential and simulat[e] turbine performance at prospective sites").

132. *See, e.g.*, Pharmacopeia Drug Discovery, Inc. & Pharmacopeia, Inc., Patent and Software License Agreement §§ 1.7, 1.8, 1.9, 4, 2004 WL 7268348 (licensing three pieces of software—TopKat, LibProp, and ADME Profiler—to the licensee; allowing the licensee to use, modify, enhance, adapt, and make derivative works from the source code of the software, but only for the development and manufacture of compounds and for drug discovery and development services for third parties).

133. *See* Gilbert, *supra* note 125, at 300; Sudhir Kumar & Joel Dudley, *Bioinformatics Software for Biologists in the Genomics Era*, 23 BIOINFORMATICS 1713, 1713 (2007).

134. Gilbert, *supra* note 125, at 300.

135. In each of these 24 transactions, the licensees obtained proprietary information or software from the patentees along with the patent license.

136. 17 U.S.C. § 504 (2012).

tangible medium of expression.[137] For example, copyright law protects proprietary information that appears in drawings, blueprints, flowcharts, and diagrams, if it satisfies the requirement of originality. Without a copyright license, licensees infringe the copyright if they make copies of proprietary information by, for example, downloading the information from a database.[138]

Software, which consists of source codes, object codes, and documentation, is considered to be a literary work and is protected by trade secret law and copyright law under 17 U.S.C. § 102.[139] Copyright law restricts the unauthorized reproduction and distribution of copies as well as the unauthorized preparation of derivative works of copyrightable software,[140] so licensees of software patents or licensees that obtain software along with licensed technologies often obtain a copyright license from the patentees in order to avoid the risks of copyright infringement.[141]

d) Trademark

Licensees might obtain trademarks or other symbols from patentees because they depend on the patentees' goodwill and reputation to promote the sales of patented products.[142] In 32 of the 400 patent licensing transactions (8%), the licensee obtained trademarks from the patentee.

Trademark licenses can benefit patentees. If patentees collect running royalties based on the sales of the patented product, the more products the

137. 17 U.S.C. § 102 (2012); *see* 2 ROGER M. MILGRIM & ERIC E. BENSEN, MILGRIM ON LICENSING § 6.15 (2006).

138. *See, e.g.*, Analog Devices, Inc. & Ikanos Comms., Inc., Patent and Technology License Agreement §§ 1, 2.02, 2006 WL 8326192; Analog Devices., Inc. & Ikanos Comms., Inc., Assets Purchase Agreement (Form 10-K, Exhibit 2.2) §§ 1.1(jj), 2.1 (Feb. 27, 2006), https://www.sec.gov/Archives/edgar/data/1219210/000104746906002539/a2167797zex-2_2.htm, (obtaining a copyright license that covers "all databases and data collections").

139. Under current practice, the Copyright Office accepts the registration of computer programs as literary works. COMPENDIUM OF U.S. COPYRIGHT OFFICE PRACTICES § 503.1(B) (3d ed. 2021).

140. 17 U.S.C. § 106 (2012); *see also* Mark A. Lemley, *Convergence in the Law of Software Copyright*, 10 HIGH TECH 1 (1995) (discussing how copyright law evolved to protect software).

141. *See, e.g.*, Lenovo (Beijing) Ltd. et al., Patent, Copyright and Technology License Agreement §§ 2.1, Schedule 1.1, Schedule 2.1.3, 2004 WL 7297504 (licensing software to operate the patented information systems with copyright licenses that cover the source codes, the object codes, and the design documentation); The Regents of the U. of Cal. & Innovation Econ. Corp., Exclusive Patent License and Non-Exclusive Copyright Agreement § 2, 2015 WL 8562911 (licensing a copyright covering a graphical user interface software that appears in one of embodiments of the patented invention); Violin Memory, Inc., Asset Purchase Agreement (Form 8-K, Exhibit 2.1) § 1.1(xx) (May 29, 2014), https://www.sec.gov/Archives/edgar/data/1407190/000119312514217541/d735360dex21.htm.

142. HOLMES, *supra* note 26, § 10:3 (noting that licensees obtain trademarks from patentees to help them promote the sales of patented products).

licensees sell, the more royalties they can earn. This is especially the case when the licensees are the exclusive distributors of the patented products.[143] In this situation, the patentees' earnings are completely subject to the licensees' market performance.

For example, along with a patent license concerning a specific biopolymer and implants, STAAR Surgical AG (the licensee) also acquired a trademark license covering a service mark and a trademark of the patentee, The Eye Microsurgery Intersectoral Research and Technology Complex.[144] These two companies share the same graphic " ,"[145] indicating that the patentee is the origin of the technologies that the licensee used in the products.

In this transaction, the licensee is an exclusive distributor of the patentees' products in certain regions – the parties signed a supply and distribution agreement that put the licensee in this role.[146] Under the patent license agreement, the patentee collected a running royalty of 4.5% to 6.0% of the sales of the patented products from the licensee.[147] These two agreements tied the patentee's earnings to the licensee's sales' performance. The patentee can collect more royalties if its business goodwill associated with the licensed trademarks increases the licensee's sales of the patented products.

Though patentees can benefit from attaching their trademark to the licensees' sales of patented products, they risk damage to their reputations if the licensees sell poor quality products that taint the licensed brand. Patentees also risk a judicially declared abandonment of their trademark if they do not exercise sufficient quality control over the licensees' use of it.[148] To maintain their business reputations and avoid this judicial ruling, patentees often require the product bearing their trademark to meet certain standards, and they

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143. *See, e.g.*, Samaritan Pharm. Ir. Inc. Ltd. & Taconic Farms, Inc., Patent and Trademark License Agreement § 3.1, 2008 WL 11135080; Samaritan Pharm., Inc., Annual Report (Form 10-K) 1 (June 19, 2009), https://www.sec.gov/Archives/edgar/data/1057377/000143774909000657/samaritan_10k-123108.htm (patentees grant exclusive license to the licensee to commercialize its research tool, a rat model, for studying new drugs in some specified regions).

144. The Eye Microsurgery Intersectoral Res. & Tech. Complex & STAAR Surgical AG, Patent License Agreement §§ 1.3, Appendix 3, 2001 WL 37100872.

145. Graphic trademark in the USA. Certificate No. 1.485.586, class 41; Graphic trademark in the USA. Certificate No. 1.298.658, class 10.

146. *See* STAAR Surgical Co., Annual Report (Form 10-K) 9-10 (Mar. 28, 1996), https://www.sec.gov/Archives/edgar/data/718937/0000898430-96-001034.txt.

147. The Eye Microsurgery Intersectoral Res. & Tech. Complex & STAAR Surgical AG, *supra* note 146, § 17.

148. Freecycle Sunnyvale v. Freecycle Network, 626 F.3d 509, 515-16 (9th Cir. 2010) (holding that the licensors' failure to exercise adequate quality control over their licensees' use of the trademark constituted "naked licensing," which leads to abandonment of the trademark).

preserve the right to monitor the quality of the products.[149] Patentees also often incorporate complex governance mechanisms into trademark licenses to ensure the licensees' use of the trademark complies with trademark law.[150]

2. *Property*

a) Facilities

Licensees sometimes need patentees' specialized facilities[151] to implement patented technology.[152] In these cases, licensees also obtain rights to gain access to these facilities.[153] In the innovation marketplace, building specialized facilities sometimes requires special knowledge that patentees have, but that both licensees and third parties lack.[154] Developing specialized facilities might incur significant irreversible investments; making such an investment can be too risky to be worthwhile for the licensees and third parties.[155] Therefore, licensees might lease or acquire these facilities from the patentee or third parties rather than building these themselves. Among the 400 transactions examined for this Article, 26 (or 6.5%) involved a transfer of facilities

Along with the patent license, licensees sometimes rent patentees' facilities through a lease agreement. For example, American Science and Technology Corporation (the patentee) had a patented technology concerning a process to

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149. *See, e.g.*, Dexcom, Inc. & SM Tech., LLC, Exclusive Patent License Agreement § 11.4, 2005 WL 8063058 ("[The patentee] shall have the right to insure proper quality control is performed by [the licensee] in connection with all goods bearing the [*****]® trademark"); The Eye Microsurgery Intersectoral Res. & Tech. Complex & STAAR Surgical AG, *supra* note 146, § 8 ("The Licensee shall manufacture the products under license whose quality is the same as those manufactured by Licensor. . . . The Licensor has the right of quality monitoring so as to check if the products manufactured under license correspond to the quality established by the Agreement."); *see* HOLMES, *supra* note 26, § 10:7.

150. *See, e.g.*, Dexcom, Inc. & SM Tech., LLC, *supra* note 149, § 11.4; Samaritan Pharm. Ir. Inc. Ltd. & Taconic Farms, Inc., Patent and Trademark License Agreement § 7.2, 2008 WL 11135080 (setting detailed rules to regulate the licensee's use of the licensed trademark).

151. "Facilities" here not only refers to physical plants but also to relevant hardware or machinery.

152. *See* 2 MILGRIM & BENSE, *supra* note 137, § 16.01 (noting that in some instances real property can be "intimately related to a licensing transaction"; for example, "the owner of the technology also owns the manufacturing facilities and essentially leases them to the licensee, which operates the facilities under the license").

153. *Id.*

154. *Id.* § 16.07 (noting that licensors sometimes retain certain undisclosed technology in their equipment and lease it to licensees; such equipment is "not generally available and is necessary to practice the licensed technology").

155. *See* Teece, *supra* note 27, at 119-20; Rosemarie Ham Ziedonis, *Don't Fence Me in: Fragmented Markets for Technology and the Patent Acquisition Strategies of Firms*, 50 MGMT. SCI. 804, 808 (2004) (discussing the technical difficulty, significant investments, and high risk of developing specialized facilities in the semiconductor industry).

"convert lignocellulosic biomass into high-value, bio-based chemicals and products."[156] The patentee also had a facility "equipped with a wide range of biomass processing equipment" to implement the patented technology.[157] Meridian Waste Solutions, Inc. (the licensee) obtained a patent license from the patentee and rented its processing facility through a lease agreement.[158] With the patentee's facility, the licensee believed that it could launch its business "immediately."[159] It also believed that the facility was the "only existing production facility" for the licensees' production operation, and that "significant and prolonged disruptions at the facility would have a material adverse effect on [its] business, financial condition and results of operations."[160]

Instead of leasing, licensees can acquire facilities from patentees by signing an asset purchase agreement.[161] In particular, if a firm decides to enter an industry that is remote from the field in which it previously worked, it might need to take over an entire business segment from another entity, including patents, facilities, and other assets. In this situation, the asset purchase agreement is the core of the transaction, while the patent licensing agreement is ancillary to it. For example, Viking Systems, Inc. (the licensee) obtained a complete business segment relating to visualization technology from Vista

156. Meridian Waste Sols., Inc., Annual Report (Form 10-K) 6 (Apr. 16, 2018), https://www.sec.gov/Archives/edgar/data/949721/000121390018004538/f10k2017_meridianwaste.htm.

157. *Id.*

158. *Id.*; *see also* Am. Sci. & Tech. Corp. & Meridian Innovations, LLC., Exclusive Commercial Patent License Agreement, 2017 WL 05182776. For a description of the relation between the lease and the licensee, see Meridian Waste Sols., Inc., Current Report (Form 8-K) 3 (Nov. 9, 2017), https://www.sec.gov/Archives/edgar/data/949721/000121390017011682/f8k110717_meridianwaste.htm ("Pursuant to the Lease, effective January 1, 2018, AST will lease to Innovations the premises located at 6445 Packer Drive, Wausau, Wisconsin 54401 and all improvements located thereon and all equipment and fixtures located therein."); Meridian Waste Sols., Inc., Commercial Lease Agreement (Form 8-K, Exhibit 10.5) § 1.07 (Nov. 9, 2017), https://www.sec.gov/Archives/edgar/data/949721/000121390017011682/f8k110717ex10-5_meridian.htm.

159. *Meridian Waste Solutions Attains Facility and Exclusive Licensing for Advanced Bio-Refining Technology*, AM. SCI. & TECH., http://www.amsnt.com/news/2017/11/13/meridian-waste-solutions-attains-facility-and-exclusive-licensing-for-advanced-bio-refining-technology (last visited Feb. 17, 2019).

160. Meridian Waste Sols., Inc., Annual Report (Form 10-K) 38 (Apr. 16, 2018), https://www.sec.gov/Archives/edgar/data/949721/000121390018004538/f10k2017_meridianwaste.htm.

161. *See, e.g.*, Analog Devices, Inc. & Ikanos Comms., Inc., Patent and Technology License Agreement, 2006 WL 8326192; Ikanos Comms., Inc. Asset Purchase Agreement (Form 10-K, Exhibit 2.2) (Feb. 27, 2006), https://www.sec.gov/Archives/edgar/data/1219210/000104746906002539/a2167797zex-2_2.htm.

Medical Technologies, Inc. (the patentee). Their asset purchase agreement stated that the patentee would give the licensee a patent license and all the fixed assets and tangible personal property necessary for the operation of the business.[162] The acquisition of the business segment helped the licensee, a software developer, enter the medical devices manufacture and sales business.[163]

b) Products

In nine of the 400 patent licensing transactions in the dataset of this study (or 2.25%), the patentee manufactured final products or components for the licensee. A licensees' need for a continuous product supply from patentees arises when they lack the capacity to manufacture final products or related components on their own. Third party manufacturers might not be able to handle the production efficiently as the patentee does, as they lack the specialized techniques that are relevant to the patented technology.

For example, M-Systems Flash Disk Pioneers Ltd. (M-Systems) is a company that mainly designs and sells consumer electronics.[164] It established a strategic relationship with the Toshiba Corporation (Toshiba) for the purpose of jointly developing certain flash disk products.[165] Along with their patent license agreement, M-Systems also signed a "master purchase agreement" under which it agreed to purchase raw flash disk components and some of the final products from Toshiba.[166]

In this case, M-Systems substantially depended on Toshiba's manufacturing capability for producing patented products for sale. In its annual report, M-Systems disclosed that Toshiba "will be the sole source of

162. Vista Med. Tech. & Viking Sys., Inc., Asset Purchase Agreement (Form 10-K, Exhibit 10.59) 5 (Mar. 30, 2004), https://www.sec.gov/Archives/edgar/data/1035181/000110465904008956/a04-3915_1ex10d59.htm; Vista Med. Tech., Inc. & Viking Sys., Inc., Patent and Technology License Agreement, 2004 WL 7268013; iVOW, Inc., Annual Report (Form 10-K) 3, 8 (Mar. 31, 2005), https://www.sec.gov/Archives/edgar/data/1035181/000110465905014437/a05-1980_110k.htm.

163. Viking Sys., Inc., Annual Report (Form 10-K) 30 (Apr. 15, 2009), https://www.sec.gov/Archives/edgar/data/1065754/000101968709001382/vkng_10k-123108.htm.

164. M-Systems Flash Disk Pioneers Ltd., Annual Report (Form 20-F) 30 (June 30, 2004), https://www.sec.gov/Archives/edgar/data/895361/000089536104000028/msystems20f.htm.

165. *Id.* at 15, 23.

166. Toshiba Corp. & M-Systems Flash Disk Pioneers Ltd., Patent License Agreement, 15-16, 2004 WL 7236004; Toshiba Am. Elec. Components, Inc. & M-Systems Flash Disk Pioneers Ltd., Master Purchase Agreement (Form 20-F/A, Exhibit 4 (A) 5) § 8 (Jan 13, 2004), https://www.sec.gov/Archives/edgar/data/895361/000089536104000004/msystems20faexhibit4a5mpa_2.htm.

supply" of these products and components.[167] If Toshiba breached the contract, M-Systems would lose the ability to fulfill customers' orders in a timely fashion, "which would result in lost sales and significantly lower revenues."[168] M-System also disclosed that it was seeking to cooperate with third parties to make products comparable to the one that Toshiba manufactured.[169] But it acknowledged that handing the manufacturing tasks to the third party would incur "additional hardware and software development," and that there was no guarantee that development of comparable products would succeed, or that the third party products would be of "similar cost, quality and functionality."[170]

3. Labor

a) Technical Services

In 36 (or 9%) of the pool of 400 patent licensing transactions, licensees acquired technical services from the patentees. We can categorize these technical services into four types — training services, consulting services, quality control services, and maintenance support services. In general, patentee's technical services have two functions: (1) they address unanticipated technical difficulties that arise in the implementation of the patented technology;[171] and (2) they provide licensees with continuing access to the patentees' "tacit knowledge."[172] Such knowledge can help them to implement the patented technologies but is hard to articulate and "tends to diffuse slowly and only with effort and the transfer of people."[173]

The first type of technical services is technical training, where the patentee teaches the licensee's personnel how to implement the patent. After obtaining a patent license, licensees sometimes find that their employees are not well prepared to implement the patented technologies. When this happens,

167. M-Systems Flash Disk Pioneers Ltd., *supra* note 164, at 15.
168. *Id.*
169. *Id.*
170. *Id.*
171. *See* HOLMES, *supra* note 26, § 1:5.8.
172. *See* Lee, *supra* note 12, at 1571; *see* HOLMES, *supra* note 26, § 1:5.8.
173. DAVID J. TEECE, MANAGING INTELLECTUAL CAPITAL: ORGANIZATIONAL, STRATEGIC, AND POLICY DIMENSIONS 127 (2000); *see also* Richard R. Nelson, *What Is "Commercial" and What Is "Public" About Technology, and What Should Be?*, *in* TECHNOLOGY AND THE WEALTH OF NATIONS 57, 61-62 (Nathan Rosenberg, Ralph Landau & David C. Mowery eds., 1992) (noting that some complex techniques can be transferred to other parties only with teaching and learning); 3 MILGRIM & BENSEN, *supra* note 100, § 19.04 ("Personal technical assistance is so important because words are imperfect, plans and drawings are imperfect, specifications and even formulas are imperfect.").

licensees can ask patentees to train their personnel.[174] For example, Junning Ma (the patentee) granted Shenzhen ORB-Fortune New-Material Co., Ltd. (the licensee) a patent license relating to an adhesive composition and its related preparation method.[175] The licensee also needed the patentee to teach its techniques and train the licensee's personnel. The patent license agreement required the patentee to (1) teach the licensed technology, (2) answer the licensee's questions about how to use the technology, and (3) send a specialist to the licensee's factory to assist and train the licensee's personnel.[176] The agreement also allowed the licensee to send its personnel to the patentee's factory for technical training and guidance.[177]

The second type of technical services is consulting. By consulting patentees, licensees can obtain technical information that they have not yet fully articulated. For example, along with a patent license concerning techniques for manufacturing mineral oil-based gels, SSL Americas, Inc. (the licensee) obtained consulting services from Applied Elastomerics, Inc. (the patentee).[178] The patentee agreed to provide consulting services relating to the performance of scientific or technical activities, demonstrations, wet or physical chemistry, experiments, etc.[179] When seeking consulting services, the licensee would need to make a request in writing and wait for the patentee's decision about whether it had the expertise and the ability to provide the requested services.[180]

The third type of technical services is quality control. Quality control services ensure that the patented products are manufactured in a way that meets technical standards.[181] Patentees might have better knowledge about

174. *See* HOLMES, *supra* note 26, § 12:8.2(B) ("Because the licensor usually is the party initially possessing the superior knowledge of the licensed product, the costs of introductory training of the licensee's personnel are often borne by the licensor."); 2 MILGRIM & BENSEN, *supra* note 137, § 16.10 ("Personnel training can occur at other facilities of the licensor (or its other licensees). This offers the advantage of enabling the licensed operation to achieve the shortest learning curve when its own operations commence."); *see, e.g.*, Zhao Zifeng & Yinlips Dig. Tech. (Shenzhen) Co., Ltd., Patent License Agreement § 6, 2008 WL 11096485 (requiring the patentee to send qualified technical specialists to "provide on-the-spot technical guidance, and give training course" to the licensee's technical staff and to ensure the staff mastered the patented technology).

175. Junning Ma & Shenzhen ORB-Fortune New-Material Co., Ltd., Patent License Agreement, 2010 WL 11349005.

176. *Id.* § 8.

177. *Id.*

178. Applied Elastomerics, Inc. and SSL Am., Inc., Patent License Agreement § 1.7(b), 2005 WL 8064279.

179. *Id.*

180. *Id.*

181. HOLMES, *supra* note 26, § 10:7.

how to manufacture those products, so, after obtaining a patent license and the manufacturing facilities from patentees, licensees might enter an agreement to require patentees to supervise the manufacturing process. For example, Uni-Pixel Displays, Inc. (the licensee) acquired a set of assets from Atmel Corporation (the patentee) that included the patents and facilities necessary for producing touch sensors.[182] The parties also entered a transition services agreement under which the patentee agreed to provide (1) quality assurance and failure analysis services; (2) business data, email, and network and communication services; (3) facilities support services; (4) manufacturing execution system services; and (5) operations services.[183]

The fourth type of technical services is maintenance support. Licensees might need patentees to maintain and enhance licensed technologies. The services might be conveyed to both the licensees and the licensees' customers. For example, Avistar Communications Corporation (the patentee) licensed its patent that relates to bandwidth management software to International Business Machines Corporation (the licensee).[184] The patentee also agreed to provide maintenance support services, including installment, subsequent updates, error corrections, and basic enhancement of the licensed software, to the licensee.[185] The services also included providing documentation for customers to enable developer tools to program the licensed software and providing documentation for end-users for the purposes of installing, configuring, and the performance of licensed software.[186]

182. Uni-Pixel, Inc., Current Report (Form 8-K) 2-3 (Apr. 17, 2015), https://www.sec.gov/Archives/edgar/data/1171012/000118518515000934/unipixel8k041615.htm; Atmel Corp. & Uni-Pixel Displays, Inc., XSense Patent License Agreement, §§ 1.3, 1.4 2015 WL 8030164.

183. Uni-Pixel Displays, Inc, Transition Services Agreement (Form 8-K, Exhibit 10.4) § 2.1 (Apr. 17, 2015), https://www.sec.gov/Archives/edgar/data/1171012/000118518515000934/ex10-4.htm.

184. *See* Avistar Comms. Corp. & Int'l Bus. Mach. Corp., Patent License Agreement, 2008 WL 11084690; Avistar Comms. Corp., Quarterly Report (Form 10-Q) 9 (Nov. 14, 2008), https://www.sec.gov/Archives/edgar/data/1111632/000111163208000034/form_10q.htm.

185. Avistar Comms. Corp., Licensed Works Agreement (Form 10-Q, Exhibit 10.21) § 2.0 (Nov. 14, 2008), https://www.sec.gov/Archives/edgar/data/1111632/000111163208000034/exhibit_1021.htm; Avistar Comms. Corp., Licensed Works Agreement Statement of Work (Form 10-Q, Exhibit 10.22) §§ 1.0, 3.0, 5.0 (Nov. 14, 2008), https://www.sec.gov/Archives/edgar/data/1111632/000111163208000034/exhibit_1022.htm [hereinafter Avistar Comms. Corp., Licensed Works Agreement Statement of Work].

186. Avistar Comms. Corp., Licensed Works Agreement Statement of Work, *supra* note 185, § 3.1.1.

b) R&D Services

Licensees can acquire R&D services from patentees in cases where the licensed technologies are immature.[187] Patentees, as technology creators, have comparative advantages when it comes to making technological improvements.[188] So, licensees might hire patentees' inventors or technical personnel in order to improve the licensed technologies and to develop products.[189] Empirical evidence shows that engaging with inventors during the development process can increase the likelihood and extent of a firm's success at commercializing technology.[190] Among the 400 patent licensing transactions in the dataset of this Article, 16 transactions (or 4%) involved R&D services transfers.

Patentees' effective research tools can be a reason for licensees to acquire their R&D services in order to turn the patented technologies into final products. For example, Cue Biopharma, Inc. (the patentee) developed a technology relating to antigen-specific T cell-targeted biologics and licensed the technology to Merck Sharp & Dohme Corp. (the licensee).[191] The licensed product candidates were immature and needed further development.[192] The patentee had exclusive possession of a highly productive biologic drugs designing platform, which was critical to the discovery of the drug.[193] For this reason, the licensee obtained the patentee's R&D services for the drug's future development.[194] It financed the patentee's relevant R&D and agreed to pay

187. *See* BRUNSVOLD ET AL., *supra* note 123, at 356 (noting that most R&D collaboration agreements "involve promising but unproven technology that will require significant expense to develop, usually with a significant risk of failure").

188. *See* Lee, *supra* note 12, at 1556 (noting that "licensees actively seek relationships with the inventors whose patents they license" for their "technical knowledge" and their "side-by-side problem solving" that "addresses . . . specific technical need[s]").

189. For example, the University of Pennsylvania licensed its pharmaceutical patents concerning DNA vaccines to VGX Pharm., Inc. and agreed to collaborate on the development of the product candidates. *See* The Tr. of the U. of Pa. & VGX Pharm., Inc., Patent License Agreement, 2009 WL 10547085.

190. Ajay Agrawal, *Engaging the Inventor: Exploring Licensing Strategies for University Inventions and the Role of Latent Knowledge*, 27 STRATEGIC MGMT. J. 63, 77 (2006).

191. *See* Cue Biopharma, Inc., Registration Statement (Form S-1/A) 74 (Dec. 13, 2017), https://www.sec.gov/Archives/edgar/data/1645460/000157104917008698/t1703167-s1a.htm.

192. *See id.* at 56.

193. *See id.* at 54.

194. *See id.* at 1-3, 8; Cue Biopharma, Inc. & Merck Sharp & Dohme Corp., Exclusive Patent License and Research Collaboration Agreement § 2, 2017 WL06347621; *see also* Ben Adams, *Cue Biopharma in $374M-plus Merck Immunotherapy Pact*, FIERCEBIOTECH (Nov. 16, 2017), https://www.fiercebiotech.com/biotech/cue-biopharma-374m-plus-merck-immunotherapy-pact; *Cue Biopharma Announces Strategic Research Collaboration and License*

considerations of $101 million, $120 million, and $150 million upon the achievement of certain research, development, regulatory, and commercial milestones.[195]

Patentees' deep knowledge in the relevant field of the licensed technology can be a reason for licensees to obtain their R&D services. For example, Daré Bioscience, Inc. (the licensee) obtained a patent license from Strategic Science & Technologies, LLC (the patentee) concerning a technology for treating female sexual arousal disorder.[196] But the product candidate was still in the clinical-stage and needed more development before it could pass the FDA's regulatory hurdles.[197] Since the patentee had "deep knowledge" of the targeted symptom, the licensee wanted its R&D services.[198] The licensee agreed to pay considerations "ranging from $500,000 to $150,000,000 contingent on achieving certain clinical, regulatory and commercial milestones."[199]

Obtaining a patentee's R&D services does not mean that the patentee's research capability will outperform that of the licensees in every aspect. Their capabilities might have comparative advantages in different technology fields that are complementary to each other.[200] For example, along with their patent license, Dow Chemical Company (the patentee) and Millennium Cell Inc. (the

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Agreement with Merck, BUSINESS WIRE, https://www.businesswire.com/news/home/20171116005197/en/Cue-Biopharma-Announces-Strategic-Research-Collaboration-License (last visited Feb. 17, 2019).

195. Cue Biopharma, Inc., *supra* note 191, at 74.

196. Strategic Science & Technologies-D LLC. & Daré Bioscience, Inc., License and Collaboration Agreement at 1, 2018 WL 01516513 (showing recitals).

197. Daré Bioscience, Inc.*, Enters into License and Collaboration Agreement for a Product with the Potential to Receive the First FDA Approval for Female Sexual Arousal Disorder* (Feb. 12, 2018), https://darebioscience.gcs-web.com/news-releases/news-release-details/dare-bioscience-inc-enters-license-and-collaboration-agreement.

198. *Id.*

199. Daré Bioscience, Inc., Annual Report (Form 10-K) 38 (Mar. 28, 2018), https://www.sec.gov/Archives/edgar/data/1401914/000156459018006989/dare-10k_20171231.htm; *see also* Strategic Science & Technologies-D LLC. & Daré Bioscience, Inc., License and Collaboration Agreement § 8, 2018 WL 01516513 (partly redacted due to confidential treatment).

200. *See* BRUNSVOLD ET AL., *supra* note 125, at 356 (stating that "companies with different market interests may join to develop a new technology-based product having application in both markets. Competitors may collaborate on costly research and development activities that neither could do alone"); *see also* Frank T. Rothaermel, *Incumbent's Advantage Through Exploiting Complementary Assets Via Interfirm Cooperation*, 22 STRATEGIC MGMT. J. 687, 690, 693, 696-97 (2001) (showing that new biotechnology firms collaborate with traditional pharmaceutical firms to research and develop new products, combining the former's advantage in technological expertise of and the latter's advantage in FDA regulatory management, and that 68.2% of the strategic alliances in the biopharmaceutical industry are established with the target to develop new products).

licensee) established a joint development project to work on a portable hydrogen battery.[201] The patentee was one of the leading companies in the field of innovative chemical and plastic products.[202] The licensee was a company that had a unique technology for storing and delivering hydrogen energy in small package.[203] The licensee believed that the combination of the two companies' technical resources would help them both achieve their business goals.[204]

B. BUNDLED ASSET TRANSFERS IN EX ANTE AND *EX POST* PATENT LICENSING CONTEXTS

The relationship between patent licensing and innovation has been an issue of concern for scholars. Some contend that patent licensing merely transfers the legal right to use existing technological information from the patentee to the licensee.[205] However, others argue that some patent licenses may promote innovation because in these licenses, the patentee transfers new knowledge to the licensee, which is a type of asset that complements patented technology in realizing its value.[206]

Lemley and Feldman's surveys of American companies reveal that whether a patent license involves the transfer of new knowledge may depend on the timing of the license. They believe that patent licenses entered into after a patent infringement dispute ("ex post patent licenses") might not promote innovation because they are unlikely to involve the transfer of new knowledge.[207] Although their studies do not contain data on patent licenses

201. *See* The Dow Chem. Co. & Millennium Cell Inc., Patent Assignment Agreement and License, 2005 WL 8087484; *Millennium Cell Inc: Millennium Cell and The Dow Chemical Company Achieve Milestone 2*, BUSINESS WIRE (July 26, 2007, 9:00 AM), https://www.marketscreener.com/quote/stock/MILLENNIUM-CELL-9974/news/Millennium-Cell-Inc-Millennium-Cell-and-The-Dow-Chemical-Company-Achieve-Milestone-2-394718/

202. *See* Millennium Cell Inc., Annual Report (Form 10-K) 2 (Mar. 29, 2006), https://www.sec.gov/Archives/edgar/data/1114872/000111487206000006/form10k123105.htm.

203. *See id.* at 1-2.

204. *See id.*

205. *See* Spindelfabrik Suessen-Schurr, Stahlecker & Grill GmbH v. Schubert & Salzer Maschinenfabrik Aktiengesellschaft, 829 F.2d 1075, 1081 (Fed. Cir. 1987) ("As a threshold matter, a patent license agreement is in essence nothing more than a promise by the licensor not to sue the licensee."); *cf.* Feldman *supra* note 13 ("A license, after all, is merely an agreement not to sue in return for a monetary payment, and the threat of a lawsuit is what drives companies to pay the licensing fee.").

206. *See* Chien, *supra* note 12, at 167-80; Graham et al., *supra* note 22, at 1316; Risch, *supra* note 26, at 983 (claiming that the transfer of sufficient know-how is a way to "maximize [the patented technology's] potential"); *cf.* Barnett, *supra* note 11, at 1 (noting that IP licensing transactions facilitate "value-creating exchanges of knowledge assets").

207. Feldman & Lemley, *Sound and Fury*, *supra* note 37, at 1795; Feldman & Lemley, *Patent Licensing Demands*, *supra* note 37, at 139.

entered into prior to a patent infringement dispute ("ex ante patent licenses"), they believe that ex ante patent licensing may contain the transfer of new technological information.[208] If their view is consistent with reality, we can infer that patent licensing promotes innovation is likely to occur in ex ante context.

This Article argues that Lemley and Feldman limiting their observations of complementary assets to new knowledge might cause their studies to underestimate the role of patent licensing in promoting innovation. Although new knowledge is an important asset that facilitates licensees to implement the patented technology, other types of assets, such as equipment, can also play a role in enhancing the value of the technology. Focusing only on the transfer of new knowledge might risk regarding certain innovation-enhancing patent licenses as non-innovation-enhancing. This Article expands the scope of observation to other types of complementary assets to help scholars gain a better understanding of the role of patent licensing in promoting innovation. It also examines bundled asset transfer in ex ante patent licensing,[209] filling the gap in Lemley and Feldman's studies for ex ante patent licensing data. Furthermore, this Article also explain the differences between ex ante and ex post patenting concerning bundled asset transfers.

349 of the 400 material patent licensing transactions (or 87.25%) did not reflect the goal of settling patent litigation. If this result is generalizable, it suggests that parties in the innovation marketplace tend to complete their important patent licensing transactions in an ex ante and voluntary way. 166 of the 349 ex ante patent licensing transactions involved bundled asset transfers, accounting for 47.56%. This confirms the theory of the existing literature that bundled asset transfers tend to happen in an ex ante context.[210]

Nevertheless, it is also worth noting that even in an ex ante context, the majority of the material patent licensing transactions (52.44%) did not involve bundled asset transfers. The licensees in these transactions merely needed the patentee's promise not to file a patent infringement lawsuit against them. Their

208. Feldman & Lemley, *Sound and Fury*, *supra* note 37, at 1799-80; Feldman & Lemley, *Patent Licensing Demands*, *supra* note 37, at 139.

209. It distinguishes the licensing transactions that parties entered in the context of patent infringement litigation from those that occurred without that overt pressure by searching the dockets with the parties' names in the Bloomberg Law database. *See infra* Appendix for a description of the data collection.

210. Feldman & Lemley, *Sound and Fury*, *supra* note 37, at 1799; Feldman & Lemley, *Patent Licensing Demands*, *supra* note 37, at 139.

assets were no less effective or better than the assets of the patentees themselves with respect to implementation of the patented technology.[211]

51 of the 400 licensing transactions (12.75%) occurred in context of settling pending patent litigation.[212] We can view these transactions as ex post patent licensing transactions because the patent licenses were granted after the licensee reduced the patent to practice by infringement. In an ex post context, parties need to deal with two issues in the same transaction – settling their pending patent disputes and figuring out the terms of a patent license for the future use of the relevant technology. Parties might complete the transaction with one contract, combining the settlement and the patent license in one document.[213] Sometimes, parties sign a settlement agreement to resolve all of the disputes in their litigation and sign a patent licensing agreement ancillary to it to govern the specific issues relating to patent licensing.[214]

Among the transactions settling pending patent litigation, only three (or 5.88%) involved complementary asset transfer. In one example, Butamax filed eight complaints against Gevo, alleging that Gevo was infringing some of its patents.[215] These patents related to the production of isobutanol, a type of alcohol.[216] The parties decided to settle the pending cases and establish "a new relationship."[217] Along with their settlement agreement, they entered a patent license agreement, under which each party licensed certain patents and patent applications to the other party.[218] Despite its right to the patents, Butamax also granted Gevo an option to obtain its "engineering package" to implement a

211. A technology owner might not have the necessary assets with which to implement its technology and earn profits. In this situation, it is profitable for it to license the technology to users who have these assets. *See* ARORA ET AL., *supra* note 12, at 96 ("[T]he producer of the knowledge may not have the necessary downstream assets to exploit it commercially The producer may therefore find it profitable to license the technology or enter into cooperative agreements with other firms."); *see also* BRUNSVOLD ET AL., *supra* note 123, at 355 (noting that small research-based companies or nonprofit organizations that do not have "significant manufacturing and marketing capabilities" might grant patent license to large firms with these capabilities in order to commercialize their inventions).

212. *See generally* Chien, *supra* note 12, at 1677 (noting that "licenses [are] often signed when cases are settled").

213. *See, e.g.*, Thermage, Inc. & Syneron, Inc., Patent License and Settlement Agreement, 2006 WL 8385002.

214. *See, e.g.*, Beckman Coulter, Inc. & Applera Corp., Real-Time Instrument Patent License Agreement, 2008 WL 11065970 (stating that the patent license agreement was ancillary to a settlement agreement).

215. *See* Gevo, Inc., Annual Report (Form 10-K) 48 (Jun. 3, 2016), https://www.sec.gov/Archives/edgar/data/1392380/000156459016015604/gevo-10k_20151231.htm.

216. *Id.* at 7-8, 48.

217. *Id.* at 48.

218. Butamax Advanced Biofuels LLC & Gevo, Inc., Patent Cross-License Agreement §§ 2(a), (b), 2015 WL 8601900.

special technology for the production of isobutanol.[219] The parties believed that this transaction would allow them to "leverag[e] each other's strengths and accelerat[e] development of competitive supply for bio-based isobutanol."[220]

The findings reveal a divergence in ex ante and ex post patent licensing transactions with respect to bundled asset transfers. The percentage of transactions that involved bundled asset transfers in the group of ex post transactions is substantially lower than in the group of ex ante ones. The result supports the conclusion that Lemley and Feldman reached about the difference between ex post and ex ante transactions. Two factors might explain the divergence: (1) the degree of the licensee's dependence on patentee, and (2) the extent to which the licensee has completed its innovation process.

First, the timing of the licensing transactions reflects the licensee's dependence on the patentee's assets. Some users do not have and cannot obtain from third parties the complementary assets that are necessary to deploy the patentee's technology. Due to the absent necessary complementary assets, they are unable to implement the technology without the patentee's permission, i.e., by infringement. Therefore, these users will not be the licensees in ex post licensing transaction, but would have to obtain complementary assets from the patentee ex ante their implementation of technology. The fact that a licensee can infringe a patent and enter ex post licensing transactions with the patentees indicates that it does not substantially depend on the patentee's assets to implement the relevant technology. So, it should not be surprising to find that so few of the ex post transactions involved bundled asset transfers.[221]

Second, in the ex post context, the licensees might already have finished the stage of innovation that relates to patentees' assets. The process of innovation often consists of several stages: refinement of inventions, product development, product manufacture, and product distribution in the marketplace.[222] As Part II A shows, licensees obtain patentees' assets to

219. *Id.* § 2(c); Gevo, Inc., *supra* note 215, at 7.

220. Gevo, Inc., Press Release (Form 8-K, Exhibit-99.1) 1 (Aug. 27, 2015), https://www.sec.gov/Archives/edgar/data/1392380/000119312515304010/d71855dex991.htm.

221. For more discussion, see Part IV.B.

222. *See* Rosanna Garcia & Roger Calantone, *A Critical Look at Technological Innovation Typology and Innovativeness Terminology: A Literature Review*, 19 J. PROD. INNOVATION MGMT. 110, 110-12 (2002) (claiming that "an invention does not become an innovation until it has processed through production and marketing tasks and is diffused into the marketplace"); Marianna Makri, Michael A. Hitt & Peter J. Lane, *Complementary Technologies, Knowledge Relatedness, and Invention Outcomes in High Technology Mergers and Acquisitions*, 31 STRATEGIC MGMT. J. 602, 604 (2010) (claiming that "innovation involves the exploitation of an invention

implement the patented technology in one or several stages.[223] Patent litigation often happens after all of these stages or at least at a relatively late stage.[224] By this time, the licensee's demand for the asset might have disappeared. For example, a patentee who has know-how that can help a licensee develop a product might no longer be able to sell the know-how to the licensee in the settlement if the licensee has completed the product development stage.[225] In other words, the delay of the licensing transaction can diminish or eliminate the patentee's trading opportunities of its complementary assets.

IV. IMPLICATIONS

A. ALLOW EFFICIENCY-ENHANCING BUNDLING ARRANGEMENTS

As Part II of this Article notes, the technical information that the patent system discloses might not by itself lead to innovation. Before implementation of a patented technology, potential users might need information that the patent does not disclose in order to understand the technology fully. Even if they grasp the technology, they might be unable to implement it if they lack the related non-informational assets. These impediments keep the patent system from achieving its goal of promoting innovation. The findings in Part III show that patent licensing contracts with bundling arrangements help the patent system to achieve its goal – promoting innovation – by allocating

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through product development, manufacturing, marketing, distribution, and after-sales service"); Teece, *supra* note 72, at 288 ("In order for such know-how to generate profits, it must be sold or utilized in some fashion in the market."); Feldman & Lemley, *Patent Licensing Demands*, *supra* note 37, at 138 (considering innovation as "the development and deployment of new technology into the world").

223. In the early stage of innovation, the licensee can employ a patentee's proprietary information, software, and R&D services to refine the invention and develop products. When the licensee enters the stage of product manufacture, the patentee's production facility, manufacture capacity, and quality control services can come into play. In the stage of product distribution, the patentee's trademark and trade secrets, such as sales information and customer lists, can help the licensee. Even after sale, the patentee can provide maintenance support services to the licensee and its customers.

224. Feldman & Lemley, *Sound and Fury*, *supra* note 37, at 1800 ("Patent litigation and licensing demands for existing patents, by contrast, tend to occur well after the defendant has developed and implemented the technology."); Chien, *supra* note 12, at 1685 ("Patent licenses signed as the result of patent litigation are a highly selected part of the patent market, and because they are formed ex post, they also tend to take place after technology has been transferred or copied, or independently invented.").

225. *Cf.* Feldman & Lemley, *Patent Licensing Demands*, *supra* note 37, at 156, 160 (determining that licensees rarely generate new products or services after they enter ex post patent licensing transactions).

"complementary assets"[226] to licensees in order to deploy the technology that the patent discloses.[227] Though the contracts that Part III examines represent only a subset of patent licensing transactions – transactions that are material to relatively large companies – the findings indicate that the bundling arrangements in technology transactions tend to be efficiency-enhancing arrangements.

The law of patent misuse and antitrust case law, however, regard bundling (or tying)[228] arrangements in patent licensing as illegal solely on the basis of their potential anticompetitive effects, without regard to their efficiency-enhancing effects. Even if a bundling arrangement has efficiency-enhancing effects, a patentee cannot use this as a reason to avoid a court finding that the bundling arrangement is illegal. In other words, courts currently will not use the efficiency-enhancing effects of bundling arrangements to counterbalance their potentially anticompetitive effects. This Article argues that the offsetting of efficiency-enhancing effects against anticompetitive effects might be necessary because the former may outweigh the latter, resulting in a positive net effect on social welfare.

Potential anticompetitive effects are the sole consideration in the law of patent misuse and antitrust case law to determine the illegality of a bundling arrangement.[229] A bundling arrangement would be held illegal if it is "coercive in nature"[230]–the patentee is forcing the licensee to purchase assets that it does

226. Economists use "complementary assets" to refer to the assets that technology users use to "package[] [the technology] into products or services to yield value." TEECE, *supra* note 27, at 25; *see also* Petra Christmann, *Effects of "Best Practices" of Environmental Management on Cost Advantage: The Role of Complementary Assets*, 43 ACAD. MGMT. J. 663, 664 (2000) (claiming that complementary assets are the assets needed "to capture the benefits associated with a strategy, a technology, or an innovation"); *cf.* David J. Teece, *Firm Organization, Industrial Structure, and Technological Innovation*, 31 J. ECON. BEHAV. & ORG. 193, 196 (1996) (noting that successful innovation requires maintenance of the linkages to complementary assets).

227. TEECE, *supra* note 27, at 101 (stating that "the innovator could attempt to access [complementary] assets through straightforward contractual relationships").

228. *See* U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, *supra* note 15, at 103 (noting that the case law in the United States sometimes uses "bundling" and "tying" interchangeably); *see, e.g.*, United States v. Microsoft Corp., 253 F.3d 34, 95 (D.C. Cir. 2001).

229. *See* Ill. Tool Works Inc. v. Indep. Ink, Inc., 547 U.S. 28, 37 (2006) ("Per se condemnation—condemnation without inquiry into actual market conditions—is only appropriate if the existence of forcing is probable. Thus, application of the per se rule focuses on the probability of anticompetitive consequences . . . ."); *see also* Eastman Kodak Co. v. Image Tech. Servs., Inc., 504 U.S. 451, 464 (1992); 2 EARL W. KINTNER, JOSEPH P. BAUER, WILLIAM H. PAGE & JOHN E. LOPATKA, FEDERAL ANTITRUST LAW § 15.13 (2019) ("At a minimum, the plaintiff must show that the defendant had 'sufficient market power' in the tying product market to coerce the unwanted purchase of the tied product.").

230. *See* KINTNER ET AL., *supra* note 229, § 15.13.

not want or that it would otherwise purchase from others on different terms.[231] Courts consider two factors to determine whether a bundling arrangement is illegal: (1) the patentee conditions the patent license on the purchase of other assets;[232] and (2) "the patent owner has market power in the relevant market for the patent. . . ."[233] If a court finds a bundling arrangement illegal under the law of patent misuse, it can hold patentee's patent unenforceable.[234] If it determines that a given arrangement violates Section 1 of the Sherman Act, it can impose federal antitrust liabilities, including fines and imprisonment, on the patentee.[235]

The approach to finding bundling arrangements in patent licensing illegal on the basis of potential anticompetitive effects has been generally consistent from the past to the present. In the past, the Supreme Court has adopted a *per se* rule against bundling arrangements.[236] The *per se* rule regarded a bundling arrangement as an antitrust violation or as patent misuse if it is coercive. The Court presumed that a patent confers market power on the patentee,[237] and that forcing the licensee to purchase unpatented goods has anticompetitive effects.[238] In an early patent misuse case, *Motion Picture Patents Co.* v. *Universal Film Manufacturing Co.*, the patentee granted the licensee a license to manufacture and sell patented projectors, with a covenant that it sell them "under the restriction and condition" that the machines "shall be used solely" with certain films, which the patent did not cover.[239] The Court held this

231. Jefferson Par. Hosp. Dist. No. 2 v. Hyde, 466 U.S. 2, 12 (1984) ("Our cases have concluded that the essential characteristic of an invalid tying arrangement lies in the seller's exploitation of its control over the tying product to force the buyer into the purchase of a tied product that the buyer either did not want at all, or might have preferred to purchase elsewhere on different terms.").

232. 35 U.S.C. § 271(d) (2012); N. Pac. Ry. v. United States, 356 U.S. 1, 5-6 (1958) (stating that "a tying arrangement may be defined as an agreement by a party to sell one product but only on the condition that the buyer also purchases a different (or tied) product, or at least agrees that he will not purchase that product from any other supplier").

233. 35 U.S.C. § 271(d) (2012); *Ill. Tool Works*, 547 U.S. at 37.

234. 35 U.S.C. § 271(d) (2012); *see* Morton Salt Co. v. G.S. Suppiger, 314 U.S. 488, 494 (1942) (holding the plaintiff's patent unenforceable on the ground that the plaintiff conditioned its patent license on the use of the product bundled with the license).

235. 15 U.S.C. § 1 (2012).

236. *See* U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, *supra* note 15, at 104 (2007).

237. *Ill. Tool Works*, 547 U.S. at 38 (noting that in 1940s "[t]he presumption that a patent confers market power migrated from patent law to antitrust law").

238. *See supra* note 255.

239. Motion Pictures Patents Co. v. Universal Film Mfg. Co., 243 U.S. 502, 506 (1917) (internal quotation marks omitted).

restriction void, as it was "wholly without the scope and purpose of our patent laws" and because sustaining it would be against public interest.[240]

In *Carbice Corp.* v. *American Patents Development Corp.*, the licensor refused to license a patented technology unless the buyer purchased unpatented dry ice from it.[241] Though it did not formally grant licenses to buyers, it used the invoices of the sale of its dry ice to specify certain limitations, requiring the buyers to use the patented technology only with its dry ice.[242] The Court held that "it may not exact as the condition of a license that unpatented materials used in connection with the invention shall be purchased only from the licensor."[243] In *Morton Salt Co.* v. *G.S. Suppiger Co.*, the patentee leased its patented machine to commercial canners for depositing salt tablets "under licenses to use the machines upon condition and with the agreement of the licensees that only [its] subsidiary's salt tablets be used with" the machine.[244] The Court condemned this arrangement as it allowed the patentee to use "its patent monopoly to restrain competition in the marketing of unpatented articles."[245]

Similarly, in a 1947 antitrust case, *International Salt Co.* v. *United States*, the patentee used restrictive clauses or other standard provisions to require those who leased its patented machines to also buy salt and salt tablets from them.[246] The Court held that the patentee "engaged in a restraint of trade"[247] as its "patents confer no right to restrain use of, or trade in, unpatented salt."[248] It held the bundling arrangement was held "unreasonable, per se," as its purpose was "to foreclose competitors" from the market of unpatented salt.[249] The Court condemned bundling a patent license with unpatented supplies, because "the tendency of the arrangement to accomplishment of monopoly seems obvious."[250]

Currently, a market power analysis has become part of the application of the *per se* rule as Congress, the antitrust enforcement agencies, courts, and most economists have concluded that patents do not necessarily confer market

240. *Id.* at 508.
241. Carbice Corp. v. Am. Patents Dev. Corp., 283 U.S. 27, 29-30 (1931).
242. *Id.* at 30.
243. *Id.* at 31.
244. Morton Salt Co. v. G. S. Suppiger Co., 314 U.S. 488, 491 (1942).
245. *Id.*
246. Int'l Salt Co. v. United States, 332 U.S. 392, 394-95 (1947).
247. *Id.* at 395-96.
248. *Id.*
249. *Id.*
250. *Id.*

power on the patentee.[251] In 1988, Congress added Section 271 (d) to the Patent Act, under which conditioning a patent license on the purchase of a separate product would not constitute patent misuse unless "the patent owner has market power in the relevant market for the patent . . . on which the license . . . is conditioned."[252] In a 2006 antitrust case, *Illinois Tool Works Inc.* v. *Independent Ink, Inc.*, the Supreme Court held that "[a]ny conclusion that an arrangement is unlawful must be supported by proof of power in the relevant market rather than by a mere presumption thereof"[253] and that "a patent does not necessarily confer market power upon the patentee."[254] Since *Illinois Tool Works Inc.*, in all antitrust cases involving a bundling arrangement, the plaintiff must prove that the defendant has market power.

While the Supreme Court was primarily concerned with the anticompetitive effects of bundling arrangement,[255] the impact of a bundling arrangement on social welfare might be far less certain that what the court expected. Even if a patentee with market power conditions its patent license on the purchase of its complementary assets, this would not necessarily diminish the positive impact that the bundling arrangement brings about on social welfare. The assets in the bundle will facilitate the use of the technology if they are complementary to it, regardless whether the patentee has forced the licensee to purchase them. End-user-consumers might benefit from the bundling arrangement, as the complementary assets might enable the licensee to deliver higher quality products.[256] The efficiency-enhancing effects are

251. *See* Ill. Tool Works Inc. v. Indep. Ink, Inc., 547 U.S. 28, 45-46 (2006) ("Congress, the antitrust enforcement agencies, and most economists have all reached the conclusion that a patent does not necessarily confer market power upon the patentee. Today, we reach the same conclusion."); Barnett, *supra* note 11, at 9-14 (describing the changes of attitude toward bundling arrangement from the 1930s to 1980s); Herbert Hovenkamp, *The Rule of Reason and the Scope of the Patent*, 52 SAN DIEGO L. REV. 515, 519 (2015) (noting that in 1988 Congress made it clear that a unilateral refusal to license was not an unlawful patent abuse, and that a tying arrangement was only unlawful if the defendant had market power in the tying product).

252. 35 U.S.C. § 271(d) (2012); *see* Hovenkamp, *supra* note 31, at 1992 (providing the background of the legislation).

253. *Ill. Tool Works Inc.*, 547 U.S. at 29.

254. *Id.* at 46.

255. Jefferson Par. Hosp. Dist. No. 2 v. Hyde, 466 U.S. 2, 12 (1984) ("When such 'forcing' is present, competition on the merits in the market for the tied item is restrained and the Sherman Act is violated."); *id.* at 14-16 (regarding that bundling arrangements "undermine competition on the merits" in other markets and allow "potentially inferior product[s] [to] be insulated from competitive pressures"); Standard Oil Co. v. United States, 337 U.S. 293, 305-06 (1949) (holding that bundling arrangements "serve hardly any purpose beyond the suppression of competition"); *see* KINTNER ET AL., *supra* note 229, § 15.13.

256. Patentees' product quality control services, manufacturing support, and maintenance support services can improve the quality of the products that licensees deliver to end-user-

consistent with the goals that patent law and antitrust law pursue – "promoting innovation and enhancing consumer welfare."[257] Hence it is necessary to counterbalance bundling arrangements' potential anticompetitive effects with their efficiency-enhancing effects to determine the impact of bundling arrangements on social welfare.

Under the current *per se* rule, however, courts do not weigh the efficiency-enhancing effects of bundling arrangements against their potential anticompetitive effect before holding them illegal.[258] Given the added efficiency that bundling arrangements bring about and their frequent occurrence in patent licensing transactions,[259] this Article suggests that Congress and the Supreme Court should switch the current *per se* rule to a *rule of reason* approach.[260] The *rule of reason* approach adds a third prong to the coercion and market power aspects of the current *per se* rule – an analysis balancing the efficiency-enhancing effect against the potential anticompetitive effect of the relevant bundling arrangement.[261] This approach would ensure that courts examine the actual impact that bundling arrangements have on the innovation market and on the markets for other assets. In doing its analysis, if a court finds that the efficiency-enhancing effect of a bundling arrangement outweighs the anticompetitive effect, the courts should not hold it illegal. In fact, some lower courts and the antitrust enforcement agencies have already applied the *rule of reason* approach when analyzing bundling arrangements.[262]

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consumers. *See* David S. Evans & Michael Salinger, *Why Do Firms Bundle and Tie—Evidence from Competitive Markets and Implications for Tying Law*, 22 YALE J. ON REG. 37, 41 (2005).

257. U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, ANTITRUST GUIDELINES FOR THE LICENSING OF INTELLECTUAL PROPERTY 2 (1995), http://www.usdoj.gov/atr/public/guidelines/0558.pdf; *see also* Hovenkamp, *supra* note 31, at 1981 (stating that antitrust law "has become much more focused on protecting consumer welfare").

258. *See* United States v. Microsoft Corp., 253 F.3d 34, 94 (D.C. Cir. 2001) (noting that there might be "a number of efficiencies" that bundling arrangements bring about but "have been ignored in the calculations underlying the adoption of a *per se* rule").

259. *See* U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, *supra* note 15, at 114 (noting that bundling arrangements in patent licensing transactions are "ubiquitous," can "often entail" efficiencies, and "usually are not anticompetitive").

260. *See Microsoft Corp.*, 253 F.3d at 89-90 (stating that applying the current per se rule to bundling arrangements "creates undue risks of error and of deterring welfare-enhancing innovation"); Evans & Salinger, *supra* note 256, at 37 (concluding that efficiency which bundling arrangements entail supports the abandonment of the per se rule).

261. *See* Hovenkamp, *supra* note 251, at 516.

262. *See, e.g.*, *Microsoft Corp.*, 253 F.3d at 84 (applying the rule of reason to examine the bundling of operating systems and applications software); Suture Express, Inc. v. Owens & Minor Distrib., 2016 U.S. Dist. LEXIS 47421, at *90-103 (D. Kan. Apr. 7, 2016) (applying the rule of reason to examine the defendants' bundling of medical supplies), *aff'd*, 851 F.3d 1029 (10th Cir. 2017). The Department of Justice and the Federal Trade Commission have incorporated an examination that weighs the efficiency justification of bundling arrangements

As for the patent licensing transactions in the dataset, this Article does not find within the four corners of the contracts any restrictive clauses conditioning a patent licensing on purchase of complementary assets. None of the contracts stated that the licensee could use the licensed technology only if it agreed to purchase other assets from the patentee. If only the text of the contracts is analyzed, the patentees of these transactions seem to sell multiple assets in one deal. In most of the transactions, the patentees simply added clauses to the "grant of rights" section of the patent license agreement as a way to transfer the rights to their other assets to the licensees.[263] In the rest of the transactions, the parties signed one or several separate agreements, such as a know-how transfer agreement, to transfer the complementary assets along with the patent license.[264]

Through licensees' reports filed with the SEC, this Article can identify a number of bundling arrangements are made based on the licensee's preference, not the patentee's coercion.[265] For example, in some transactions, licensees explicitly stated that they were acquiring assets from the patentees based on efficiency concerns, such as accelerating development of products.[266] In a transaction, the licensee acknowledged that it was considering obtaining complementary assets from third parties, while recognizing that the assets of

against their anticompetitive effects before challenging them since 1995, though this examination is recommended rather than mandatory. *See* U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, *supra* note 15, at 26.

263. *See, e.g.*, Annamed, Inc. & Dermin Sp. zo.o., Patent and Technology Development and License Agreement 2-3, 2016 WL 01469341 (adding a clause to grant "Technology Rights" to the licensee, with "Technology Rights" including the rights to proprietary information, know-how, or data that is necessary for implementing the licensed patent); *see also, e.g.*, Cambridge Enter. Ltd. & Psynova Neurotech Ltd., Exclusive Patent and Non-Exclusive Know-How Licence Agreement § 2.1, 2010 WL 11300071.

264. *See, e.g.*, Pioneer Hi-Bred Int'l, Inc. & S&W Seed Co., Patent License Agreement §§ 1.3, 1.4, 1.7, 2015 WL 6623061 (licensing patents related to seed coatings to the licensee); Pioneer Hi-Bred Int'l, Inc. & S&W Seed Co., Know-How Transfer Agreement (Form 8-K, Exhibit 10.13) § 2 (Jan. 17, 2015), https://www.sec.gov/Archives/edgar/data/1477246/000113626115000008/swexh10-13.htm (transferring know-how along with the license).

265. *See* U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, *supra* note 15, at 114 (stating that bundling arrangements in patent licensing transactions can often lead to efficiencies and "usually are not anticompetitive").

266. *See, e.g.*, *supra* notes 20, 219 and accompanying texts; Millennium Cell Inc., Annual Report (Form 10-K) 2 (Mar. 29, 2006), https://www.sec.gov/Archives/edgar/data/1114872/000111487206000006/form10k123105.htm (stating that the licensee cooperated with the patentee to "accelerate the path towards product commercialization"); *see also* Ill. Tool Works Inc. v. Indep. Ink, Inc., 547 U.S. 28, 45 (2006) (acknowledging that many bundling arrangements "are fully consistent with a free, competitive market").

the patentee would outperform those of third parties.[267] In an extreme example, the patentee's technology is critical to the use of the patented technology and an alternative supplier for the complementary assets did not exist in the innovation marketplace at all.[268]

However, this Article cannot completely rule out the possibility that in some of the transactions the patentee had market power in the patent licensing market and conditioned the license on licensee's purchase of complementary assets. Adding restrictive clauses to the contract is not the only way to force a licensee to purchase complementary assets. For example, it is possible that in some of the transactions a patentee with market power forced the licensee to purchase complementary assets from it but did not incorporate any restrictive clauses in the contracts.

While this Article cannot conclude that in the dataset there are illegal bundling arrangements under the current *per se* rule, the proposal to shift it to the *rule of reason* approach is meaningful because allowing efficiency-enhancing effects to counterbalance potentially anticompetitive effects will affect patentees' design of licensing arrangement in general. The current *per se* rule has raised concerns among lawyers, as it is "potentially applicable to an enormous range" of bundling arrangements, including those that result from "harmless commercial decisions."[269] As they felt the need to give cautious advice to clients not to bundle intellectual property with other assets because the risk of litigation is "too great,"[270] a shift to the *rule of reason* approach would allow innovators to enter into bundling arrangements that enhance efficiency with less concern about the potential legal liabilities.

267. *See supra* notes 169-70 and accompanying text. In the innovation marketplace, it is not surprising that licensees obtain complementary assets from patentees rather than from third parties. Patentees often have complementary assets that are "specialized" for the implementation of the patented technology. *See* TEECE, *supra* note 27, at 99-100.

268. Meridian Waste Sols., Inc., Annual Report (Form 10-K) 38 (Apr. 16, 2018), https://www.sec.gov/Archives/edgar/data/949721/000121390018004538/f10k2017_meridianwaste.htm (The licensee explicitly stated that patentee's facility is the "only existing production facility" for the relevant technology); *see also* TEECE, *supra* note 27, at 101 (noting that "successful commercialization of the innovation may depend critically on a bottleneck asset which has only one possible supplier").

269. *See* U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, *supra* note 15, at 111-12 (internal quotation marks omitted).

270. *See id.* at 111 (internal quotation marks omitted); *see also id.* at 112 (noting that "it's per se malpractice to fail to advise a client who is considering an intellectual property infringement suit that he must be prepared to litigate any manner of crazy antitrust or misuse counterclaim – or misuse defense" (internal quotation marks omitted)).

B. FACILITATE BUNDLED ASSET TRANSFERS IN AN EX ANTE CONTEXT

Lemley and Feldman's surveys show that ex post licensing transactions are unlikely to involve bundled asset transfers.[271] But they believe that the bundling arrangement of a patent license and informational assets can exist in an ex ante licensing context.[272] This Article adds new evidence to support this supposition. The findings show that in material patent licensing transactions, there is indeed a divergence between ex ante and ex post licensing transactions with respect to bundled asset transfers. This Article finds that whereas only 5.88% of the ex post licensing transactions involved bundled asset transfers, 47.56% of the ex ante licensing transactions included them.

This Article demonstrates that, for certain technology users, contracting with the patentee in an ex ante context can lead to efficient allocation of assets, while contracting with the patentee in an ex post context might incur an efficiency loss. This echoes Lemley and Feldman's view that ex post licensing transactions "seem less promising."[273] For the purpose of demonstration, this Article classifies technology users into three categories – independent users, quasi-independent users, and dependent users. This chart presents a visual description of the analysis that follows. The shaded area refers to the situations where efficiency loss might occur.

Table 1: Bundled Asset Transfers in Ex Ante/Ex Post Licensing Contexts by User Types

User Types	Bundled Asset Transfer	
	Ex Ante Licensing	*Ex Post* Licensing
Independent Users	No	No
Quasi-Independent Users	Yes	Maybe
Dependent Users	Yes	Not Applicable

"Independent users" refers to users who have assets that are not less effective than those of patentees with respect to the implementation of the patented technology.[274] What they want from the patentees is merely a promise not to file a patent lawsuit against them. As the findings show, in 52.44% of

271. *See* Feldman & Lemley, *Patent Licensing Demands*, *supra* note 37, at 161-62; Feldman & Lemley, *Sound and Fury*, *supra* note 37, at 1837.

272. Feldman & Lemley, *Sound and Fury*, *supra* note 37, at 1799.

273. Feldman & Lemley, *Patent Licensing Demands*, *supra* note 37, at 139.

274. *See* TEECE, *supra* note 27, at 55 (stating that individual inventors might license their technology to "incumbent firms who already have the necessary complementary assets in place"); *supra* note 211 and accompanying text.

the ex ante licensing transactions in this study, the licensees did not obtain other assets from the patentees. The licensees in these transactions are likely to be independent users because they had the chance to obtain other assets from the patentees in an ex ante context but did not do so. This suggests that they did not need the patentees' assets.

If independent users are unable to enter ex ante licensing agreements with the patentees, they might infringe the patent and then pay patent damages back to the patentees' ex post the implementation, according to the terms of the settlement agreement or the court's decision.[275] As in an ex ante context, they would not acquire other assets from the patentee at this stage because they have comparable or more effective assets. That is to say, independent users would not acquire the patentees' assets to implement the patented technology in either an ex ante context or an ex post context. The timing of the licensing transaction does not affect the outcome of the allocation of patentees' assets to them.

"Quasi-independent users" refers to users who are able to deploy the patented technology with their own assets, even though these assets are less effective than those of the patentees. Rather than using their own assets, quasi-independent users would prefer to deploy the technology using the patentees' assets. If they are unable to contract the patentee in an ex ante context, then they, like independent users, can infringe the patent by implementing the technology with the assets that they possess. Quasi-independent users can pay royalties to the patentees when they solve their patent dispute. But this leads to inefficiencies because the users would not be able to implement the more effective assets of the patentees at earlier stages of innovation.

In ex post licensing transactions, quasi-independent users might acquire patentees' assets, especially when they have a plan to develop the patented products further.[276] The findings show that 5.88% of the ex post licensing transactions involved bundled asset transfers. But if they have already completed the stage of innovation to which the patentee's assets would apply,

275. *Cf.* Guido Calabresi & A. Douglas Melamed, *Property Rules, Liability Rules, and Inalienability: One View of the Cathedral*, 85 HARV. L. REV. 1089, 1092 (1972) (stating that under liability rules, "someone may destroy the initial entitlement if he is willing to pay an objectively determined value for it"); Robert P. Merges, *Of Property Rules, Coase, and Intellectual Property*, 94 COLUM. L. REV. 2655, 2664 (1994) (stating that when transaction costs are high, liability rules might be more favorable and that under liability rules "a court sets the price in a proceeding that typically takes place after the right has been infringed").

276. *See* Feldman & Lemley, *Sound and Fury*, *supra* note 37, at 1837 (finding that ten percent of the firms always acquire new knowledge in ex post licensing transactions from patentees that are operating companies); *see, e.g.*, Gevo, Inc., *supra* note 220, at 1.

they would no longer need the patentees' assets[277] In this situation, what they need is merely permission to keep doing what they have already done. The findings show that 94.22% of the ex post licensing transactions did not involve bundled asset transfers. The licensees of these transactions can be independent users or quasi-independent users who no longer need the patentees' assets.

"Dependent users" refers to users who depend on the patentees' assets to implement the technology. For example, in one licensing transaction, the patentee's facility is the "only existing production facility" that manufactures the patented products.[278] In this case, the user must utilize the patentee's facility if it is going to use the patented technology. Because they cannot implement the technology without the patentee's support, dependent users must enter ex ante licensing transactions for the complementary assets.[279] Inefficiency occurs if they fail to do so. Here, the user would have to abandon the technology.[280] The findings show that 47.56% of the ex ante transactions involved bundled asset transfers. The licensees of these transactions can be dependent users or quasi-independent users. Both of them would demand the patentees' assets in an ex ante context.

This analysis shows that licensees' inability to enter ex ante licensing transactions with patentees leads to efficiency loss for dependent users and quasi-independent users.[281] The fact that ex post bundled asset transfers exist indicates high transaction costs impeding technology users' ability to enter ex ante patent licensing transactions, leading to efficiency loss.[282] The fact of any given ex post transaction suggests that the patentee's assets are more effective than the licensee's. After all, a licensee would not acquire complementary assets from the patentee unless those assets were the more effective ones. It also suggests that both parties were able to agree on the price and the terms.

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277. Feldman & Lemley, *Patent Licensing Demands*, *supra* note 37, at 156, 160 (noting that ex post licensing transactions rarely lead to new products or services).

278. Meridian Waste Sols., Inc., Annual Report (Form 10-K) 38 (Apr. 16, 2018), https://www.sec.gov/Archives/edgar/data/949721/000121390018004538/f10k2017_meridianwaste.htm.

279. *See* TEECE, *supra* note 27, at 25 (noting that certain complementary assets might be the "choke point" in the value chain of innovation).

280. *See, e.g.*, Walsh et al., *supra* note 109, at 321 (noting that the failure to gain access to certain important databases leads to delay and abandonment of innovation projects).

281. Quantifying the magnitude of such efficiency loss accurately is beyond the scope of this study—it requires extra data, such as the amount of financial loss due to the licensees' delay in obtaining the patentee's complementary assets.

282. The efficiency loss in reality is likely to be worse than what the findings suggest, because the dataset of this Article only covers the transactions that parties entered successfully—it does not include cases in which dependent users abandoned a technology due to their inability to enter ex ante transactions with the patentee.

If a potential licensee whose assets are less effective than the patentee's can identify the patentee and its complementary assets in an ex ante context, it should approach the patentee in a timely fashion in order to contract for the assets and the license of the technology. Doing so leads to an efficient outcome because the potential licensee can promptly use the patentee's assets to deploy the technology. Instances when a licensee as such does not act quickly suggest that the transaction cost of detecting licensing opportunities was too high, which delayed the efficiency-enhancing ex ante bundled asset transfer.

This Article recommends that policymakers improve patent disclosures, as many potential technology users rely on the information that patents disclose in order to detect the opportunities for patent licensing, as well as to develop a sense of the patentee's relevant assets and capabilities.[283] Improved patent disclosures would lower the cost of detecting the opportunities of contracting with relevant patentees, reducing the possibility of efficiency loss for dependent and quasi-dependent users. Policymakers can create a secondary platform through which patentees can disclose the information about the complementary assets that they are willing to transfer along with a patent license. They can allow patentees to create links in the relevant patent documents to the information that patentees disclose to the platform. The platform and the links would make the connection between patented technology and its complementary assets explicit. This would allow potential users to identify the patentee's complementary assets at a lower cost, giving them the opportunity to reach out promptly to the patentee regarding a contract for a bundled asset transfer. As potential users would need to locate the relevant patent documents to use the links and the platform, it is critical to

283. *See* Lee, *supra* note 12, at 1543 (claiming that patents as "publicly recorded instruments" can help the technology owners and users to "find each other relatively easily in the marketplace"); Merges, *supra* note 60, at 1501 (stating that "the *primary* purpose of patents is to spearhead the transfer of the really valuable stuff—the associated unpatented information"); Holger Ernst, *Patent Information for Strategic Technology Management*, 25 WORLD PAT. INFO. 233, 239-40 (2003); Makri et al., *supra* note 222, at 606 (discussing how to use patent information to identify which targeted technology firms to acquire); Ming-Yeu Wang, *Exploring Potential R&D Collaborators with Complementary Technologies: the Case of Biosensors*, 79 TECH. FORECASTING & SOC. CHANGE 862 (2012) (discussing the use of patent information in order to explore potential R&D partners with complementary capabilities); *see also* Bomi Song, Hyeonju Seol & Yongtae Park, *A Patent Portfolio-Based Approach for Assessing Potential R&D Partners: An Application of the Shapley Value*, 103 TECH. FORECASTING & SOC. CHANGE 156 (2016); Jeonghwan Jeon, Changyong Lee & Yongtae Park, *How to Use Patent Information to Search Potential Technology Partners in Open Innovation*, 16 J. INTELL. PROP. RTS. 385 (2011).

reduce the search costs of relevant patent documents by making them easier to locate[284] and read.[285]

V. CONCLUSION

Though bundling arrangements frequently occur in patent licensing transactions, the nature of these arrangements is not well understood. This is partly due to a lack of access to these arrangements because firms often hold patent licensing agreements and associated agreements in confidence as trade secrets.[286] This Article takes a preliminary step toward revealing their nature by analyzing 400 material patent licensing transactions that public companies filed with the SEC and finding that 42.25% of them involved bundled asset transfers. The assets in the bundles included intellectual property, property, and labor.

The findings suggest that there are two complementary relationships underlying the innovation marketplace. In terms of *assets*, intellectual property, property, and labor can work complementarily with patented technology in the licensees' process of innovation, helping the licensees to deploy the technology. Regarding *legal institutions*, contracts complement the patent system as they bundle complementary assets with patent licenses and transfer them as a package to licensees. This helps the patent system achieve its ultimate goal of promoting innovation, as the assets in the bundles can facilitate the development and implementation of the technology that the patent system discloses.

The positive effects on innovation that bundling arrangements facilitate cannot be realized if government intervention or high transaction costs hinder

284. For proposals for improving the searchability of patent information, see Fromer, *supra* note 46, at 543 (proposing the inclusion of patent documents into the principal databases or libraries of relevant technological fields); Ouellette, *supra* note 46, at 583-87 (proposing to make patents appear alongside the technical literature in the commonly used search engines; to use peer production platforms such as WikiPatents to share information about patents; and to increase the number of patent citations in scientific articles).

285. For proposals for improving the readability of patent documents, see *Disclosure Function*, *supra* note 47, at 2027 (suggesting that patent applicants should provide "a summary section within their written description that reads more like a journal article than a patent"); Ouellette, *supra* note 46, at 601 (proposing that the PTO should make patents subject to peer review of scientists); Seymore, *supra* note 69, at 666 (proposing to transform patents into reader-friendly "teaching documents"); Fromer, *supra* note 46, at 543 (suggesting technical and legal information in the patent document should be "teased apart for each layer to speak most fruitfully to its audience").

286. *See* Chien, *supra* note 12, at 1677 (noting that the lack of public data is part of the reason why scholars paid relatively little attention to the transactional events that involve patents).

their formation. This Article suggests that lawmakers incorporate into the law of patent misuse and antitrust case law an analysis that weighs bundling arrangements' efficiency-enhancing effects against their potential anticompetitive effects. This would encourage bundling arrangements that promote innovation because it would allow patentees to use this kind of arrangement with less concern about the potential legal liabilities. In addition, this Article suggests that policymakers lower the transaction costs of bundled asset transfers by making patent documents easier to read and locate, and by linking them to a platform in which patentees can present information about the complementary assets that they are willing to transfer along with the patent license.

This Article adds empirical evidence to the growing body of literature concerning the role that contracts play in promoting innovation. It provides a detailed account of the contractual bundles that innovators frequently use in material patent licensing transactions and suggests that contracts can promote innovation by overcoming the limitations of the patent system. Because the observations of this study are confined to the material patent licensing transactions of public companies, its conclusions are tentative. A more comprehensive study will follow this one if the data of less substantial patent licensing transactions or smaller firms' patent licensing transactions becomes accessible.

APPENDIX. THE DATASET

Information about the actual patent licensing practices of companies is difficult to obtain because they often hold patent license agreements and associated agreements in confidence as trade secrets.[287] The reasons for doing so are compelling as the agreements can reveal the licensee's costs, strategic partnerships, future business plans, etc. Much of this information could be helpful to competitors. If there is no legal requirement that firms reveal this information, they are very likely not to do so. But the Securities Act of 1933 and the Securities Exchange Act of 1934 authorize the U.S. Securities and Exchange Commission (SEC) to require public companies to disclose certain information in order to protect investors and to insure fair dealing. The SEC has exercised that statutory authority to promulgate rules requiring the disclosure of certain information that is "material" to public companies.

287. *See* Mark A. Lemley, Kent Richardson & Erik Oliver, *The Patent Enforcement Iceberg*, 97 TEX. L. REV. 801, 801 (2019) (noting that "licensing negotiations and license deals that don't result in litigation are almost invariably kept secret").

Companies must disclose to the public all patent license agreements that fall into the category of "material contracts."[288]

Specifically, under Section 7 of the Securities Act of 1933 and Section 12 of the Securities Exchange Act of 1934, when a company makes a public offering, it must file a registration statement and the relevant material contracts with the SEC.[289] Under Sections 13 and 15(d) of the Securities Exchange Act of 1934, a public company must file material contracts, along with annual reports and both quarterly and current reports, with the SEC.[290] According to 17 CFR § 229.601(a)(4), public companies must file their material contracts as exhibits to their reports and registration statements if the material contracts are executed or become effective during the reporting period that the annual reports, quarterly reports, or current reports reflect, or if the text of the registration statement incorporates them by reference.[291] According to 17 CFR § 229.601(b)(10), "material contracts" are the contracts that are not made in the ordinary course of business and that are material to the registrant.[292] The same rule applies to patent licenses. Even those made in the ordinary course of business qualify as "material contract[s]" if the registrant's business substantially depends on them.[293] This means that if a registrant files a patent license as an exhibit with its reports, it is, by definition, a material contract that is important to the registrants' business.

The agreements that I examined for this Article were all "material contracts" that SEC registrants filed as exhibits to their reports. These agreements were stored in the SEC's Electronic Data Gathering, Analysis, and Retrieval system (EDGAR). But EDGAR does not organize documents by category, which made it difficult to collect EDGAR's patent licenses systematically. Fortunately, Westlaw has drawn exhibits from EDGAR since January 1, 2000 and saved them by category, including a category for patent license agreements. Specifically, Westlaw created a library called "Patent License Agreements" where it stores the patent licenses registrants disclosed as material contracts. The "Patent License Agreements" library picks out and stores an agreement if (1) its title contains the term "license," "royalty," or "sub-license"; (2) its title contains the word "patent"; and (3) its title does not contain the terms "collateral," "amendment," or "amended."[294] Westlaw

288. 17 C.F.R. § 229.601(a)(4) (2018).
289. 15 U.S.C. §§ 77g, 78l (2012).
290. 15 U.S.C. §§ 78m, 78o(d) (2012).
291. 17 C.F.R. § 229.601(a)(4) (2018).
292. 17 C.F.R. § 229.601(b)(10) (2018).
293. *Id.*
294. Live Chat Transcript with Westlaw Staff (Oct. 22, 2018) (on file with author).

regards agreements that meet these three criteria as "patent license agreements" that it stores in the library.

Admittedly, this data selection method is bound to neglect patent license agreements with titles that do not meet these three criteria. For example, this library will miss patent license agreements with the titles of "intellectual property agreement" or "license agreement." But this selection method is relatively efficient and accurately picks out patent license agreements from among millions of documents without intensive analysis of their contents. Because of the lack of a better database of patent license agreements, I chose this library as the data source.[295]

From the "Patent License Agreements" library, I collected agreements that companies filed between January 1, 2000, and May 14, 2018, collectively 659 documents. Some of these were not suitable for patent license analysis, however, because they contained duplications or irrelevant documents, such as press releases, patent security agreements, and patent sublicense agreements. I examined the documents one by one to identify and delete the irrelevant ones. This left me with 400 patent license agreements and 61 amendments to patent license agreements.

The patent license agreements record what patentees transferred to licensees. I scrutinized each contract, looking for every complementary asset that patentees conveyed to licensees with the patent licenses. When I identified any, I examined the transaction background to see how the parties expected to use the patented technologies and complementary assets together. The transaction background appeared in the reports to which patent license agreements were attached, as well as the registration statement of the filing parties. The reports of the SEC registrants often explained how they planned to use patented technologies and complementary assets in their process of innovation. The reports also disclosed the signing of any other agreements with the patent licensing agreement. When I found that the patentee and licensee signed other agreements, I looked into them to see whether the patentee also transferred other assets to the licensee.

This Article also distinguishes patent licensing transactions that parties entered in the context of patent litigation and those that did not involve litigation. I made this distinction using the "Dockets Search" feature of the

295. Westlaw states that its "EDGAR Precedent Agreements" database "provides access to over a million executed business agreements with language, clauses, and provisions drafted by leading law firms and in-house counsel." The "Patent License Agreements" library is one of the sub-databases. *See Patent License Agreements*, WESTLAW EDGE, https://1.next.westlaw.com (follow "EDGAR Precedent Agreements" hyperlink under "Business Law Center") (last visited Oct. 25, 2018).

Bloomberg Law database. Specifically, I entered the names of the parties of each patent licensing agreement into the Dockets Search to see whether it brought up a relevant court case. When I found patent litigation, I read the complaint to see whether the patents in dispute were the patents licensed in the agreement. To avoid mistakes, I also read the report to which each patent licensing agreement was attached. The report revealed the agreement's licensing background. If the parties entered the agreement as a way to settle a patent litigation, the company that filed the report would disclose the litigation in it.

This dataset has several limitations. First, all of the patent licenses in this research came from companies that registered with the SEC or from their subsidiaries. The dataset does not cover any patent licensing transactions between private companies with no relationship to SEC registrants. Second, the SEC does not require the disclosure to the public of contracts that are "immaterial in amount or significance."[296] Therefore, the data might not represent the contracts that are insubstantial to the companies' business. Third, Westlaw's selection of patent license agreements might have filtered out a number of relevant agreements. Fourth, the dataset only includes 400 patent licensing transactions, meaning that the sample size of this dataset is relatively small. Due to these limitations, the conclusions that this Article makes based on this dataset might not apply to the overall population of patent licensing transactions.

296. 17 C.F.R. § 229.601(b)(10) (2018).

END USER LICENSE AGREEMENT TAILORING FOR VIRTUAL ITEMS

Justin Tzeng†

ABSTRACT

End user license agreements (EULAs) allow developers to specify contractual limitations on aspects of software usage such as scope, license transferability, and user conduct. Doing so enables developers to offer tailored rights that diverge from those guaranteed by common law, allowing for more granular price discrimination that can yield more efficient outcomes.

In virtual worlds such as online games, EULAs override property law defaults by categorizing items as license rights rather than property. Instead of acquiring ownership in the items they purchase, players receive revocable, non-transferable license grants to access the items as features within the game. These heavily developer-favorable terms, which place significant restrictions on the alienation of virtual items and grant developers plenary discretion to modify or terminate such items, provide developers with much-needed flexibility to curate the virtual world experience. Developers can update game graphics, maintain competitive balance, and preserve player community without incurring the significant costs associated with repeatedly securing individual user approval.

Scholars have criticized the existing EULA regime for benefiting developers at users' expense. Much of the existing commentary focuses on normative concerns, such as labor theory and personhood or the desirable balance between common law default and contract, and typically argues for a systemic overhaul that introduces real-world property law defaults into virtual worlds. Many arguments also frame EULAs as unilaterally siphoning value from players to developers.

This Note takes a more incremental approach and assumes that, given scant government scrutiny and developer disincentives to disrupt a favorable equilibrium, EULAs are unlikely to be replaced in the near term. It suggests that, rather than solely distributing value, EULA rights can create allocable joint value between players and developers. This Note argues that even developers, who are most advantaged by the existing regime, would benefit from relinquishing power and granting players certain rights in virtual items. It demonstrates that while developers cannot operate without certain flexibility, the plenary discretion they currently grant themselves across all games and items grossly outstrips such needs. Drawing from economic theory on secondary markets and recent developments in the blockchain space, this Note highlights how the marginal benefit of this excess flexibility can be outweighed by reduced consumer willingness to pay for such heavily encumbered items. Selectively relinquishing discretion for certain types of worlds or items could allow developers to create and capture player value in a cost-efficient manner. While ultimately an incremental change within an

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existing system, a more tailored approach would depart from decades of EULA uniformity, with significant ramifications for a licensing regime that has underpinned the rapid ascent of a hundred-billion-dollar industry.[1]

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1. Gaming has changed significantly since this piece was written in early 2021. Accordingly, some of the examples mentioned here may appear less relevant than when this piece was originally written. In particular, as the blockchain space continues to rapidly evolve, developers may find new technical solutions to some of the challenges highlighted in this piece. However, the notion that legal terms can address these same challenges or enable their solutions is as relevant as ever—traditional game EULAs remain exceedingly one-sided, and even emergent games touting blockchain as an avenue to player ownership often feature discordant legal terms that undermine such aspirations. As player awareness of and demand for in-game item ownership continue to grow, legal terms that enable such ownership without hamstringing developers will only become more valuable.

I. INTRODUCTION

Monetizing in-game items has transformed the video game business model, supercharging the industry's growth into a hundred-billion-dollar business.[2]

Under the traditional model, game developers would release a game, often on a CD, for players to purchase upfront for a one-time fee.[3] To generate additional revenue, developers would have to either develop a new game or create expansion modules for an existing one, either of which would entail significant development costs.[4] In recent years, however, developers have increasingly introduced additional in-game features that players can separately purchase to enhance their experience in a game they already own.[5] For

2. In-game item revenues for free-to-play games alone reached approximately $98 billion worldwide in 2020. Rebekah Valentine, *Digital Games Spending Reached $127 Billion in 2020*, GAMESINDUSTRY.BIZ (Jan. 6, 2021), https://www.gamesindustry.biz/articles/2021-01-06-digital-games-spending-reached-USD127-billion-in-2020.

3. Nenad Tomić, *Economic Model of Microtransactions in Video Games*, 1 J. ECON. SCI. RSCH. 17, 17 (2018).

4. *Id.*

5. *Id.* at 18-19.

example, some players buy cosmetic "skins" that alter their characters' appearances to distinguish themselves from players using the free default appearance, while other players purchase in-game currency to spend on attribute upgrades that make their characters stronger, faster, or smarter.[6] A number of notable secondary market transactions reflect the tremendous value that players assign to certain in-game items: $14,000 paid for a mace in *Diablo III*, $38,000 for a pink dog in *Dota 2*, and $635,000 for a virtual nightclub in *Entropia*, to name just a few examples.[7]

By selling additional items within an existing game, developers now generate additional "microtransactions" beyond the upfront purchase, allowing them to monetize existing games for longer windows at nearly nonexistent marginal costs. In *Grand Theft Auto V*, for example, players spent an average of $79 on in-game items in 2019—more than the $60 price charged upfront for the entire game in 2013.[8] In 2020, the game generated $710 million in revenue, almost all of which was driven by in-game item sales.[9]

Even more drastically, in-game items have given rise to a new lucrative business model. Free-to-play games, which do not charge an upfront purchase price and rely exclusively on optional in-game purchases, now dominate the industry, generating about $98 billion in annual revenue and accounting for seventy eight percent of the worldwide market.[10] In 2020, the top three performers among these free-to-play games generated $2.45 billion (*Honor of Kings*), $2.32 billion (*Peacekeeper Elite*), and $2.29 billion (*Roblox*) in revenue, respectively.[11] Roblox Corporation, which generates nearly all of its revenue from sales of its optional Robux in-game currency, achieved a valuation of

6. *See, e.g.*, *League of Legends Champion Skins*, MOBAFIRE, https://www.mobafire.com/league-of-legends/skins (last visited Mar. 28, 2021) (listing character skins for *League of Legends*); *see also* Adam, *NBA 2K20 - What is VC and How Does It Work?*, 2K (Aug. 19, 2020), https://support.2k.com/hc/en-us/articles/360026840333-NBA-2K20-What-is-VC-and-how-does-it-work (explaining how *NBA 2K20*'s purchasable in-game currency can be used to upgrade player attributes).

7. Julius Jamarque, *10 Most Expensive Virtual Goods Ever Sold*, FRAG HERO (Nov. 23, 2016), https://www.fraghero.com/10-most-expensive-virtual-goods-ever-sold/.

8. J. Clement, *Average Annual Spend on Downloadable Content (DLC) in Selected Video Games in the United States in 2019*, STATISTA (Mar. 3, 2021), https://www.statista.com/statistics/1104745/video-gaming-dlc-spend-game/.

9. *See* TAKE-TWO INTERACTIVE SOFTWARE, INC., 2020 ANNUAL REPORT 27, 29 (2020).

10. Valentine, *supra* note 2.

11. *Id.*

more than $45 billion after going public through a direct listing in March 2021.[12]

However, the entire system currently rests on a shaky foundation of developer-dominated end user license agreements (EULAs) and weak in-game item license rights. Many in-game items look and act like virtual versions of real-world property, but are merely held pursuant to licenses that can be terminated at a developer's absolute discretion.[13] Unlike physical analogues, such as trading cards or TV and movie collectibles, in-game items cannot be freely sold or otherwise transferred.[14] While secondary market transactions between players do occur in third-party gray markets, most of these transactions violate EULA terms, and in some cases developers have terminated the licenses involved, instantly rendering worthless goods previously valued at thousands of dollars.[15] The shadow cast by these one-sided license terms creates a discrepancy between the sizable sums that players spend and the limited rights they receive, undermining players' expectations in their purchases.

While there are many possible criticisms of the developer-favorable status quo, most of the existing commentary centers around normative concerns and addresses why and how the existing contract-dominant regime should be abandoned in favor of property rights and common law defaults.[16] This Note assumes instead that EULAs are unlikely to be replaced in the near to medium term but nonetheless argues that even developers—those most advantaged by the existing regime—would benefit from a more balanced approach. This Note argues that developers forfeit significant value when they grant themselves plenary power because the flexibility they receive over players' in-game items is regularly outweighed by players' reduced willingness to pay, and that selectively relinquishing discretion could allow developers to create and capture player value in a cost-efficient manner. Drawing lessons from economic theory on secondary markets and the meteoric ascent of non-fungible tokens (NFTs) and code-enforced promises, this Note highlights certain rights and assesses their feasibility across certain game and item types, providing developers with tools to better tailor EULAs to the needs of both developers and players.

12. Paul R. La Monica, *Roblox Goes Public and is Instantly Worth More Than $45 Billion*, CNN (Mar. 10, 2021), https://www.cnn.com/2021/03/10/investing/roblox-stock-direct-listing/index.html.

13. *See infra* Section II.A.

14. *See infra* Section II.A.

15. *See infra* Section II.A.

16. *See infra* Section II.B.

Part II describes the existing developer-dominated EULA regime and highlights some of its criticisms and justifications. Part III points out the inefficiency of uniformly applying an umbrella EULA to a wide variety of games and explains how tailoring EULAs to offer specific guarantees for individual games can create joint value for players and developers. Part IV provides a toggle menu of contractual rights that developers can consider when tailoring EULAs. Part V lists factors that could influence developer drafting decisions and examines how they may have contributed to the developer-dominant status quo. While this Note primarily provides U.S.-based developers and games as examples, the existing EULA regime does not differ significantly across geographies, and the arguments set forth in this Note present implications for the global game industry.[17]

II. THE CURRENT STATE OF IN-GAME ITEMS

A. LICENSES, NOT PROPERTY

Despite the staggering amounts of money they spend, players do not receive strong legal rights in the in-game items they purchase. Instead of acquiring ownership, players receive license grants to access the items as features within the game.[18]

Such licenses are typically non-exclusive, non-transferable, and revocable, allowing use of the items exclusively in connection with the developer's game and related services, and are often subject to significant developer discretion.[19] For example, the *Fortnite* EULA grants developer Epic Games "sole discretion" and "the absolute right" to "manage, modify, substitute, replace, suspend, cancel or eliminate" a player's ability to access or use the in-game items she purchases "without notice or liability . . . ."[20] A player's continued access to the game and her purchased items is further contingent upon her

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17. *See*, *e.g.*, *Cyberpunk 2077 – End User Licence Agreement*, CYBERPUNK.NET (Dec. 10, 2020) (finding that Polish developer provided near-identical EULAs for residents of the European Union, the United States, and the rest of the world, with differences only in certain choice of law and dispute resolution terms).

18. *See Blizzard End User License Agreement*, BLIZZARD, https://www.blizzard.com/en-us/legal/fba4d00f-c7e4-4883-b8b9-1b4500a402ea/blizzard-end-user-license-agreement (June 1, 2021); *Riot Games Terms of Service*, RIOT GAMES, https://www.riotgames.com/en/terms-of-service (Apr. 30, 2021); *Take-Two Interactive Software, Inc. Terms of Service*, T2, https://www.take2games.com/legal/ (Mar. 2, 2020).

19. Additional menu options include "limited," "personal," and "subject to and specifically conditioned upon your acceptance of, and compliance with, the EULA." RIOT GAMES, *supra* note 18.

20. *Fortnite End User License Agreement*, EPIC GAMES, https://www.epicgames.com/fortnite/en-US/eula (last visited Apr. 16, 2022).

acceptance of new terms each time the EULA is updated.[21] This occurs often, as developers typically reserve the right to alter EULA terms.[22]

Consequently, players buying in-game items under this framework face significant uncertainty. In addition to having no guarantees for the items they purchase, they also receive no assurances about the terms governing their continued access to the game itself.[23] If a player finds a change in terms unacceptable, she is effectively forced to choose between acquiescing to the undesirable terms and forfeiting her right to play the game and access to items she has already paid for.[24]

One *World of Warcraft* player who purchased an account from another player for €7,000 later found that account, which included a character equipped with highly valuable items, terminated for being sold in violation of developer Blizzard's terms.[25] While terminations tend to occur in response to prohibited conduct, enforcement is often uneven and unpredictable.[26] Furthermore, since developers retain plenary discretion regardless, even EULA-abiding players are forced to rely on developers' implicit promises to not abuse their rights.[27] Hundreds of billions of dollars have been spent in reliance upon this shaky foundation.

B. CRITICISMS OF THE STA-TOS[28] QUO

Perhaps unsurprisingly, the existing EULA structure has drawn criticism for using contract law to exclude property law from virtual worlds. Joshua A.T. Fairfield has analogized the existing developer-dominated regime to "Microsoft claiming an ownership interest in every document created using" Microsoft Word.[29]

21. *See id.*

22. *See id.*

23. *See id.*

24. *See id.*

25. Cristina Jimenez, *The High Cost of Playing Warcraft*, BBC (Sept. 24, 2007, 7:58 GMT), http://news.bbc.co.uk/2/hi/technology/7007026.stm.

26. *See id.* (describing the substantial costs and technological challenges associated with enforcing against prohibited conduct).

27. *See infra* Section II.C.3.

28. "Terms of Service," a term commonly used instead of EULA.

29. Joshua A.T. Fairfield, *Anti-Social Contracts: The Contractual Governance of Virtual Worlds*, 53 MCGILL L.J. 427, 437 (2008). Although this comparison is generally a reasonable one, a key difference exists for certain games. Whereas developers like Blizzard contemplate and design every possible item in a game like *World of Warcraft*, Microsoft does not contemplate every possible memo or paper that users will create using Word. It is ultimately the user's creative efforts that generate the document. The distinction becomes less clear for games such as Minecraft, where user creativity features far more heavily, *see also infra* Section II.B.2 (discussing Lockean labor theory and its applicability to in-game items).

1. *Replacing Property Rights with Contract Restrictions*

Some fault EULAs for "supplant[ing] much of the default law that real-world communities rely on," creating "pseudoproperty systems . . . out of a patchwork quilt of contracts" that give rise to confusion and inefficiency.[30] They argue that developers, who "design virtual property to have the attributes of real-world property" and make games "look and feel like a space in which human beings can interact," subvert player expectations by excluding real-world property rights in favor of nontransferable licenses subject to plenary developer discretion.[31] Developers give players good reason to expect property law defaults to apply and, in denying said application, produce confusion[32] and undermine property law's goal of enabling resources to flow to higher-value users in a cost-effective manner, thus reducing overall societal welfare.[33]

Using contract to override property law defaults has also been criticized in certain real-world contexts. In real estate, for example, developers often draft covenants, conditions, and restrictions (CC&Rs) to impose on a new development.[34] In theory, these terms induce homebuyers to collectively agree to "reciprocal control of land use," beyond what nuisance and zoning law defaults offer, in ways that improve their collective enjoyment of the property.[35] However, CC&Rs do not always achieve their goals. They can be excessively blunt, forcing prospective buyers to either accept or reject an entire bundle of CC&Rs instead of considering its individual components.[36] Furthermore, "[t]he choice a homebuyer makes about the . . . servitude regime is necessarily bundled with a much larger and more salient choice about a particular house," and homebuyers may purchase a house in spite of, rather

30. *Id.* at 429.

31. *Id.* at 458.

32. *Id.* at 474.

33. Fairfield, *supra* note 29, at 474.

34. *See* Lee Anne Fennell, *Contracting Communities*, 2004 U. ILL. L. REV. 829, 838 (2004).

35. For example, a prospective homebuyer who hates garden gnomes with a passion may find a house with a no-garden-gnomes covenant highly valuable, since she loses nothing to the limitation and benefits greatly from knowing that none of her neighbors will have garden gnomes. Even somebody who does not particularly hate garden gnomes may be willing to pay slightly more for such a house, since she knows she can likely sell it for an even higher price to somebody who does. *Id.* at 842-43.

36. *See* Armand Arabian, *Condos, Cats, and CC&Rs: Invasion of the Castle Common*, 23 PEPP. L. REV. 1 (1996) (arguing that purchasers of homes "are extremely limited in their capacity to negotiate changes or alter burdensome restrictions"). The gnome-hating prospective homebuyer might tolerate another restriction forbidding pets, even if she likes pets, as long as she hates garden gnomes more. This is a suboptimal outcome, but often an unavoidable one because CC&Rs only come in bundles.

than because of, its CC&Rs.[37] Determining what CC&Rs homeowners might desire is also costly and difficult to begin with.[38] As a result, overriding property law defaults by introducing CC&Rs often reduces rather than enhances overall welfare.[39]

A similar phenomenon may exist within games. While a player might value a developer's ability to ban cheaters in a vacuum, she can only grant such authority if she also assents to undesirable rights such as the developer's ability to modify player items at will. Some players will find the tradeoff less desirable, but still worthwhile, and accept. But even players who find it flatly undesirable are unlikely to completely forgo playing a game or purchasing an item simply because of the EULA. Like prospective buyers in the real estate market who are forced to either accept or reject entire bundles of CC&Rs, players may be unable to effectively signal their preferences for individual terms. While some terms may simply allocate value from the player to the developer, others could reduce joint value in the process.[40] An arrangement in which the developer allows the player to retain such value and finds another way to capture a portion of it would benefit both parties, but arriving at such an arrangement is difficult when players cannot efficiently express their preferences in the first place.

2. *Locke, Radin, and Bentham: Normative Arguments in Favor of Property Rights*

Other scholars offer more normative accounts of property theory. F. Gregory Lastowka and Dan Hunter propose that labor-desert theory, personality theory, and utilitarian theory all support "a qualified conclusion" that in-game items should be considered real-world property with certain attached default rights.[41]

Lockean labor-desert theory asserts that one who "hath mixed his Labour with" something "that Nature hath provided" "thereby makes it his property."[42] Under this theory, a player who spends time and effort mining in-game, for instance, has mixed her labor into the virtual gold ore she extracts

37. Fennell, *supra* note 34, at 871.

38. *See id.* at 895-96.

39. *Id.* at 890.

40. For example, if players and developers value item ownership equally, exclusive developer ownership would merely allocate value from the player to the developer. But if players valued ownership more, exclusive developer ownership would decrease total joint value, since the players would lose more than the developer gains.

41. F. Gregory Lastowka & Dan Hunter, *The Laws of the Virtual Worlds*, 92 CALIF. L. REV. 1, 43 (2004).

42. JOHN LOCKE, SECOND TREATISE OF GOVERNMENT §§ 27, 17 (Thomas P. Peardon ed., 1952) (1690).

from "Nature" and should therefore have a corresponding interest in the ore.[43] Similar logic would apply where a player receives valuable items after spending hours on planning and in-game play to defeat a difficult in-game boss. While there are certain nuances, including the convincing observation that any portion of "Nature" with which a player might mix her labor is initially created by the developer's labor,[44] Lockean theory lends some support to the idea that players should have at least a partial property interest in items they expend significant effort to acquire.[45]

Developed by Margaret Jane Radin and others in extension of G.W.F. Hegel's philosophical work on personhood, the personality theory of property proposes that individuals may develop a personal, moral claim to certain objects that can supersede competing property rights in those objects.[46] Such claims may attach when the object impacts and becomes inextricable from basic human needs like identity, and where, "without the claimed personhood interest, the claimants' opportunities to become fully developed persons . . . would be destroyed or significantly lessened."[47] Under this theory, the personal value that a player imbues in her in-game character, which she painstakingly customizes with skins and uses to express herself throughout hundreds or thousands of hours of gameplay, might be a strong enough justification to bar a developer from deleting her character and items on a whim, even if the developer might have a contractual right to do so.[48]

Finally, Lastowka and Hunter highlight the potential applicability of utilitarian theories of property to in-game items. They suggest that granting property rights to players, who pour in tremendous amounts of time and money to acquire in-game items, would maximize overall societal utility.[49] This could be accomplished by assigning rights to those players who would derive the most enjoyment from such rights.[50]

While such theories are hardly black letter law, they do inform the rationale underlying the United States' real-world property regime and its evolution over

43. Lastowka & Hunter, *supra* note 41, at 46-48.

44. John William Nelson, *The Virtual Property Problem: What Property Rights in Virtual Resources Might Look Like, How They Might Work, and Why They Are a Bad Idea*, 41 MCGEORGE L. REV. 281, 290-91 (2009).

45. *See generally* Lastowka & Hunter, *supra* note 41 (noting that in-game items should be considered real-world property with certain attached default rights).

46. Margaret Jane Radin, *Property and Personhood*, 34 STAN. L. REV. 957, 978 (1982).

47. *See id.* at 1015.

48. *See* Lastowka & Hunter, *supra* note 41, at 48-49 (noting that "personality theory would seem to be strongly in favor of granting property rights" since "[i]t is well documented that people feel connected to their avatar, not as a thing but as a projection of their self").

49. *See id.* at 46-48.

50. *See id.*

time. If, as Lastowka and Hunter suggest, these theories provide "strong normative grounds for recognizing that property rights should inhere in virtual assets," it would raise questions as to whether the EULA status quo's treatment of items exclusively as license rights is tenable or desirable in the long run.[51]

C. Why Developer EULA Dominance Makes Some Sense

Much of the criticism of how developers treat in-game items is fair and calls for a broader reckoning on contract law's interaction with property law in developer-created virtual worlds. However, assuming EULAs remain the primary legal mechanism governing developer-player and player-player interactions going forward, game-specific requirements can provide some justification for developer discretion. While such characteristics do not justify uniform assumption of plenary power, they do support significant developer flexibility in certain cases, demonstrating that the status quo does not stem entirely from developers abusing their bargaining power for one-sided benefit.

1. *Discretion to Update and Balance*

Unlike in the traditional model, where consumers simply bought games "as-is," developers for both paid and free-to-play games now constantly provide updates to promote player engagement that could translate into in-game purchases.[52] Updates might include new character releases, graphics improvements, or new levels. In online multiplayer games, they might modify game mechanics to maintain competitive balance.[53] Developers value the ability to upgrade game graphics even if the new graphics cast certain "skins" in slightly different lighting or to weaken certain items even if doing so decreases such items' respective values. Existing EULA terms give developers the ability to execute such changes without having to repeatedly secure player approval.

Developers also value the flexibility to enforce community guidelines and address player misconduct. To promote fair play, a developer might force players to disgorge in-game benefits they receive from exploiting software bugs, or to ban players who violate community guidelines.[54] By securing these rights in a EULA, developers can resolve issues within a contractual framework, reducing the likelihood of real-world disputes.

51. *See id.* at 49.
52. *See* Tomić, *supra* note 3, at 17-19.
53. *See infra* Section III.B.
54. *See supra* note 18.

However, it is unlikely that such flexibility requires the plenary power that developers currently grant to themselves. Many actions, such as banning abusive players or updating item aesthetics, are easily specified and could be just as effectively guaranteed through more limited developer rights containing express carveouts.[55]

2. *Player Habituation*

Many players simply may not care enough about their rights to in-game items to affect their engagement, as they may view their purchases as a non-recoupable price to enhance their enjoyment of the game. On the low end, individual items tend to be relatively cheap. For example, in *League of Legends*, the cheapest "skins" cost approximately $1.70; in *Candy Crush Saga*, five additional lives cost $0.99.[56] In the context of each individual low-value purchase, any uncertainty stemming from the developer's plenary power might simply be inconsequential to most players.[57]

Players also may not sufficiently understand the rights that accompany their in-game items to alter their purchasing decisions based on EULA terms, as findings for similarly licensed digital goods suggest. For example, 86% of consumers believe that clicking "Buy Now" grants them ownership of their eBook, as opposed to the limited access license they actually receive, while 83% and 78% of consumers express similarly mistaken beliefs about MP3 files and digital movies, respectively.[58] Like consumers of other digital goods, players who buy in-game items might simply analogize their purchases to those involving physical goods such as real books or game CDs, creating misimpressions about the rights attached to their in-game items.

However, taking advantage of player ignorance is hardly a valid justification for EULA dominance, and players have pushed back in certain cases. One such case occurred when the EULA for the custom content creator

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55. *See infra* Section V.A.

56. Carrie Talbot, *Cheap League of Legends Skins and Champions – Here are This Week's Deals*, PCGAMESN (Mar. 16, 2021), https://www.pcgamesn.com/league-of-legends/lol-skins-sale-champions. This is not to say that these low prices necessarily stop players from spending a large aggregate amount across many purchases, which is part of the entire point of the microtransactions model. *See* Ashley Feinberg, *Holy Shit I Just Spent $236 on Candy Crush, Help*, GIZMODO (Aug. 7, 2013), https://gizmodo.com/holy-shit-i-just-spent-236-on-candy-crush-help-1032185653.

57. Such reasons would not apply to more expensive in-game items, such as premium skins or a $14,000 mace in *Diablo III*. *See* Jamarque, *supra* note 7.

58. Aaron Perzanowski & Chris Jay Hoofnagle, *What We Buy When We Buy Now*, 165 U. PA. L. REV. 315, 337 (2017).

program in *Warcraft 3: Reforged* assigned ownership of player-created mods[59] to its developer Blizzard.[60] Unlike other EULAs, which often grant the developer a license to such mods, the *Warcraft 3: Reforged* EULA assigned complete ownership of the mods to the developer, a decision that players and enthusiasts criticized as "convoluted legalese . . . that puts profits before players."[61] Then again, this harsh reaction belied the fact that "the EULA doesn't affect how the vast majority of people play custom games . . . ."[62]

3. *Reputation and Relation as Extralegal Gap-fillers*

In communities where actors are closely knit, parties often do not formally enforce contracts through litigation and instead rely on "mutual dependency" as "the 'real deterrent'" against undesirable behavior.[63] In such situations, extralegal sanctions associated with potential breach can be highly effective in reining in developers while having the added benefit of avoiding costs associated with contract formation and enforcement.[64] The game industry can be one such community.

Most mainstream games, which generate the majority of industry revenues and attract the largest player communities, are published by the same core group of large developers.[65] Players follow game news, interact with content on social media, and attend enthusiast conventions.[66] Information travels quickly and can significantly impact player behavior. As repeat parties, developers stand to benefit from community goodwill—for example, positive

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59. Mods, which allow players to add custom content modifications to games, have become a mainstay of gaming culture. *See* Edwin Evans-Thirlwell, *Why are People Modding Thomas the Tank Engine into Video Games?*, THE FACE (May 9, 2019), https://theface.com/culture/why-are-people-modding-thomas-the-tank-engine-into-video-games (describing how players are using mods to replace dragons, zombies, and ninjas with Thomas the Tank Engine).

60. Wes Fenlon, *The Outrage Over Warcraft 3: Reforged, Explained*, PC GAMER (Feb. 4, 2020), https://www.pcgamer.com/warcraft-3-reforged-controversy/.

61. *Id.*

62. Given that the game was also lampooned for lacking key features and performing significantly worse than early demos had suggested, it is possible this was just an ancillary gripe to add to a laundry list of gameplay-focused criticisms. *Id.*

63. Gillian K. Hadfield & Iva Bozovic, *Scaffolding: Using Formal Contracts to Support Information Relations in Support of Innovation*, 2016 WIS. L. REV. 981, 1000 (2016).

64. *Id.*

65. Nine of the top ten best-selling games the 2010s were published by two companies, Rockstar Games and Activision. Jeff Grubb, *NPD: The Top 20 Best-Selling Games of the Decade in the U.S.*, VENTUREBEAT (Jan. 16, 2020), https://venturebeat.com/2020/01/16/the-top-20-best-selling-games-of-the-decade-in-the-u-s/.

66. *See, e.g.*, Wes Fenlon, *E3 2021 Schedule: How and When to Watch Every Gaming Conference*, PCGAMER (June 13, 2021), https://www.pcgamer.com/e3-2021-schedule-dates-lineup/ (enthusiast website providing instructions on how to use social media to stream a game convention).

reception to a game can increase sales for future releases.[67] On the flip side, when missteps arise, community punishment can be harsh, swift, and extend beyond the offending game to impact a developer's entire portfolio.[68] This threat of reputational enforcement helps to police developer behavior and deter severe abuses.

Relational constraints can provide an additional layer of assurance for players' interests. For many games, profitability is driven by "whales," a small minority of players who generate an outsized proportion of in-game purchase revenues.[69] While a game's overall success is often judged by the size of the player base it attracts, its profitability depends on how well it monetizes the small fraction of "whales," high-spending individuals whose purchases subsidize the game for the vast majority of players who spend little to no money.[70] In dealing with these "whales," who are also the players with the most value tied up in in-game items, developers may be less likely to abuse their plenary power given the costs associated with alienating a VIP customer.[71]

D. NBA 2K AS A STATUS QUO POSTER CHILD

NBA 2K, Take-Two Interactive's popular basketball video game series in which players control NBA teams or custom-created avatars in simulated basketball games against an AI or other players, represents perhaps the optimal use case for today's developer-favorable EULA regime.

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67. *Cyberpunk 2077*, the latest release by CD Projekt RED, developer of universally acclaimed role-playing game *The Witcher 3*, enjoyed record-breaking pre-order sales buoyed by player confidence in the company. Allegra Frank, *How One of the Biggest Games of 2020 Became One of the Most Controversial*, VOX (Dec. 18, 2020), https://www.vox.com/culture/22187377/cyberpunk-2077-criticism-ps4-xbox-one-bugs-glitches-refunds.

68. CD Projekt RED saw that tremendous amount of player goodwill and corresponding company value dissipate nearly overnight after revelations that the company had concealed severe technical issues with *Cyberpunk 2077*. *Id.* At the time of writing, its parent company's stock price is approximately half of what it was the weekend before *Cyberpunk 2077*'s release. *CD Projekt 4 ADR Representing Ord Shs*, OTC MARKETS (Mar. 25, 2021), https://www.google.com/finance/quote/OTGLY:OTCMKTS.

69. A 2014 report found that approximately half of in-app purchases in free-to-play mobile games came from 0.15% of players, with only 1.5% of players spending any money at all. Eric Johnson, *A Long Tail of Whales*, VOX (Feb. 26, 2014), https://www.vox.com/2014/2/26/11623998/a-long-tail-of-whales-half-of-mobile-games-money-comes-from-0-15.

70. In one free-to-play *Transformers* mobile game, for example, a single player spent over $150,000 on microtransactions. Alex Walker, *Someone Spent Over $220,000 in Microtransactions on a Transformers Game*, KOTAKU AU (Oct. 11, 2019), https://www.kotaku.com.au/2019/10/someone-spent-over-220000-in-microtransactions-on-a-transformers-game/.

71. Developers may also be incentivized to provide "whales" with preferential treatment over average users. However, this is less of an issue in the player-developer relationship, where most property-related concerns lie.

One of *NBA 2K*'s most distinguishing features, aside from its increasingly realistic simulation of real-world basketball, is its annual release cycle. Each NBA season, Take-Two subsidiary 2K Sports releases a new game named after the year in which the season will end—for example, *NBA 2K19* covered the 2018–19 NBA season.[72] Like many games, *NBA 2K* has introduced a growing in-game microtransaction system revolving around "VC," a virtual currency players can use to purchase cosmetic items and attribute upgrades for their custom avatars.[73] Players acquire VC by either earning it through playing the game or purchasing it with real money.[74]

Notably, neither VC nor the items or attributes VC is used to purchase are retained across successive annual releases of *NBA 2K*.[75] As a result, each year players who migrate to the newest version effectively abandon the money they collectively sunk into the previous game. Within three years after a *2K* game's initial release, *2K Sports* discontinues server support, shutting down "any mode that earns or uses VC" for the minority of holdouts remaining.[76]

And yet, despite the transience of their rights to in-game items, players willingly purchase VC across game versions. *NBA 2K20* was the most successful game in the series yet, generating more than $1 billion within a year of initial launch, in part boosted by a 126% year-on-year increase in microtransactions revenue as players spent more than ever before on virtual shoes, tattoos, and ability boosts.[77]

NBA 2K's success suggests that, in certain cases, the EULA status quo could very well be joint value-maximizing. By continually improving its simulation engine and introducing new multiplayer social game modes,[78] each

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72. 2K, https://www.2k.com/en-US/games/ (last visited Jan. 19, 2022).

73. 2K Mike, *NBA 2K18: What is VC and How Does It Work?*, 2K SUPPORT (Jan. 19, 2021), https://support.2k.com/hc/en-us/articles/360004407013.

74. *Id.*

75. Adam, *Can I Transfer VC From NBA 2K19 to NBA 2K20?*, 2K SUPPORT (Jan. 16, 2021), https://support.2k.com/hc/en-us/articles/360026677054.

76. 2K Liana, *NBA 2K19 Server Shutdown*, 2K SUPPORT, https://support.2k.com/hc/en-us/articles/360059689094 (Sept. 17, 2021).

77. The upfront price of 14 million units sold likely accounts for the majority of this $1 billion figure, but even highly conservative assumptions would yield more than $100 million in microtransactions revenue. The COVID-19 pandemic also likely boosted sales beyond what was ordinarily expected. *See* Rebekah Valentine, *Take-Two CEO: "It's a Matter of Time Before the Business is Entirely Digital"*, GAMESINDUSTRY.BIZ (Aug. 3, 2020), https://www.gamesindustry.biz/articles/2020-08-03-take-two-ceo-its-a-matter-of-time-before-the-business-is-entirely-digital.

78. For example, the Neighborhood mode introduced in recent years allows players to play in the park, ink sponsorship deals, and get tattoos. Eli McLean, *NBA 2K20 Neighborhood Guide – Everything to Know*, HTR (Nov. 29, 2019), https://holdtoreset.com/nba-2k20-neighborhood-guide-everything-to-know/.

new *NBA 2K* promises a "latest and greatest" experience that entices players to abandon the prior year's release—including the in-game content accumulated within. The transparent release cycle leads players to view in-game items, such as custom animations and player attributes, as content associated solely with each year's release, not across the entire series, and therefore calibrate their willingness to pay accordingly. For this set of expectations, *NBA 2K*'s EULA provides close to the optimal level of assurances to players. Given how willing players are to shell out money for each new release, granting ownership of in-game content and rolling it across editions might decrease the game's profitability without producing a commensurate increase in player enjoyment.[79]

III. A THEORY-AGNOSTIC CASE FOR EULA DISAGGREGATION

Regardless of how one feels about the current balance between contract law and property law in games, developers do not appear likely to stop employing EULAs as the primary formal legal mechanism governing in-game items for at least the near to medium term. Assuming such a backdrop, one fact is apparent: not every game is *NBA 2K*, and, for the reasons discussed below, not every EULA should be like *NBA 2K*'s either.

A. PITFALLS OF PLENARY POWER

Rights to in-game items look more or less identical across developers and games.[80] Developers grant players a very weak license, and then subject that license to revocation for a wide range of reasons—including no reason at all—all of which are within the developer's complete judgment and discretion.[81] As with most blunt tools, such plenary power can give rise to inefficiencies when developers seize more power than is optimal.

Perhaps the bluntest feature of EULAs under the status quo is their broad application to a developer's entire game portfolio. Take, for example, Activision Blizzard, one of the world's largest video game companies.[82] The developer uses a single blanket EULA across a wide range of game-types, from *Heroes of the Storm* (a multiplayer online battle arena game) to *Diablo III* (an

79. *See infra* Section V.C.2 (explaining that this is ultimately an empirical question that developers must address on a case-by-case basis).

80. *See supra* note 18.

81. *Id.*

82. J. Clement, *Market Capitalization of the Largest Gaming Companies Worldwide as of June 2021*, STATISTA (June 16, 2021), https://www.statista.com/statistics/1197213/market-value-of-the-largest-gaming-companies-worldwide/.

action role-playing game), *World of Warcraft* (a massively multiplayer online role-playing game), *Overwatch* (a team first-person shooter game), *Starcraft II* (a real-time strategy game), and *Hearthstone* (a digital collectible card game).[83] The situation is similar for Take-Two (which treats *NBA 2K* the same as it does *Grand Theft Auto V* and *Red Dead Redemption*) and *League of Legends* developer Riot Games (which lumps its multiplayer online battle arena, collectible card, and team first-person shooter games under one EULA).[84]

Such uniformity, especially when so favorable to developers, can provide them convenience and peace of mind. But it also fails to recognize that in-game features vary significantly across games and genres, as does the corresponding need for developer discretion.

Figure 1: Selection of Blizzard Games and Items Governed by the Same EULA[85]

	Hearthstone	*Heroes of the Storm*	*Overwatch*	*World of Warcraft*
Game genre	Digital card game	Multiplayer online battle arena	First-person shooter	Massively multiplayer online role-playing
Primary purchasable in-game item	Cards	Characters/ Skins	Skins	In-game currency (through tokens)
Items' Impact on competitive gameplay	High	Moderate/Low	Low	Moderate
Importance of item aesthetics	Low	Moderate/High	High	Low

For example, Blizzard might rightfully desire significant leeway to alter the attributes of certain potions in *World of Warcraft* to preserve competitive

83. *See supra* note 18.

84. *Id.*

85. *Hearthstone Shop*, BLIZZARD, https://us.battle.net/support/en/article/32545 (Oct. 2021); Dan O'Halloran, *Heroes of the Storm Microtransactions Guide*, BLIZZARD WATCH (May 19, 2015), https://blizzardwatch.com/2015/05/19/heroes-of-the-storm-microtransactions-guide/; *Skins*, OVERWATCH WIKI, https://overwatch.gamepedia.com/Skins; *Using a WoW Token*, BLIZZARD, https://us.battle.net/support/en/article/31218 (Mar. 15, 2021).

balance and foster diversity of strategies. However, the same logic would not apply for skins in *Overwatch*, which are purely cosmetic and do not impact competitive play.[86] Similarly, while *NBA 2K* players who expect yearly turnover may not care as much about assurances of ownership,[87] *Grand Theft Auto V* players who have purchased in-game content across nearly a decade might appreciate the contractual assurance that Take-Two will not terminate access to their items on a whim—especially if players are worried about discontinuation of support once *Grand Theft Auto VI* is released.[88] Under the right conditions, selectively relinquishing plenary power in certain areas can more than pay for itself by increasing players' willingness to pay for content.

Given the significant opportunity involved, developers who treat widely varying in-game content across genres as identical might be either complacent or conservative.[89] Disaggregating the umbrella EULA into a set of EULAs more narrowly tailored to each game and its unique content can create joint value for developers and players.[90]

B. *MAGIC ONLINE* AND *MAGIC: THE GATHERING ARENA*: HOW CONTRACTUAL RIGHTS IMPACT ITEM VALUE

Since most EULAs under the status quo look nearly identical, there are few counterfactuals that demonstrate the extent to which EULAs produce inefficiencies and, if they do, whether modifications to the licenses would help reduce them. The simultaneous existence of *Magic Online* (*Online*) and *Magic: The Gathering Arena* (*Arena*), however, provides a useful opportunity for comparison.

Both *Online* and *Arena* are free-to-play digital collectible card games that allow players to compete online with others across the world.[91] With some caveats, both feature the same cards and rules as the traditional physical version ("Analog") does.[92] Digitally enabled features in both digital games

86. *Cosmetics*, OVERWATCH WIKI, https://overwatch.fandom.com/wiki/Cosmetics (last visited Oct. 20, 2021).

87. *See supra* Section II.D.

88. *See* Alden Etra, *GTA 5's 8 Year Anniversary is Making Gamers Feel Old*, SCREENRANT (Sept. 17, 2021), https://screenrant.com/gta-5-8-year-anniversary-gamers-feel-old/ (describing how players have graduated college, gotten married, had kids, and bought a house in the time since the game's 2013 release).

89. *See infra* Section V.C.

90. *See infra* Part IV.

91. *See* MAGIC THE GATHERING ONLINE, https://magic.wizards.com/en/mtgo (last visited Mar. 4, 2021); *MTG Arena FAQ*, MAGIC THE GATHERING, https://magic.wizards.com/en/mtgarena/faq (last visited Mar. 4, 2021).

92. Some competition formats (think blitz or rapid in chess) and limited editions of cards can be game specific. *Id.*

include automatic rule enforcement, visual effects, skill-based matchmaking, and removal of a colocation requirement. *Arena*, the newer of the two games, offers better graphics and effects, fewer system glitches, and a more intuitive user interface.[93] In both *Online* and *Arena*, players can acquire cards by purchasing booster packs using in-game currency.[94] Much like with physical cards, a player seeking a specific digital card cannot be sure how many packs she will need to buy to actually acquire it. For the purposes of this Note—and, indeed, for many players—there is one key difference between the two games: when a player acquires a card, *Online* provides a degree of ownership that *Arena* does not.[95]

Like its competitors *Hearthstone* and *Legends of Runeterra*,[96] *Arena* treats cards as licenses to access and use a certain feature in *Arena* gameplay, but *Arena* does not allow players to trade, sell, or otherwise dispose of their cards.[97] Meanwhile, though *Online* still treats cards as "licensed digital objects that depict physical *Magic: The Gathering* trading cards," it allows players to dispose of their cards by trading or selling them to other players, or even redeeming them for corresponding physical versions.[98] *Online* facilitates these transactions by offering its own marketplace.[99] *Arena* shares a blunt EULA with all of Wizards of the Coast's other digital games, whereas *Online* has its own more narrowly tailored EULA, suggesting that the situation may be somewhat awkward or unintentional.[100]

The incongruence between the rights provided is reflected in card price disparities across *Online* and *Arena*. An enthusiast site recently estimated that a specific *Online* competitive deck for the Standard format would cost nearly 500 dollars in targeted secondary market purchases to assemble.[101] The probability-

93. Christine Petit, *MTG Arena vs. MTGO: The Pros & Cons of Each (2021)*, NERDMUCH? (Feb. 20, 2021), https://www.nerdmuch.com/mtg-arena-vs-mtgo/.

94. *See supra* note 91.

95. *See Magic Online End User License Agreement and Software License*, MAGIC THE GATHERING, https://magic.wizards.com/en/mtgo/eula (Dec. 5, 2020); *General Terms*, WIZARDS OF THE COAST (Oct. 22, 2020), https://company.wizards.com/en/legal/terms.

96. Developed by Blizzard and Riot Games, respectively.

97. *See supra* note 95.

98. Players can terminate their license to use certain cards deemed redeemable by Wizards for a corresponding set of physical *Magic: The Gathering Cards*, subject to certain conditions and a handling fee. *See supra* note 91.

99. *Magic Online: Payments*, MAGIC THE GATHERING (last visited Oct. 20, 2021), https://magic.wizards.com/en/mtgo/payments.

100. *See* MAGIC THE GATHERING, *supra* note 91.

101. Dan Troha, *Magic Online vs. MTG Arena – Which is Right for You?*, DRAFTSIM (Nov. 20, 2020), https://draftsim.com/mtg-online-vs-arena/.

weighted expected cost of acquiring that same deck through booster packs in *Arena* would be around 150 dollars.[102]

Despite the price difference, many players prefer the *Online* ecosystem because *Online*'s system helps invested and dedicated players save in the long run. No competitive deck in *Magic: The Gathering* stays competitive for long because Wizards of the Coasts periodically releases new cards and bans existing ones to maintain competitive balance and foster new strategies.[103] Unlike in *Arena*, *Online* players who continually buy new cards to optimize for the latest set of available cards can sell unneeded cards to fund purchases of new ones.[104] Players can also purchase specific cards, a valuable alternative when the card's asking price is lower than the expected cost of finding it in booster packs. As a result, *Online* tends to attract more high-spending "whales"[105] and features a more skilled player pool overall, thus making it more attractive for online competitive play.[106]

Online also allows players to create joint value by trading with each other. A card that has been banned from tournament play may lose all value for a competitive player, but may nonetheless retain some value in the broader market due to its viability in casual play.[107] The competitive player's ability to recoup a portion of her cost may increase her initial willingness to pay, while the casual player benefits from acquiring a card she may not have been willing to buy at its higher pre-ban price.[108] Enabling these transactions allows *Online* to create and capture a portion of this additional value through fees or higher booster pack sales.

Online's more narrowly tailored developer rights make sense. Wizards of the Coast does not need the discretion to modify card attributes to balance game dynamics, a common rationale for developer EULA dominance.

102. *Id.*

103. *See Banned and Restricted Lists*, MAGIC THE GATHERING, https://magic.wizards.com/en/game-info/gameplay/rules-and-formats/banned-restricted (Sept. 24, 2021).

104. Entire enthusiast sites are dedicated to these optimization efforts. *See, e.g.*, MTG BUDGET, http://mtgbudget.com/standard.html (last visited Mar. 4, 2021).

105. *See supra* notes 69-71 and accompanying text (discussing the desirability of "whales" within a game's player base).

106. Troha, *supra* note 101.

107. In this instance, a competitive player refers to one who enters tournaments or events with money-induced prizes. A casual player refers to one who plays the game primarily for the experience. *See* Mark Rosewater, *Casual Play*, MAGIC THE GATHERING (Nov. 16, 2020), https://magic.wizards.com/en/articles/archive/making-magic/casual-play-2020-11-16.

108. *See infra* Section IV.A; *see also* Valerie Thomas, *Demand and Dematerialization Impacts of Second-Hand Markets: Reuse or More Use?*, 7 J. IND. ECOLOGY 65, 75 (2003) (pointing out that in "second-hand markets with nonzero second-hand price," buyers of new goods "may buy more readily and at higher prices because they can resell the goods later").

Through its historical experiences with Analog, where players trading in physical cards for new physical ones with updated attributes would have been too costly, Wizards of the Coast developed an alternate system of banning and restricting cards that effectively preserves competitive balance while also pushing players to buy new cards.[109] Under this system, the right to dispose is attractive because it reduces the ongoing costs of competitive play. *Online* players willingly pay more upfront to play with the same cards under the same rules on "an old, bloated app built on an outdated platform" with an "'Excel Simulator' style user interface,"[110] while the developer retains the discretion it needs to shape core gameplay. For a digital collectible card game with a constantly evolving competitive scene and new card sets, contractual rights that may fall short of the absolute bundle of property rights nonetheless appear to provide significant value.[111]

Perhaps Wizards of the Coast is using *Arena* to attract casual players and eventually push them toward becoming high-spending *Online* or Analog players. Perhaps they are trying to use addictive "gacha" mechanics to influence players into spending more than they rationally would in a traditional marketplace.[112] But, regardless of the developer's strategy, the differences between *Online* and *Arena* demonstrate that contractual rights substantially impact game value and that developers would be best served making more thoughtful choices about what rights to offer through EULAs.

109. *See* MAGIC THE GATHERING, *supra* note 103.

110. Troha, *supra* note 101.

111. Some competitors have based their entire differentiation strategy on ownership. Despite starting from scratch with no valuable IP, upstart competitor *Gods Unchained* raised $15 million in a Series A funding round for its digital collectible card game, in which card ownership and scarcity are guaranteed using the Ethereum blockchain. *See* Brady Dale, *'Gods Unchained' Crypto Game Raises $15 Million from Naspers, Galaxy*, COINDESK (Sept. 23, 2019, 7:59 PM), https://www.coindesk.com/gods-unchained-crypto-game-raises-15-million-from-naspers-galaxy-digital. However, the company has not seen much success since then, suggesting that ownership rights alone are not sufficiently valuable. *See* Alex Lielacher & Andy Pickering, *Gods Unchained Updates Aim to Win Back Blockchain Gamers*, BRAVE NEW COIN (Sept. 9, 2020, 18:05 UTC), https://bravenewcoin.com/insights/the-rise-of-gods-unchained-the-hottest-blockchain-game-since-cryptokitties.

112. In "gacha" games, players cannot designate an item to purchase, but instead must purchase a random pack that may contain the desired item. Collectible card games and Kinder Surprise Eggs employ similar mechanics. *See* Gene Park, *I Spent $130 in 'Genshin Impact.' If You Might Do This, Maybe Don't Play It*, WASH. POST (Oct. 6, 2020), https://www.washingtonpost.com/video-games/2020/10/06/genshin-impact-gambling/ (detailing the addictive nature of loot boxes and "gacha" mechanic-induced spending).

IV. RECOMMENDATIONS

One benefit of using EULAS to silo virtual worlds from the real world is that developers can also silo virtual worlds from each other using the same method. Since most games are discrete platforms that do not interoperate with each other, they can serve as "laboratories for experimentation with different levels of interaction between the inside and the outside world."[113] Developers stand to take advantage of this opportunity for experimentation by adopting different EULAs for different games, allowing them to specify different packages of contractual rights within each game without impacting their discretion in others. Doing so may provide incremental benefits in ways that accommodate some of the criticisms of the existing EULA regime without having to upend the entire system.

A. VIRTUAL PARALLELS TO REAL-WORLD RIGHTS: OWNERSHIP AND DISPOSITION

Like Wizards of the Coast does for *Online* players, developers should first consider providing players ownership rather than a license.[114] A revocable license right, however constrained by extralegal enforcement,[115] will be less valuable than an ownership right given the inherent risk that license revocation presents to a prospective buyer.[116] Mitigating that risk through a contractual guarantee should increase a player's willingness to pay for essentially any item, although the magnitude of that increase could vary significantly by game and item.

Alternatively, rather than offer a full "bundle" of property rights, developers could consider granting players a right of disposition alone. By fostering the creation of what would essentially be a secondhand market, allowing disposition could yield even greater economic benefits.[117] Here, the right of disposition refers to a player's right to transfer authority over her item, permanently or temporarily, to another player.[118] Doing so could "partly [solve] the problem of divisibility and flexibility of holdings," by allowing different

113. Mark A. Lemley, *The Dubious Autonomy of Virtual Worlds*, 2 U.C. IRVINE L. REV. 575, 579 (2012).

114. *See supra* Section III.B.

115. *See supra* Section II.C.3 (discussing extralegal deterrents to developer abuse).

116. In this sense, ownership rights refer to the archetypal "bundle" of property rights. The allocation of such rights for virtual items may present unique complications, full consideration of which is beyond the scope of this Note. Instead, this Note proposes the possibility and invites further discussion on the matter.

117. *See*, *e.g.*, *supra* Section III.B (discussing *Online*'s secondary market).

118. *See Freedom of Disposition*, LEGAL INFO. INST., CORNELL L. SCH., https://www.law.cornell.edu/wex/freedom_of_disposition (last visited Nov. 1, 2021).

owners to hold the same asset at different times when each respectively values it most, thereby maximizing the total value derived from an old item and increasing demand for new ones.[119] While depreciation, which plagues physical items and makes second-hand markets even more useful, does not have nearly the same impact in virtual worlds,[120] individual preferences can shift even for items whose conditions do not deteriorate.

Cosmetic skins, for example, might be analogized to real-life fashion, where a second-hand market for expensive clothing benefits both fashion labels and individual consumers.[121] In a stylized illustration, Player A, who highly values wearing the latest skin, will pay a high upfront price for the skin, wear it for a week, and leave it to gather dust in a virtual closet once it is older and commonplace. Player B, who is more cost-conscious, currently makes do with looking like a default character but would be willing to buy a skin at a price lower than what the developer is offering.[122] With the right of disposition, Player A could sell that skin to Player B at a discount, and both would benefit. In permitting the transaction between the two players, the developer allows the skin to go to its highest value owner at each given point in time.[123] Furthermore, Player A's knowledge that she can recoup part of her cost by selling to Player B can further increase her willingness to pay for new skins, which benefits the developer in future releases.[124]

The rights to own and dispose need not go hand in hand. Developers who are uncomfortable with granting ownership rights to assets they view as simply being in-game features can nonetheless consider strengthening the existing licenses they provide. For example, by making licenses transferable, a developer could enable player-to-player trades while retaining the discretion to unilaterally suspend a player for poor behavior and revoke her access to her

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119. Arthur H. Fox, *A Theory of Second-Hand Markets*, 24 ECONOMICA 99, 114-15 (1957).

120. *See infra* Section IV.B.1.

121. *See* Fox, *supra* note 119, at 115.

122. In certain games, there can also be social stigma attached to being a "default" who does not pay for custom skins. *See* Patricia Hernandez, *Fortnite is Free, but Kids are Getting Bullied into Spending Money*, POLYGON (May 7, 2019, 12:21 PM) https://www.polygon.com/2019/5/7/18534431/fortnite-rare-default-skins-bullying-harassment (describing how *Fortnite* skins "became a status symbol" and how some children were bullied because they played *Fortnite* as a "default").

123. *See supra* note 119 and accompanying text.

124. *Cf. supra* Section III.B (highlighting a similar phenomenon with digital trading cards in *Magic Online*).

items. Doing so would likely yield benefits similar to granting ownership rights while avoiding a portion of the associated costs.[125]

B. UNIQUELY VALUABLE OR COST-EFFECTIVE FEATURES OF VIRTUAL WORLDS

1. *Unleashing Virtual-Native Benefits*

Developers can take advantage of the virtual nature of in-game goods to create surplus value and reduce transaction costs beyond what might be possible in the real world.

First, virtual items allow owners to avoid many costs and inconveniences associated with physical goods. For example, in the absence of built-in virtual deterioration, items will not degrade over time, and any decrease in their value will not be tied to their condition. This helps preserve tremendous amounts of value for many collectors' items, especially in cases where items gathering dust in an attic—real or virtual—return to unexpected relevance.[126] A seller seeking to convey a virtual item to a distant buyer can also do so safely and instantly, avoiding transportation costs and risks.

Furthermore, virtual goods do not suffer from information asymmetry and associated costs. In the real world, informational challenges can distort buyer and seller incentives, leading to adverse selection that either leaves one side unhappy or prevents any exchange from the outset.[127] Such challenges are even greater with online used goods sales, where distance and relative anonymity reduce accountability and further contribute to information challenges.[128] However, in virtual goods sales, where an authoritative source—the game code

125. A similar measure has worked in the Chinese real estate market, where land ownership is technically just possession of a 70-year government lease that is subject to certain involuntary repossession rights. *See* Frank Chen, *China Poised for Major Property Rights Overhaul*, ASIA TIMES (May 27, 2020), https://asiatimes.com/2020/05/china-poised-for-major-property-rights-overhaul/.

126. A "Near Mint" 1999 edition holographic Charizard Pokémon card has a market value of approximately $13,000, while a "Gem Mint" copy commands above $200,000. *1999 Pokémon Game – 1st Edition*, PSA AUTHENTICATION & GRADING SERVS., https://www.psacard.com/smrpriceguide/non-sports-tcg-card-values/1999-poke-mon-game-1st-edition/2432 (last visited Mar. 3, 2021). However, if all cards going forward are guaranteed to stay in mint condition, each of them will likely be less valuable individually than the "Gem Mint" copies are today.

127. *See, e.g.*, George A. Akerlof, *The Market for "Lemons": Quality Uncertainty and the Market Mechanism*, 84 Q. J. ECON 488, 489-90 (1970) (examining how information asymmetry between buyers and sellers can leave only low-quality "lemons" in the market).

128. *See, e.g.*, Gregory Lewis, *Asymmetric Information, Adverse Selection and Online Disclosure: The Case of eBay Motors*, 101 AM. ECON. REV. 1535, 1540-44 (2011) (discussing the types of credible disclosures required to resolve information asymmetry in online used goods).

itself—clearly calculates and displays item attributes, such concerns are almost nonexistent. Whereas real-world sellers must rely on a costly combination of certificates, inspections, and warranties to assure a buyer of an item's quality, sellers in virtual worlds can convey more information more reliably by simply displaying the item's attributes in the trade screen.

Many of these superior, virtual-native characteristics inherently exist, but their benefits are hampered by developer restrictions and can only be fully realized if developers provide players with the right of disposition and allow them to buy and sell their items.

2. Formalizing Wizardly Benevolence

Developers can use their near-absolute, wizardly control over both game code and EULA terms to introduce virtual perks that further enhance in-game item value. Developers already provide for many of these perks within their games, in non-EULA policies, and in informal procedures. To formalize them, developers should consider either incorporating such perks into their (newly disaggregated) EULAs or adding them as addendums, where applicable.

For example, Blizzard offers *World of Warcraft* players an "Item Restoration" service that allows players to restore items they sell or destroy, whether purposefully or accidentally.[129] While restoration is conditioned upon certain requirements, such as having an active subscription and not being a banned account, it essentially functions as free "accident or dumb mistake" insurance for players' most prized possessions.[130] Since it is nearly costless for Blizzard to use its virtual omnipotence to restore an item and highly valuable for the poor individual who fat-fingered a rare item into the void, this technology-enabled feature likely increases joint value.[131]

However, this *World of Warcraft* policy is relegated to one of at least 16,572 support pages, and the EULA clearly states that Blizzard has no obligation to comply with it.[132] Since players should presumably value this insurance more than Blizzard values the flexibility avoid compliance with this nearly costless policy, Blizzard should consider formalizing policies like this in its EULA or in individual item purchase agreements. Other services that might similarly

129. *World of Warcraft Item Restoration*, BLIZZARD, https://us.battle.net/support/en/article/16572 (Oct. 2021).

130. *See id.*

131. This is the virtual equivalent of your jeweler promising to give you a new ring if you accidentally drop the old one down the toilet or give it to your neighborhood orc blacksmith. If you were a clumsy individual, you might be willing to pay for such a promise.

132. *See* BLIZZARD, *supra* note 129. Continuing the analogy above, a verbal "we'll probably give you a new one, but no guarantees" statement would presumably be less valuable to you than a signed promise.

provide value outweighing costs might include reversing the effects of player-on-player fraud or providing escrow services for high-value transactions.

C. NON-FUNGIBLE TOKENS AND THE POWER OF FIRM COMMITMENTS

The recent hype surrounding NFTs demonstrates how firm commitments can provide significantly more value than vague statements.[133]

NFTs, which are unique and non-interchangeable digital assets recorded on a blockchain, allow creators to "codify" assets onto a digital ledger, "establishing a verifiable record of price, ownership, and transference" that will exist permanently on the blockchain.[134] Since blockchains are maintained and verified by a decentralized network of nodes, no individual can alter the properties of an entry once it has been created and recorded on the blockchain.[135] This allows individuals to enshrine promises in unalterable code, an action that in certain circumstances can be more forceful than contract.[136]

For example, in *Top Shot*, a partnership between the NBA and blockchain company Dapper Labs,[137] users can buy collectible "Moments" that contain player photos, highlights, and stats.[138] Users can freely trade these "Moments," which are essentially digitally enhanced trading cards recorded as tokens on an Ethereum-based blockchain, freely with each other on the *Top Shot* marketplace, including for real money.[139] Each card is given a scarcity tier, ranging from "Common," denoting at least 1,000 copies in existence, to

133. Admittedly, much of the fervor can be attributed to some combination of U.S Federal Reserve monetary policy, post-GameStop brave-new-world momentum investing, and resurgent interest in blockchain amidst rising Bitcoin prices. *See, e.g.*, Cooper Turley, *If You Haven't Followed NFTs, Here's Why You Should Start*, TECHCRUNCH (Feb. 27, 2021), https://techcrunch.com/2021/02/27/if-you-havent-followed-nfts-heres-why-you-should-start/ (suggesting that the NFT craze is likely to be a bubble in the short-term).

134. Terry Nguyen, *NFTs, The Digital Bits of Anything That Sell for Millions of Dollars, Explained*, VOX (Mar. 11, 2021), https://www.vox.com/the-goods/22313936/non-fungible-tokens-crypto-explained.

135. *See, e.g.*, Kaushiki Srivastav, *A Guide to Blockchain Immutability and Challenges*, DZONE (Mar. 29, 2021), https://dzone.com/articles/a-guide-to-blockchain-immutability-and-chief-chall (explaining the mechanics behind blockchain immutability and highlighting certain challenges).

136. *See, e.g.*, Stuart D. Levi & Alex B. Lipton, *An Introduction to Smart Contracts and Their Potential and Inherent Limitations*, HARV. L. SCH. F. ON CORP. GOVERNANCE (May 26, 2018), https://corpgov.law.harvard.edu/2018/05/26/an-introduction-to-smart-contracts-and-their-potential-and-inherent-limitations/ (describing "smart contracts," computer code that "automatically executes" contract terms and is stored on a blockchain).

137. Dapper Labs also created *CryptoKitties*, another famous blockchain collectibles platform. DAPPER, https://www.dapperlabs.com/#products (last visited Mar. 2, 2021).

138. *See* NBA TOP SHOT, https://www.nbatopshot.com/about (last visited Mar. 2021).

139. *See id.*

"Genesis," which denotes a single copy.[140] When it first launched in October 2020, *Top Shot* performed extraordinarily well, generating more than $230 million in sales in its first six months, including a whopping ninety-five percent generated by secondary user-to-user activity on the *Top Shot* marketplace.[141] Rare "Moments" sold at astronomical prices, with a Lebron James dunk selling for $200,000, while a 5,000-pack release sold out instantly after 90,000 signed up to buy in.[142]

Putting aside the fact that NFTs can be freely bought and sold, the primary source of value (or at least hype) behind *Top Shot* and other NFTs is its code-enforced commitments. If Dapper Labs issues one "Genesis" Zion Williamson block highlight, the decentralized nature of the Ethereum blockchain ensures that there will only ever be one authentic copy.[143] If Dapper Labs minted another, it would be visible to everyone on the platform and would come with severe reputational consequences.[144] Anybody viewing the highlight can view its properties, including its scarcity and entire transaction history, and therefore be assured that it is indeed the one and only "Genesis" Zion Williamson block. Such guarantees of provenance, authenticity, and scarcity, enforced by immutable code, can prove highly valuable, including in adjacent contexts such as art.

Some developers have developed blockchain-native games whose items are recorded on popular protocols such as Ethereum and Solana.[145] Many of these games promise to "replicat[e] the tangibility of real-world assets and

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140. *Infographic*, NBA TOP SHOT, https://www.nbatopshot.com/infographic (last visited Mar. 4, 2021).

141. Jabari Young, *People Have Spent More Than $230 Million Buying and Trading Digital Collectibles of NBA Highlights*, CNBC (Feb. 28, 2021), https://www.cnbc.com/2021/02/28/230-million-dollars-spent-on-nba-top-shot.html.

142. Thomas Urbain, *Digital Authentication Opens New Doors for Art, Sports Collectors*, YAHOO! NEWS (Feb. 27, 2021), https://news.yahoo.com/digital-authentication-opens-doors-art-015902230.html. Note, however, that this pales in comparison to the $5.2 million recently paid for a mint condition 1952 Topps Mickey Mantle physical baseball card. Bill Shea, *NBA Top Shot: People are Buying the Virtual Highlight Cards, But Risks Remain*, THE ATHLETIC (Feb. 15, 2021), https://theathletic.com/2385311/2021/02/15/nba-top-shot-people-buying-virtual-highlight-cards-risks-remain/.

143. Ethereum is one of a handful of blockchains upon which NFTs are recorded. *Blockchains Vie for NFT Market, but Ethereum Still Dominates* , COINTELEGRAPH (Oct. 8, 2021), https://cointelegraph.com/news/blockchains-vie-for-nft-market-but-ethereum-still-dominates-report.

144. It would also be much easier to catch Dapper in the act than it would be to realize that a baseball card company actually printed 700 instead of 500 copies of a particular card.

145. For a list of games on the Ethereum blockchain, ordered by user activity, see *Top Ethereum Games*, DAPPRADAR, https://dappradar.com/rankings/protocol/ethereum/category/games (last visited Jan. 19, 2022).

ownership" and provide for direct player-to-player transactions.[146] Some have even managed to sell items that do not yet exist to raise money to develop the very games that the items will be featured in—for example, "virtual gaming metaverse" *Star Atlas* raised $20 million for development by selling NFTs conveying ownership of spaceships that could be used in the game when it eventually launches.[147] For these games, code-enforced "ownership" can be a valuable core feature that simultaneously functions as competitive differentiation and fundraising mechanism.

This is hardly to suggest that all developers should enshrine commitments made to players on a decentralized ledger, which comes with its own challenges and implications,[148] or that NFT prices are not primarily driven by speculation and unfounded hype.[149] If applied indiscriminately to all items and features, immutable code-based commitments would hamstring developers and likely resurface some of the very problems that the EULA status quo helps address—competitive imbalance, increased difficulty moderating player behavior, and reduced update flexibility.[150]

However, NFTs do show that firm promises can enhance virtual asset values, and developers could draw on this insight by formalizing many of the

146. STAR ATLAS, WHITE PAPER: YOUR GUIDE TO THE UNIVERSE! (2021), https://staratlas.com/white-paper.pdf; *see also Axie Economy & Long-term Sustainability*, AXIE INFINITY, https://whitepaper.axieinfinity.com/gameplay/axie-population-and-long-term-sustainability (last visited Jan. 19, 2022) ("Game resources and items are tokenized [on the blockchain], meaning they can be sold to anyone, anywhere on open peer-to-peer markets").

147. *Star Atlas: The Most Ambitious Blockchain Game*, NAAVIK, https://naavik.co/themetas/staratlas-ua (last visited Jan. 19, 2022) .

148. For example, the fees paid to process transactions on a blockchain can sometimes outstrip the transaction amounts themselves. *See, e.g.*, Will Gottsegen, *Time's NFT Launch Sends Gas Fees Spiraling*, COINDESK (Sept. 23, 2021), https://www.coindesk.com/business/2021/09/23/chaotic-time-magazine-nft-launch-sends-gas-fees-spiraling/(describing how buyers spent "almost four times as much on transaction fees as they did on the NFTs themselves"). This has been an issue for *Gods Unchained* players seeking to buy and sell trading cards to optimize their decks. u/maiopupli, *Are You Guys Just Eating the Gas Fees?*, REDDIT (Sept. 22, 2021), https://www.reddit.com/r/GodsUnchained/comments/ptcc2a/are_you_guys_just_eating_the_gas_fees/. Additionally, no discussion involving blockchain is complete without acknowledging its arguably significant negative environmental impact. *See* Justine Calma, *The Climate Controversy Swirling Around NFTs*, THE VERGE (Mar. 15, 2021), https://www.theverge.com/2021/3/15/22328203/nft-cryptoart-ethereum-blockchain-climate-change.

149. *See, e.g.*, Anil Dash, *NFTs Weren't Supposed to End Like This*, THE ATLANTIC (Apr. 2, 2021), https://www.theatlantic.com/ideas/archive/2021/04/nfts-werent-supposed-end-like/618488/ ("Companies selling toilet paper, potato chips, and light beer are tailgating on NFTs' newfound popularity to offer incomprehensible blockchain-themed promotions on social media.").

150. *See supra* Section II.C.

policies and features they currently offer on a merely informal or ad hoc basis. Clearly announcing that an item will have a limited supply, contractually guaranteeing scarcity within a EULA or purchase agreement, or displaying specific information about an item's scarcity in an in-game trade menu could help achieve similar effects for rare in-game items. Given the current state of developer discretion, such formal assurances would represent a significant step toward a more optimal balance of developer and player rights.

D. DISTINGUISHING BETWEEN GAME AND ITEM

Developers seeking to make new, firm promises can consider adding contract layers that distinguish in-game items from the underlying game to avoid triggering some of the common concerns about ownership discussed in Section II.C. A base EULA can lay out ground rules on issues such as updates, player conduct, and termination that apply broadly to the entire game, while additional language can address item-specific topics such as ownership, disposition, scarcity, and developer-provided virtual perks.

The *Top Shot* terms of service provide an instructive example. Dapper Labs distinguishes between the "App," the platform which allows players "to purchase, collect, and showcase NBA moments," and "Moments," the NFTs themselves that have "a defined set of attributes . . . ."[151] Users own the underlying NFT "completely," but Dapper Labs own all rights "in and to all other elements of the App, and all intellectual property rights therein . . . ."[152]

In typical EULA fashion, *Top Shot* users agree to refrain from engaging in illegal or undesirable behavior such as posting objectionable content or distributing viruses, while Dapper Labs reserves sole and absolute discretion to terminate users' accounts for such behavior.[153] However, termination only impacts a user's ability to access or use the "App" and does not affect the user's ownership rights in any NFTs she already owns.[154] A user who finds herself suspended and unable to enjoy her "Moment" displayed through the "App" can nonetheless sell it to somebody who can, which preserves the NFT's value within the shared *Top Shot* ecosystem. With this structure, a developer in the virtual game world could ban a player for illegal behavior while allowing such player to sell her items in a separate marketplace to somebody who can use them. The benefits of this contractual distinction also flow in the opposite direction. Just as a user's behavior on the base *Top Shot*

151. *Terms of Service*, NBA TOP SHOT, https://www.nbatopshot.com/terms (last visited Mar. 4, 2021).

152. *Id.*

153. *Id.*

154. *Id.*

platform does not undermine her ownership, Dapper Lab's mishaps in maintaining the platform do not give users a claim against Dapper Labs, even if those mishaps impact the value of users' NFTs. In the *Top Shot* terms of service, users expressly assume the risk that upgrades to the "Flow" platform—the blockchain that *Top Shot* runs on—may have "unintended, adverse effects" on the *Top Shot* ecosystem.[155] Since a user pays for ownership of the NFT itself, Dapper Labs makes no promises regarding the *Top Shot* platform, which acts more as an ancillary vehicle to boost NFT values.

Others in the NFT space have pushed this distinction even further. One example is Loot, an NFT platform whose NFTs are simply "text file[s] consisting of 8 phrases overlaid on a black background."[156] Such phrases, like "Short Sword" or "Divine Slippers," for example, evoke gaming archetypes but are not themselves usable items in any game.[157] Instead, entire communities, at times referred to as "decentralized autonomous organizations" (DAOs), emerged to build out the infrastructure of "the Loot ecosystem,"[158] with some creating entire games that accept Loot's text phrases as inputs and grant holders corresponding in-game features.[159] Just like how players own "Moments" that are displayable on—but independent of—the *Top Shot* "App," players can take their Loot NFTs, which exist independently of the games that incorporate them, and use their Loot NFTs across a wide range of games.[160] Such a model flips the existing in-game item model on its head by making items the focal point—akin to developing an entire basketball game based on "Moments" and providing that players could only play as Lebron James if they held a Lebron James NFT. To successfully accommodate this paradigm shift, EULAs would need to meticulously distinguish the underlying item from the overlaying game.

Such developments, still in nascent stages, are unlikely to pose a direct threat to mainstream games in the short term. In very few games do players currently care more about the items than the underlying game, and developers must be careful not to undermine gameplay by allowing players to "pay-to-

155. *See* NBA TOP SHOT, *supra* note 151.

156. *See Loot Project: The First Community Owned NFT Gaming Platform*, COINBASE BLOG (Sept. 14, 2021), https://blog.coinbase.com/loot-project-the-first-community-owned-nft-gaming-platform-125fa1d5ffa8.

157. *Id.*

158. *See* DivineDAO, *Introducing the Divine City*, MEDIUM (Oct. 5, 2021), https://divinedao.medium.com/introducing-the-divine-city-460596889bfc.

159. *See, e.g.*, GENESIS PROJECT, https://genesisproject.xyz/ (allowing Loot holders to "resurrect a Genesis Adventure of Brilliance" for use in future games by inputting certain pieces of Loot "equipment" text phrases).

160. *Id.*

win" using expensive, rare NFTs.[161] Furthermore, even if players are amenable, blockchain developers will need massive budgets and multi-year development cycles to create games that compete in production quality with the mainstream industry's top performers.[162]

Meanwhile, even proactive mainstream developers seeking to introduce player rights may find the adoption of *Top Shot*'s model a bit drastic—a developer might prefer to reserve the ability to modify items to ensure that they work across updates, or bar sales from terminated accounts to deter bad behavior. But developers are better served when these policies arise from thoughtful consideration of the particular characteristics of their virtual worlds, rather than blunt application of EULA terms. Contract layers can help facilitate such decisions.

V. A TOGGLE MENU APPROACH TO EULA TAILORING

Contract rights can provide valuable assurance for business promises but can also give rise to inefficiency and litigation when they conflict.[163] Developers seeking to improve their EULAs should use a toggle menu approach and selectively provide rights that comprise the optimal set for each respective game. Game characteristics will determine what rights are feasible, while commercial considerations stemming from those characteristics will dictate what rights are desirable.

Some considerations are more logistical and involve how to tweak contract language or game features to accommodate new rights. Others are based in principle and will depend on each developer's vision and strategy for each game. Understanding these considerations may help explain why developers

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161. After all, most in-game items available for player purchase are optional enhancements that exist separately from underlying core gameplay. *See infra* Section V.B.I. (discussing how allowing players to buy items that directly affect gameplay can severely undermine player experience).

162. For example, *Grand Theft Auto V* had a $265 million budget and took 5 years to produce. *See From Development to Marketing, Game Studios Spared No Expense in Making These Games*, GAMEDESIGNING, https://www.gamedesigning.org/gaming/most-expensive-games/ (last visited Jan. 19, 2022) .

163. *See, e.g.*, Bragg v. Linden Rsch., Inc., 487 F. Supp. 2d 593 (E.D. Pa. 2007). Defendant Linden Lab auctioned rights to virtual land in *Second Life*, a game it developed. When plaintiff Marc Bragg used a loophole in the auction system to acquire virtual land cheaply, Linden Lab terminated Bragg's account and his rights to the land. Bragg argued that Linden Lab could not represent that it was selling "ownership" and then unilaterally revoke his rights to the land, while Linden Lab argued that the rights were always licenses and that termination was fully within its discretion under the EULA; *see also* Evans v. Linden Rsch., Inc., No. C 11-01078 DMR, 2012 WL 5877579 (N.D. Cal. Nov. 20, 2012) (addressing a similar issue for a separate group of *Second Life* players).

have not been as active in tailoring in-game rights as this Note argues they should.

A. LOGISTICAL CONSIDERATIONS

1. Updates

Developers need flexibility to update their games to fix bugs, maintain competitive balance, and otherwise improve the game experience, since promising to obtain consent from players prior to each update would be costly and inefficient.

However, developers can explore less limiting promises that nonetheless prove valuable by reducing the risk that an update will adversely impact an item. For example, a developer selling a plot of land in a game might be unwilling to guarantee that new updates will not decrease the plot's value. However, if the developer did not expect to update the game map going forward, it could provide approximately the same assurance by guaranteeing that the plot would always be conveniently situated near the main teleportation portal—a promise that would help preserve a key source of the plot's value.[164] Similarly, a developer selling a limited-edition item might promise to never change the item's aesthetic, even if surrounding game graphics were updated, so that it would retain a distinctive character that might grow more desirable over time.[165]

2. Obsolescence

An adjacent challenge arises when a game nears the end of its lifecycle and the costs of maintaining servers for the game exceed expected future revenues. Under the status quo, the developer would simply post an announcement, shut down the servers, and shift resources to newer games.[166] With players granted certain ownership rights, however, the alternatives available to a developer could be more complicated. For example, a developer who grants ownership rights may need to commit to maintaining support for a fixed period of time

164. Plot 5 in The Mist is a highly desirable housing location in *Final Fantasy XIV* in part because it is conveniently located "close to a Market Board, a Summoning Bell, and an Aetheryte." bxakid, *FFXIV: The Best Housing Plots You Need to See Before 5.35*, MGG (Oct. 1, 2020), https://www.millenium.gg/news/20497.html.

165. For example, some legacy skins in *League of Legends* are prized specifically for their dated aesthetic even as the game's graphics have improved over the past decade. Luke Winkie, *9 of the Rarest League of Legends Skins*, PC GAMER (Nov. 19, 2018), https://www.pcgamer.com/lol-skins/ (noting how the "Rusty Blitzcrank" skin's "unappealing design has now become one of the rarest variants in League of Legends history.").

166. *See, e.g.*, 2K Liana, *supra* note 76 (describing annual shutdowns for old versions of *NBA 2K*).

or allow players to cash out their items for in-game currency in a newer version of the game. Developers might even consider allowing players to host their own private servers, subject to certain limitations, to access their in-game items if the developer abandons support.[167] What arrangement proves most efficient will depend largely on player expectations, which can in turn be shaped by the developer's public stance and marketing at the time of sale.[168]

3. *Transaction Costs*

Making more numerous and more complicated contractual promises will also require developers to draft, administer, and keep track of those promises, introducing additional costs for developers. Certain promises, such as reversing fraud after an investigation, may prove more expensive to carry out than others.

Guaranteeing certain rights and attributes at the item level could also be costly, as developers would have to draft a set of rights that players would have to agree to with each purchase. However, for ultra-rare collectibles whose value stems from scarcity, a contractual promise to limit the supply of those items might be worth the cost, especially where such formalization is merely the outward manifestation to players of the developer's original intent. Developers should make their own determinations as to what rights to provide, and at what level of detail, based on the particular characteristics of their virtual world. In a case like *NBA 2K*, the optimal choice may be to limit costs by keeping things simple and promising nothing.[169]

4. *Secondary Markets*

Developers offering ownership and disposition will need to determine what level of secondary market activity to allow. Different degrees of activity provide their respective advantages: allowing real money trades in any medium may allow for more efficient pricing, whereas only allowing in-game item

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167. *See generally* Mark A. Lemley, *Disappearing Content*, 101 B.U. L. REV. 1255 (2021) (suggesting a similar arrangement in which libraries or even private companies are allowed to make old versions of copyrighted material available for preservation purposes, but also noting difficulties associated with doing so for multiplayer video games given interoperability challenges for players with different versions).

168. As an increasing number of developers release remastered versions of classic games, even items from games previously considered obsolete may come to retain unexpected value. *See, e.g.*, Sean Hollister, *Diablo II: Resurrected Will Let You Import Your 20-Year-Old Savegames*, THE VERGE (Mar. 4, 2021), https://www.theverge.com/2021/3/4/22314085/diablo-ii-remastered-original-save-files-savegames (noting how *Diablo II: Resurrected* will allow players to import old *Diablo II* saved files, including the rare in-game items contained within, into the remastered game).

169. *See supra* Section II.D.

trades in an official market would enable a more curated player experience. Available options might include:

Figure 2: Potential Levels of Developer-Sanctioned Market Activity[170]

Level of player-to-player activity	Example
All trades forbidden	*Magic: The Gathering Arena*
In-game items and currency only	*World of Warcraft*
Real money in official markets only	*Diablo III* (until 2014)
Real money in any market	*Magic: The Gathering Online*

While a gray market will always exist,[171] the degree to which a developer blesses and facilitates transactions in a particular market will affect the level of risk associated with such transactions.[172] The robustness of a game's secondary market can impact its in-game economy, including inflation rates and demand for new goods directly offered by the developer.[173] Developers should carefully consider what works best based on each game's core mechanics and incentive

170. *See supra* note 91; *Auction House*, WOWPEDIA, https://wow.gamepedia.com/Auction_House (last visited Mar. 4, 2021); John Hight, *Diablo III Auction House Update*, DIABLO III (Sept. 17, 2013), https://us.diablo3.com/en-us/blog/10974978/diablo%C2%AE-iii-auction-house-update-9-17-2013.

171. *See*, *e.g.*, EL DORADO, https://www.eldorado.gg/ (last visited Mar. 4, 2021) (unapproved third-party site making "in-game trading great again" by selling in-game currency and items for real money).

172. *Compare* Jimenez, *supra* note 25 (describing how Blizzard terminated an account sold by one player to another), *with* WIZARDS OF THE COAST, *supra* note 95 (outlining Wizards of the Coast's policy allowing players to buy and sell online cards and even redeem them for physical copies).

173. For example, since in-game currency spent in *World of Warcraft*'s auction houses goes to other players instead of back to the developer, players collectively retain the same spending power as before their trade. Blizzard charges a 5% transaction fee to force indirectly players, as a collective whole, to eventually have to acquire more gold by playing the game. *See Gold Sink*, WOWPEDIA, https://wow.gamepedia.com/Gold_sink (last visited Mar. 3, 2021) (discussing how developers combat inflation by removing money from the game's economy using "gold sinks").

structure, as a laissez-faire approach to real-money transactions may not always be the best approach.[174]

B. PRINCIPLE-BASED CONSIDERATIONS

1. *Pay-to-Win*

Developers introducing the right to own and dispose of in-game items risk undermining core gameplay and enabling players to take shortcuts instead of playing or improving at the game. Such was the case with the auction house in *Diablo III*, an attempt by Blizzard to create a convenient and safe way for players to buy and sell in-game currency and items, including with real money.[175] Unlike in many other games,[176] where microtransactions often involve nonessential items such as cosmetic skins, the *Diablo III* auction house allowed sales of items, such as powerful weapons, that affected gameplay.[177] The auction house proved hugely unpopular among a large group of players, who felt that it undermined *Diablo III*'s core experience.[178] Less than two years after launching the auction house, Blizzard shut it down completely.[179]

However, Diablo III's main problem was not that that it allowed real-money transactions, but "[r]ather . . . the existence of the auction house in the first place, whether for real cash or fake gold."[180] In a game where "better loot *is* the ultimate goal," the decision to allow players to simply buy loot instead of grinding for it by repeatedly killing in-game monsters removed "the reward structure that would otherwise motivate them to play . . . ."[181] *Diablo III*'s failure, when contrasted with the success of auction houses in other games such as *World of Warcraft*,[182] does not suggest that developers should avoid allowing user transactions, but rather that they need to tailor market design to each game instead of carelessly defaulting to either extreme.[183]

174. *See infra* Section V.B.1 (discussing the drawbacks of *Diablo III*'s real-money Auction House); *see also infra* Section V.C.2 (discussing potential concerns about cannibalizing whale revenue).

175. Bo Moore, *Why Diablo's Auction House Went Straight to Hell*, WIRED (Sept. 20, 2013), https://www.wired.com/2013/09/diablo-auction-house/.

176. *See*, *e.g.*, OVERWATCH WIKI, *supra* note 86 (describing how cosmetics "do not affect gameplay").

177. *See* Moore, *supra* note 175.

178. *See* Hight, *supra* note 170.

179. *Id.*

180. *Id.*

181. *Id.*

182. *World of Warcraft* does not allow sales of gameplay-altering items beyond basic crafting materials. *See* Moore, *supra* note 175.

183. Note that *World of Warcraft*'s auction houses do not allow real money transactions. *Id.*

2. *Maintaining the Fantasy*

A related risk is whether introducing certain rights may make the game appear too transactional, bursting the fantasy bubble that developers strive so hard to create. However, since every developer who has introduced microtransactions has already made a similar tradeoff, this risk should not be viewed as an insurmountable obstacle.

Thoughtful developers can seamlessly integrate money into the game experience. Many developers have made some effort in this regard by charging prices in virtual currency, which removes the purchase experience one step further from the real world.[184] Others go further. For instance, in *Genshin Impact*, the immensely popular open-world RPG developed by miHoYo, the "gacha" mechanism[185] for obtaining new characters, weapons, and items is deftly packaged as the player making a "wish."[186] Each "wish" is accompanied by a beautiful animation of a shooting star that dovetails with the game's overall fantasy theme.[187] While not every game will lend as well to such a mechanism, developers should weigh the risks and benefits of particular transaction designs based on their own game and player community.

3. *Gambling, Speculation, and Addiction*

Developers will need to further consider whether facilitating increased microtransactions, which can lead to increased addiction, gambling, and speculation among players,[188] is a desirable goal for their strategy and community.

In years past, an addictive game could destroy a player's health, relationships, and career prospects,[189] but its direct financial costs would often

184. See *supra* note 112 for a recap on "gacha" mechanisms.

185. *See*, *e.g.*, 2K Mike, *supra* note 73 (explaining how "VC" or virtual currency works in *NBA 2K*).

186. *Wishes*, GENSHIN IMPACT WIKI, https://genshin-impact.fandom.com/wiki/Wishes (last visited Mar. 3, 2021).

187. The animation does not make whiffing on a rare character any less infuriating, but at least it looks good and engages the community—a user rendition of the "*Genshin Impact* Gacha Experience" animation is the second-most upvoted post on the *Genshin Impact* subreddit. *See* u/Totouri, *I Animated the Genshin Impact Gacha Experience*, REDDIT (Jan. 2021), https://www.reddit.com/r/Genshin_Impact/comments/kx4sbv/i_animated_the_genshin_impact_gacha_experience/.

188. *See*, *e.g.*, Luke Winkie, *Here's How Loot Box & Microtransaction Addiction Destroys Lives*, IGN (July 13, 2020, 2:57 PM), https://www.ign.com/articles/heres-how-loot-box-addiction-destroys-lives (describing the harmful effects of microtransaction addiction).

189. Meredith Watkins, *Video Game Addiction Symptoms and Treatment*, AM. ADDICTION CTRS., https://americanaddictioncenters.org/video-gaming-addiction (last visited Sept. 29, 2021).

be limited to its purchase price and potentially the cost of licensed merchandise. But, since microtransaction spending does not have a hard limit, the potential financial impact on an addicted gamer is much greater, to the point where financial planners have issued self-promoting pieces warning about the significant risks that microtransactions pose for student loan borrowers.[190] These dangers are further compounded by the "gacha" or "loot box" mechanisms present in many games, which add an addictive element of uncertainty that many argue should be considered gambling.[191]

Furthermore, valuable items almost invariably attract opportunistic behavior such as speculation and fraud. Casual *Magic: The Gathering* players "have complained, loudly and for years," about increasingly high prices and rampant speculation, including "hostage situation[s]" where "[a]mbitious dealers have been suspected of buying out every single available copy of a card to inflate its price . . . ."[192] Such undesirable behavior can be difficult to avoid and can dissuade newcomers from engaging with a game, limiting its attractiveness.

C. Possible Explanations For Developers Staying With The Status Quo

EULAs have remained noticeably static even as industry business models have evolved dramatically. Conservatism stemming from past mistakes, concerns about alienating key customers, and legitimate needs for flexibility provide some insight into why developers may have been less active in tailoring contractual rights for a $100 billion dollar industry than they likely should.

1. *Disrupting a Favorable Equilibrium*

The EULA status quo has accompanied the game industry in its meteoric ascent to becoming a hundred-billion-dollar business. In the absence of clear and appealing counterfactuals, many developers may have adopted a more

190. *See* Ameritech Financial, *Microtransactions in Video Games May Lead to Financial Troubles, Says Ameritech Financial*, CISION PR NEWSWIRE (June 13, 2018), https://www.prnewswire.com/news-releases/microtransactions-in-video-games-may-lead-to-financial-troubles-says-ameritech-financial-300665429.html.

191. *See, e.g.*, Sheldon A. Evans, *Pandora's Loot Box*, 90 GEO. WASH. L. REV. (forthcoming 2022) (arguing that loot boxes should be regulated as a form of gambling); David Lazarus, *Column: Are 'Loot Boxes' in Video Games a Form of Gambling?*, L.A. TIMES (Dec. 11, 2020, 6:00AM), https://www.latimes.com/business/story/2020-12-11/video-game-loot-boxes-gambling (describing legislative amenability to loot box regulation in both the United States and the United Kingdom).

192. Cecilia D'Anastasio, *The Stockbrokers of Magic: The Gathering Play for Keeps*, WIRED (Apr. 23, 2020, 7:00AM), https://www.wired.com/story/the-stockbrokers-of-magic-the-gathering-play-for-keeps/.

conservative "if it ain't broke, don't fix it" approach, especially when considering the apparent apathy that most players have demonstrated even while spending large amounts of money.[193] For developers, players' implicit willingness to rely on extralegal enforcement may serve as unspoken assent to maintain a developer-friendly equilibrium.[194]

Prominent mishaps by more forward-thinking developers may have also discouraged the crowd. *Diablo III*'s real-money auction house and Linden Labs' sales of virtual land "ownership" rights in *Second Life* both tried and failed to create and capture user value by selectively introducing pseudo-property rights—one was widely criticized by the player community,[195] while the other invited opportunistic behavior and litigation.[196] This Note has sought to explain their shortcomings and provide recommendations that avoid their mistakes.[197]

2. *Uncertain Impact on Whales*

Developers may be concerned about the impact that EULA changes could have on whales' spending behavior. Whereas the average player might spend a few dollars a year, whales can spend hundreds or thousands per month, with as few as 0.15% of players accounting for fifty percent of total revenue.[198] The player spending $150,000 on the free-to-play *Transformers* game drives much of the game's profitability and may not behave in ways that developers can reliably predict.[199] For example, allowing players to pay more for in-game items that roll over across versions of *NBA 2K* could increase joint value by giving mainstream players an efficient way to express their preferences and increasing their incentive to buy future versions of *NBA 2K*. However, doing so would also decrease developer revenues from whales, many of whom already buy every new version and purchase massive amounts of new in-game items from scratch without additional incentives.[200]

Whether such a change would yield a net benefit for developers would likely be an empirical question. Cannibalization of whale revenue could outweigh any increase in mainstream spending, but increased player engagement might also drive whales to spend even more to differentiate

193. *See infra* Section II.C.2.
194. *See supra* Section II.C.3.
195. *See infra* Section V.B.1.
196. *See*, *e.g.*, *supra* note 163 and accompanying text.
197. *See supra* Part V.
198. *See supra* note 69.
199. *See supra* note 70.
200. *See supra* notes 75-76 and accompanying text.

themselves.[201] Some developers may have already made the relevant assessments and concluded that most rights discussed in this Note are not worth introducing. However, since these dynamics likely vary by right and by game, it appears unlikely that all developers have consciously arrived at the same conclusion across all rights and all games.

3. Business Premium on Flexibility

Developers may assign much greater value to flexibility than this Note expects. They may be concerned that granting certain rights, some of which could be perpetual, might limit their ability to quickly pursue unexpectedly lucrative opportunities. If Epic Games had contractually committed to dedicating significant resources to its original main "Save the World" game mode in *Fortnite*, it may not have been able to pivot as quickly as it did to growing its vastly more successful "Battle Royale" game mode, which has generated billions in revenue and made the franchise one of the largest in the world.[202] As the industry continues to grow rapidly and acquire mainstream legitimacy, new opportunities will emerge. High-profile partnerships, such as *League of Legends*' virtual skin and real-world apparel collaborations with Louis Vuitton or *Fortnite*'s in-game concert with rapper Travis Scott, likely involved complex negotiations surrounding assignment and licensing of rights and may have required significant in-game changes that could hardly have been anticipated when the developers first drafted their EULAs.[203] Developers may find that retaining absolute flexibility to make the changes necessary to pursue these opportunities might be more valuable than securing marginal gains in current revenue. However, considering the tremendous revenue that games already generate and the fact that certain rights such as free item restoration can provide value without meaningfully limiting developers, such concerns should only apply to a subset of rights in a subset of games.

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201. Derision of "defaults" and admiration for rarer skins in *Fortnite*, for example, may increase spending among both mainstream players and "whales." *See supra* note 122.

202. *See* Brandon Saltalamacchia, *The Evolution of Fortnite: How Fortnite Became the Game We Know and Love Today*, GAMESRADAR (June 29, 2018), https://www.gamesradar.com/the-evolution-of-fortnite-how-fortnite-became-the-game-we-know-and-love-today/.

203. *See* Jake Silbert, *Louis Vuitton Drops 'League of Legends' Apparel Collaboration*, HYPEBEAST (Dec. 9, 2019), https://hypebeast.com/2019/12/league-of-legends-louis-vuitton-apparel-collaboration-collection-accessories (describing the virtual apparel collaboration between Louis Vuitton and *League of Legends*); Andrew Webster, *Travis Scott's First Fortnite Concert Was Surreal and Spectacular*, THE VERGE (Apr. 23, 2020), https://www.theverge.com/2020/4/23/21233637/travis-scott-fortnite-concert-astronomical-live-report (noting that Scott's performance attracted an average live audience of 4.7 million viewers).

VI. CONCLUSION

Regardless of how one feels about the existing balance between contract and property in virtual worlds, the existing EULA regime will likely remain the primary legal mechanism governing in-game items in the near to medium term. The contrast between games such as *NBA 2K* and *Magic: The Gathering Online* demonstrates that developers' uniform assumption of plenary discretion across a wide range of games and items is likely suboptimal. Unbundling contractual rights and guarantees provides a toggle menu that developers can use to tailor EULAs to the particular characteristics of individual games. While developers undoubtedly benefit from their EULA dominance, selectively relinquishing plenary power in certain areas can more than pay for itself by providing increased opportunities for player engagement and spending. Doing so would help address some of the most glaring weaknesses in the existing EULA regime and provide a stronger foundation for an industry that is poised for further explosive growth.