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Embracing Digital

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EMBRACING DIGITAL*

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One of the most pressing questions in the era of digital media is whether and how to enable digital "first sale": the statutory right that allows the owner of a copy of a creative work to alienate it as they would any other physical property. First sale is easy to apply to physical copies—an owner simply transfers possession of their copy and thus loses access to it—but much more complex in the digital realm given the ease of copying digital files. The recent craze for blockchain-based non-fungible tokens ("NFTs") represents one of the most forceful attempts yet at treating digital goods like their physical counterparts. According to the scholars and technologists who advocate for them, NFTs promise a technological end to this grail quest; we are told that they constitute unique, rivalrous objects that enable not only a workable approach to digital first sale but a host of novel, wondrous uses. This Article provides a layered critique of this position by providing the legal literature's first thorough analysis of the technology behind NFTs. In doing so, it highlights the continued futility of treating digital goods like analog ones and provides the foundation for discussion of NFTs' desirability (or lack thereof) beyond the issue of first sale.

More broadly, this Article challenges the desirability of a digital first-sale right and provides a necessary corrective to the misunderstandings and misdirection characterizing much discussion of NFTs. It makes three contributions to the copyright literature and the emerging literature on blockchain technology. First, it highlights the unresolvable tensions behind arguments for digital first sale, as well as the significant social costs any digital first-sale regime would impose. Second, by engaging deeply with the technical underpinnings of NFTs, it demonstrates that NFTs are solutions in want of a problem and fail to solve any of the problems that historically plague attempts to create a workable digital first-sale right. Those failures not only illuminate the futility of the quest for digital first sale but call into question NFTs' utility in many areas of law, including property, finance, and contract. Third, it shows that NFTs, like digital first sale, succeed in imposing a range of social costs that far outweigh any potential benefit

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of the technology. In light of that dismal scorecard, this Article argues that it is long past time to accept the fundamental differences between digital and physical goods. Better distribution models cannot be achieved by forever unsuccessfully chasing a paradigm rooted in the limitations of physical media.

INTRODUCTION

It is difficult to recall a technological development generating the heady mix of glowing appraisal, utopian dreaming, and massive influx of cash that characterizes the rise of blockchain-based non-fungible tokens ("NFTs"). Proponents tout NFTs as an unmitigated boon for artists and the solution to the lack of resaleability of digital goods—indeed, they "presage the future of

digital property."[1] Even in academia, treatment of NFTs borders on the rapturous: "Consider the possibility of a truly unique digital artwork, owned by a single person, displayed in a virtual reality museum, and capable of being sold to another owner to realize the increase in value stemming from its rarity and beauty."[2] Indeed, we are told that "[t]he promise of NFTs extends to virtually every industry," and together with their "underlying technologies offer incredible opportunities which could serve to make government more efficient, food and drug products safer, and provide a method to create immutable records while protecting the data contained therein."[3] At least one proponent opines that "[i]n theory, NFTs could finally make copyright obsolete."[4] But, predictably, the reality falls well short of the dream.

The reality is this: the technologists behind the development of NFTs have succeeded, by extraordinarily complicated means and at great cost to the environment, in inventing receipts. That is arguably a generous description; in most circumstances, an NFT is less informative and less useful than a receipt. Thus far, the field has largely been ceded to NFT boosters and true believers. The result is widespread misunderstanding of every aspect of NFTs: what they are, how they are created, how they are sold, what is being sold, and their range of possible uses.[5]

1. *See, e.g.*, Clive Thompson, *The Untold Story of the NFT Boom*, N.Y. TIMES MAG. (May 12, 2021), https://www.nytimes.com/2021/05/12/magazine/nft-art-crypto.html [https://perma.cc/5DNB-VGDJ (staff-uploaded, dark archive)] ("For crypto diehards, these are the early days of a grand shift to an economy in which creators will sell anything digital—music, video-game add-ons, articles, photos—that used to be easily copyable.").

2. Joshua A.T. Fairfield, *Tokenized: The Law of Non-Fungible Tokens and Unique Digital Property*, 97 IND. L.J. 1261, 1265 (2022).

3. Kimberly A. Houser & John T. Holden, *Navigating the Non-Fungible Token*, 2022 UTAH L. REV. 891, 938.

4. Brian L. Frye, *After Copyright: Pwning NFTs in a Clout Economy*, 45 COLUM. J.L. & ARTS 341, 342 (2022).

5. Existing literature on NFTs is scarce, yet littered with such inaccuracies. Fairfield, for instance, claims that NFTs "can be used to create digital artwork that can be bought, sold, and owned like a physical sculpture," and further that "cryptoledgers provide a way to stop copying, to allow artists to sell one copy of an artwork to one person, or an author to sell one copy of a book to one reader." Fairfield, *supra* note 2, at 1266, 1290. Likewise, Tonya Evans argues that, with NFTs, "[t]he artist is . . . protected against counterfeiting." Tonya M. Evans, *Cryptokitties, Cryptography, and Copyright*, 47 AIPLA Q.J. 219, 254 (2019). Houser and Holden claim that the buyer, too, is "protected from falling prey to sellers that purport to sell fake art as authentic." Houser & Holden, *supra* note 3, at 903. Sebastian Pech contends that NFTs could solve the unauthorized copying problem that frustrates efforts to create a digital first-sale right, because the blockchain "can ensure that a file is only used by one person at a time and can therefore preclude the dissemination of unauthorized copies." Sebastian Pech, *Copyright Unchained: How Blockchain Technology Can Change the Administration and Distribution of Copyright Protected Works*, 18 NW. J. TECH. & INTELL. PROP. 1, 41 (2020). Peyman Khezr and Vijay Mohan argue that NFTs "serve the purpose of separating an original print from a reproduction by certifying the artist's involvement with the creation of the digital medium in the former instance, but not the latter." Peyman Khezr & Vijay Mohan, Property Rights in the Crypto Age: NFTs and the Auctioning

Properly understood, NFTs prove not a dream but a menace. Their rise required the intentional waste of unfathomable amounts of electricity. They draw artists, musicians, and other creators into a complicated system operated by entities that routinely misrepresent that system to leech money at the artists' expense. They not only enable but prize the development of "games" that rely on labor exploitation as a core design element. And for what? NFTs claim to solve problems that do not exist, and to the extent the problems do exist, NFTs do not solve them.

Among those possible problems is the resale of digital goods. Under existing law, and unlike physical goods, digital copies of copyright-protected works generally cannot be resold by consumers. For years, advocates for a digital first-sale doctrine have argued for reform.[6] In parallel, technologists have tried to devise ways to control use and transfer such that digital copies mimic the limitations of physical goods. To date, these efforts have been unsuccessful: neither courts nor Congress have budged on the law, and technological "solutions" have mostly proven unpopular because of the limits they impose. Some now look to NFTs as a way to finally enable digital first sale.[7] Their hope is misplaced. At the technological level, NFTs add nothing to the capabilities of existing solutions.[8] But more broadly, the shortcomings of NFTs expose the undesirability of a workable digital first-sale regimen. The supposed problems created by the current legal approach, such as impeding access to creative works, no longer appear to be problems at all. The proposed solutions enabled by NFTs, on the other hand, would decimate the remaining market for sales of digital goods while doing nothing for access. The fundamental flaw in this approach is its focus on ownership of digital media—the belief that ownership, with all its attendant rights, is vital. But in most circumstances ownership is irrelevant, a tenuous proxy for what really matters: control. If law should evolve in response to the problems identified by proponents of digital first sale, it should do so by ensuring individuals' ability to control their digital libraries.

At further remove, the quest for digital first sale, especially as empowered by NFTs, represents a curious desire to advance law and technology in order to

of Limited-Edition Artwork 9 (Aug. 9, 2021) (unpublished manuscript) (on file with the North Carolina Law Review). Andrés Guadamuz hails the built-in royalties on subsequent sales that can be made part of an NFT transaction, "as it guarantees future earnings in a manner that the law cannot." Andres Guadamuz, *The Treachery of Images: Non-Fungible Tokens and Copyright*, 16 J. INTELL. PROP. L. & PRAC. 1367, 1367 (2021). As will become clear, none of these claims are correct. *See infra* Section II.B.

6. *See* AARON PERZANOWSKI & JASON SCHULTZ, THE END OF OWNERSHIP: PERSONAL PROPERTY IN THE DIGITAL ECONOMY 1–13 (2016).

7. *See id.* at 191–93.

8. Many previous attempts to enable the type of digital resale sought by both digital first sale and NFT proponents have failed. Those failures had nothing to do with the underlying technology, but with the fact that it is not a workable idea. *See infra* Section III.B.

perpetuate a retrograde, commerce-focused approach to the dissemination of creative works. The development of high-quality, low-cost digital media created the opportunity to explore new models of distribution and compensation. The streaming model that rose to dominance over the last decade is, to be sure, deeply problematic. But digital first sale seeks to turn back the clock to rules created in an era of scarcity, while various NFT projects claim to advance by turning art into securities. From the standpoint of human flourishing, neither group is on the right path.

This Article provides a necessary counterbalance to the utopian thinking pervading public and academic discussion of NFTs. Drawing on the parallels between NFT advocacy and the quest for digital first sale, it demonstrates that both the technology and the sought-for doctrine stand to do more harm than good. Part I discusses the long-running debate over the resale of digital goods. It examines previous technological attempts to enable digital resale over the years, highlighting the unresolvable tension between the goals of digital first sale and the technical restrictions necessary to achieve those goals. Beyond the technology, it critiques the motives behind the drive for digital first sale, particularly the argument that the right to resell digital copies is critical to broadening access to creative works. Part II discusses both the inevitable marriage of digital first sale and NFTs and the essential worthlessness of the latter. To do so, it provides a thorough explanation of the technology behind NFTs. That explanation demonstrates that the reality of NFTs bears almost no resemblance to the claims of NFT proponents. By developing the connection between digital first sale and NFTs, it further shows the futility of the quest for digital first sale. Part III explores law's role in responding to the rise of digital media and NFTs, and expands the critique by demonstrating the significant social costs of both. While critics often note the environmental harm wrought by blockchain technology, the distributional problems of cryptocurrency and the implications of blockchain-based business practices have attracted less analysis. With the harms more fully in view, and the lack of benefits exposed, the desirability of either digital first sale or NFTs vanishes.

I. THE SAGA OF DIGITAL FIRST SALE

To the dismay of many, the move to digital media upended the foundational copyright doctrine of first sale. Under that doctrine, the owner of a lawfully acquired copy of a creative work is entitled to alienate that copy.[9] Whether possessed by the wish to give a favorite book to a friend or to finance the purchase of other goods, owners of physical copies enjoy a nearly unrestricted right to gift, donate, sell, or otherwise rid themselves of a copy. But the easy and perfect replicability of digital files precludes straightforward

9. *See* 17 U.S.C. § 109(a).

application of the first-sale doctrine to digital copies—at a technological level, nothing is to stop the seller of a digital copy from retaining a copy of their own.

Thus, alongside the rise of digital media, technologists repeatedly sought to devise methods to wrap copyright-protected works in enough technological wizardry to replicate transactions of physical copies of such works, reenabling invocation of the doctrine. The logic is simple enough: if I procure an authorized physical copy of a copyrighted work, the law allows me to alienate that copy as I see fit. Once I do so, I of course no longer have access to that work and would need to obtain another copy to regain access. If technology could replicate those conditions, application of the first-sale doctrine to digital copies would necessarily follow.

Alas, it cannot be done. Certainly, if saddled with sufficiently draconian digital rights management ("DRM"), duplicitous resale of digital copies can be made frustrating enough that most people will not bother. Proponents of digital first sale would be among the first to oppose any such solution.[10] That tension alone should put an end to the debate. However, the essential futility of digital first sale lies deeper. Its proponents encourage bending over backwards to create complex technological methods to make digital property behave like physical property. But there is no "there" there. Their proposed solutions do not work, both because they wrongly privilege the concept of uniqueness, and because they fail to sufficiently consider the likely consequences of their solutions. They likewise insist on ownership as a necessary component of these solutions. But ownership is a red herring. Control, not ownership, should be the goal, and can be achieved without any of the technological excess and economic risk of a digital first-sale regime.

A. *First-Sale Doctrine*

The first-sale doctrine enjoys a long and venerated history, from common-law origins to enshrinement in the Copyright Act.[11] Under that Act, the holder of a copyright enjoys a statutory monopoly over several rights, including the rights "to reproduce the copyrighted work in copies or phonorecords" and "to distribute copies or phonorecords of the copyrighted work to the public by sale

10. *See, e.g.*, PERZANOWSKI & SCHULTZ, *supra* note 6, at 123 (comparing DRM to "the types of social control that Bradbury feared" in *Fahrenheit 451*).

11. No less an authority than the Supreme Court has described it as a "common-law doctrine with an impeccable historic pedigree." Kirtsaeng v. John Wiley & Sons, Inc., 568 U.S. 519, 538 (2013).

or other transfer of ownership, or by rental, lease, or lending."[12] First sale operates as a limitation on the latter right.[13]

More than a century ago, the Supreme Court held unenforceable a license printed below the copyright notice in a novel purporting to prohibit the sale of the book for less than a given price.[14] To give effect to such a license, the Court held, would be to "give a right not included in the terms of the [copyright] statute."[15] Congress apparently agreed, specifically enacting a first-sale provision the following year.[16] In relevant part, the current provision of the Copyright Act regarding first sale provides that:

> Notwithstanding the provisions of section 106(3), the owner of a particular copy or phonorecord lawfully made under this title, or any person authorized by such owner, is entitled, without the authority of the copyright owner, to sell or otherwise dispose of the possession of that copy or phonorecord.[17]

In short, copyright provides no bar against alienating a particular copy of a creative work. From this doctrine, scores of secondhand bookstores, music retailers, and the like were born.[18] But the perfect, nonrivalrous replicability of digital files poses obvious problems for application of the doctrine in the digital world.[19]

B. *Failed Technological End-Runs*

Law often lags the development of technology, and no perceived market can remain untapped for long. Firms hoping to exploit such markets devise technologies in an attempt to evade application of existing law. Such evasions may, from time to time, demonstrate the need for law to change, to catch up to shifts in the landscape. Years before the rise of blockchains and NFTs, technologists devised potential solutions to the problem of digital duplication.

12. Copyright Act of 1976, Pub. L. No. 94-533, 90 Stat. 2541, 2546 (codified as amended at 17 U.S.C. § 106(1), (3) (1975)).

13. *See* 17 U.S.C. § 109(a) (establishing first-sale doctrine "[n]otwithstanding the provisions of section 106(3)," i.e., the distribution right); *see also* U.S. COPYRIGHT OFF., DMCA SECTION 104 REPORT 22 (2001), https://www.copyright.gov/reports/studies/dmca/sec-104-report-vol-1.pdf [https://perma.cc/5CJ3-H83B (staff-uploaded archive)] (noting that "Section 109(a) of the Copyright Act of 1976 carried forward the existing federal policy of terminating a copyright owner's distribution right as to a particular lawfully-made copy or phonorecord of a work after the first sale of that copy").

14. *See* Bobbs-Merrill Co. v. Straus, 210 U.S. 339, 351 (1908).

15. *Id.*

16. *See Kirtsaeng*, 568 U.S. at 539–40.

17. 17 U.S.C. § 109(a).

18. And with them arbitrage opportunities. *See, e.g.*, *Kirtsaeng*, 568 U.S. at 527 (describing petitioner's business of procuring low-cost foreign editions of textbooks and reselling them at a profit in the United States).

19. *See* U.S. COPYRIGHT OFF., *supra* note 13, at 83–84 (noting risks to market for creative works posed by a digital first-sale right).

The now-defunct service ReDigi provides a noteworthy example—one that suggests no need for a change in governing law.

While digital art comprises most of the NFT market for copyright goods, ReDigi went after the market for recorded music.[20] Its service promised a clever technological solution to the copying conundrum inherent in digital works. First, ReDigi's software would scan a user's machine to identify song files and verify that the user had lawfully purchased those files.[21] It would then move those files to ReDigi's cloud servers. Users could continue to listen to the songs through ReDigi's software, but, if they wished, they could also sell their copies to other ReDigi users.[22] Because the files now existed in storage under ReDigi's control, the service could disable the seller's access to the file once the transaction was completed.[23]

ReDigi's principal technological "innovation" lay in how it moved song files from user's machines to its servers. It did so by breaking up each file into chunks, transferring the files piece by piece, and deleting each piece from the user's machine as it was transferred to ReDigi's servers.[24] Thus, ReDigi claimed, the files it stored were not mere copies of the user's files—they were the *same* unique object, or at least near enough in practice. As such, they should be treated the same as physical copies for purposes of the first-sale doctrine.[25] The courts disagreed. In the Second Circuit's view, storing the file on a new device (i.e., ReDigi's servers) constituted the creation of a new "phonorecord," in the parlance of the Copyright Act, and therefore infringed the exclusive right of the copyright holder to reproduce the work.[26]

Both common sense and the desire not to incentivize complex technological end-runs around the law support that decision. Intuitively, deleting one copy of a given file contemporaneously with the creation of another does not preclude the original user from retaining another copy of that

20. *See* Capitol Recs., LLC v. ReDigi Inc., 910 F.3d 649, 652 (2d Cir. 2018).

21. *Id.*

22. *Id.* at 654.

23. *Id.*

24. *Id.* at 643.

25. *Id.* at 656.

26. *Id.* at 657. The march of progress implicates more than the difference between transfer and reproduction, as developments in technology have fundamentally changed the way that music is composed. As a result, Robert Brauneis argues that the time has come to collapse the distinction between musical compositions and sound recordings of those compositions currently enshrined in copyright law. *See* Robert Brauneis, *Musical Work Copyright for the Era of Digital Sound Technology: Looking Beyond Composition and Performance*, 17 TUL. J. TECH. & INTELL. PROP. 1, 6 (2014) (arguing "that the better course is to cease trying to divide musical sound recordings into composition and performance elements").

file.[27] ReDigi's method of transferring files, meanwhile, served no function other than to try to escape infringement liability. Nor did its convoluted method of copying files alter the question of reproduction in the slightest. Imagine, by way of comparison, that a person reads aloud a speech from a sheaf of papers, placing each sheet into a shredder after finishing it, while a stenographer faithfully records every word spoken, producing a sheaf of papers identical in every respect to the one read aloud. It strains credulity to contend the resulting transcript constitutes not a reproduction but the same object as the one that went into the shredder.

Unable to prevail on its claim that transferring files from user computers to ReDigi's servers constituted a distribution rather than a reproduction, ReDigi sought refuge in the doctrine of fair use. Like first sale, fair use is a judge-made doctrine turned statutory limitation on the exclusive rights of copyright holders, permitting a variety of uses that might otherwise constitute infringement.[28] The Copyright Act enumerates four nonexclusive factors to guide courts in determining whether any particular use is fair:

> (1) [T]he purpose and character of the use, including whether such use is of a commercial nature or is for nonprofit educational purposes; (2) the nature of the copyrighted work; (3) the amount and substantiality of the portion used in relation to the copyrighted work as a whole; and (4) the effect of the use upon the potential market for or value of the copyrighted work.[29]

The Second Circuit easily dispatched ReDigi's argument on these factors: ReDigi's purpose was commercial in nature and involved copying of the entirety of the works sold.[30] The court noted that "ReDigi made reproductions of Plaintiffs' works for the purpose of resale in competition with the Plaintiffs' market for the sale of their sound recordings."[31] Importantly, the court noted an essential distinction between resale of digital and physical goods: "The digital files resold by ReDigi, although used, do not deteriorate the way printed books and physical records deteriorate."[32] Had ReDigi's service been limited to

27. While ReDigi claimed its software guarded against this possibility, it admitted that a user could indeed retain a copy of a file uploaded for sale. *See Capitol Recs., LLC*, 910 F.3d at 654 ("Plaintiffs point out, and ReDigi does not dispute, that these precautions do not *prevent* the retention of duplicates after resale through ReDigi." (emphasis in original)).

28. *See, e.g.*, Amanda Levendowski, *Resisting Face Surveillance with Copyright Law*, 100 N.C. L. REV. 1015, 1049 (2022) (discussing historical development of fair use doctrine).

29. Copyright Act of 1976, Pub. L. No. 94-533, 90 Stat. 2541, 2546 (codified as amended at 17 U.S.C. § 107 (1976)).

30. *Capitol Recs., LLC*, 910 F.3d at 661–62. The court noted that the second factor "rarely, by itself, furnishes any substantial reasoning for favoring or disfavoring fair use." *Id.* (citing Authors Guild v. Google, Inc., 804 F.3d 202, 220 (2d Cir. 2015)).

31. *Id.* at 662.

32. *Id.*

hosting customers' digital music libraries in the cloud, it may have had some success with its fair use defense.[33] But in conjunction with its resale marketplace, the question of fair use was not close.

Yet the *ReDigi* decision is not without its critics. Perzanowski and Schultz, for example, criticize the decision because "the application of our legal rules to digital copies is inconsistent with the expectations about lending and reselling developed in the hard copy area."[34] They contend that methods like ReDigi's "are far more analogous to moving a copy or restoring/repairing a copy than reproducing one."[35] Their argument presumes that the ReDigi system effectively solved the issue of retained copies. If that were true, the argument might have some force. But it is neither true nor the point of the convoluted method of transmission and deletion implemented by ReDigi. The only purpose of that technological development was to attempt to end-run the copyright holder's exclusive right to reproduce the work—if ReDigi's concern was preventing retention of copies, it would make no difference whether the local file was deleted piecemeal during transmission or in one fell swoop after successful transmission to ReDigi's servers.

In any event, the ReDigi approach evinces the misguided notion that digital objects can be "unique," an idea that is central to the burgeoning market for NFTs. It is, however, inherent in the way that computers function that there can never be such a thing as a unique digital file. During the process of creating a digital artwork, for example, countless versions of the work pass in and out of existence even before any attempt is made to transmit the supposedly unique file to a purchaser.[36] Indeed, as discussed in more detail below, one of the primary components of an NFT is a so-called "hash" of the associated artwork.[37] The purpose of providing the hash is to provide the buyer with assurance that the copy of the work they obtain is identical to the one supposedly being sold.[38] Unless one is aiming to end-run the limitations of the first-sale doctrine, this is perhaps the principal advantage of digital media—unlike physical media, it does not degrade with "use" or transfer, but remains forever identical to its source.

33. *See* Capitol Recs., LLC v. ReDigi Inc., 934 F. Supp. 2d 640, 653 n.7 (S.D.N.Y. 2013) (noting ReDigi's argument "that uploading to and downloading from the Cloud Locker for storage and personal use are protected fair use," and that this "argument is, perhaps, a relic of the argument it previously levied that 'copying' to the Cloud Locker is protected as 'space shifting' under the fair use doctrine").

34. PERZANOWSKI & SCHULTZ, *supra* note 6, at 41.

35. *Id.* at 219 n.14.

36. For instance, versions of the file will exist for a time in the computer's "volatile" memory and more permanently in nonvolatile long-term storage. Versions in long-term storage will be automatically reallocated to different portions of that memory in the course of the computer's ordinary operation. *See* Joel Hruska, *How Do SSDs Work?*, EXTREMETECH (June 12, 2022, 4:28 PM), https://www.extremetech.com/extreme/210492-extremetech-explains-how-do-ssds-work [https://perma.cc/BM29-R56H].

37. *See infra* Section II.B.1.

38. *Id.*

C. *The Social Costs of Alienable Digital Works*

The issue of digital uniqueness can easily be set aside because there is no acceptable way to operationalize a system that could support digital first sale without eviscerating the market for digital works. Such a system would require imposing technical restrictions on digital media that would prove unacceptable to the market, and indeed to many who advocate for extending first sale to digital media.

Proponents of digital first sale tend also to be opponents of digital rights management ("DRM"). Indeed, Perzanowski and Schultz devote a full chapter to criticizing DRM,[39] and for good reason: DRM is hostile to users and, to an extent, futile. But advocacy for digital first sale and against DRM exists in fundamental tension. For multiple reasons, draconian DRM is the *sine qua non* of any possible digital first-sale regime.

The essential problem of digital first sale is that unlike with physical copies of copyright goods one can trivially transfer a perfect copy to anybody without giving up one's own copies. Were such behavior legitimized, the market for digital copyright goods would vanish, as the price of any individual work would immediately plummet to effectively zero.[40] For digital first sale to work, then, transfer of a copy must also include destruction of the transferor's copies.[41]

It seems uncontroversial to suggest that the honor system is not equal to the task. A workable right of digital first sale requires a means of enforcing the transfer of rights to use any particular digital copyright good. In other words, it requires DRM. This is the first unresolvable tension in the common positions taken by advocates for digital first sale—contrary to their preferences, we cannot have one without the other.

The second unresolvable tension is with the contention that DRM does not work. Whatever technical means any given DRM system employs, at some point it must permit the user access to the protected work: the audio or video file must play, the e-book must display, the software must run, and so on. The system cannot be made unbreakable. Inevitably, then, any such system will be broken. And again, because digital files may be reproduced endlessly and perfectly, the system need be broken only once for any given work for versions

39. *See* PERZANOWSKI & SCHULTZ, *supra* note 6, at 121–38 (discussing "DRM and the Secret War inside Your Devices").

40. More specifically, in such a regime, anybody in lawful possession of a digital copy of a copyright good might as well sell as many copies as possible. Since the cost of doing so is negligible, and because there would likely be at least two sellers of any given work, price competition would quickly drive the price down to no more than the transaction cost.

41. Proponents of digital first sale of course recognize this. *See, e.g.*, PERZANOWSKI & SCHULTZ, *supra* note 6, at 180–81 ("[F]or digital goods no less than physical ones, a transfer of rights can't lead to an increase in the number of people simultaneously enjoying the work. So if an owner doesn't give up their rights—if, for example, they 'sell' their digital record collection but listen to a backup copy—their behavior isn't protected by exhaustion.").

of that work unencumbered by DRM to proliferate across the internet.[42] Although media distributors and hackers continue to engage in an arms race of DRM design and decoding, it has only ever been a matter of time before the hackers have defeated the restrictions on the protected media. Thus, to engender confidence that users, empowered by law to alienate their digital libraries, will not retain additional copies of works would require DRM to be far more draconian than most would tolerate, let alone desire. Put otherwise, DRM is about risk management. In the absence of a legitimate market to resell digital copyright goods, individuals have less incentive to engage in unauthorized distribution of copies. Sellers design DRM to pose enough of an obstacle to deter rampant file sharing but not so high an obstacle as to impede ordinary use. Creation of a legitimate resale market increases the first seller's risk substantially, requiring resort to much more elaborate and frustrating DRM.

Examples of existing systems that *do* permit resale of digital goods highlight the undesirability of extending the model to all digital media, if it could even be done. While ReDigi failed to create a market for resale of digital music files, many of the tools used to *create* digital music are resalable and have been for decades. So-called digital audio workstation ("DAW") software, plugins that enhance the capability of DAWs, and software-based virtual instruments are to today's musician what a reel-to-reel tape machine, mixing desk, outboard gear, and roomful of instruments were to musicians of an earlier era. Such software can be extremely expensive.[43] Some developers take the sting out of high prices by permitting users to resell their licenses.

There is, of course, a catch. To enable resale but preclude resellers from keeping their own copy, software of this type relies on checking license status before it is run. When first running one of Arturia's many virtual synthesizers, for instance, the user is prompted to log into their Arturia account to activate their license or run the software in a feature- and time-restricted demo mode.[44] Alternatively, the user can use Arturia's Software Center program to handle

42. As a practical matter, the method developed to break the DRM on any given work may apply to some or all other works using the same DRM system. *See, e.g.*, *id.* at 125.

43. For example, a subscription license for the industry-leading DAW Pro Tools retails for $99 per month or $999 per year. *See Pro Tools Flex Subscriptions Pricing*, AVID, https://www.avid.com/pro-tools/audio-recording-software [https://perma.cc/M982-RMF4 (staff-uploaded archive)]. Other popular DAWs are not quite as expensive, but remain hefty investments, such as Ableton's Live Suite ($749), *Live*, ABLETON, https://www.ableton.com/en/shop/live/ [https://perma.cc/P9L5-D5QK], and Apple's Logic Pro ($199.99), *Logic Pro*, MAC APP STORE, https://apps.apple.com/us/app/logic-pro-x/id634148309?mt=12 [https://perma.cc/8D99-NZRS]. Plugins and virtual instruments likewise can prove costly, such as Spitfire Audio's $999 BBC Symphony Orchestra sample library. *See BBC Symphony Orchestra Professional*, SPITFIRE AUDIO, https://www.spitfireaudio.com/shop/a-z/bbc-symphony-orchestra-professional/ [https://perma.cc/AP6J-KV4Q].

44. In demo mode, the software does not permit saving or loading instrument presets and may be run for only twenty minutes.

installation and license activation. Other software, like Neural DSP's virtual guitar amplifiers, relies on the third-party iLok License Manager.[45] In either case, the software will not run until a license is activated on that particular machine.

Should the user eventually desire to resell their software, deactivation of the license is a required precondition. After the active license has been removed, the software will once again refuse to run when launched. The vagaries of transferring the license to a subsequent user vary across programs, but the logic remains the same: since the developer is satisfied that the license is no longer active on any machine, the license may be transferred to a new owner, who may activate it for use on their own machine.[46]

An additional wrinkle in these systems is that, like all software, sometimes license managers malfunction. One need not put any stock in the online complaints about, and criticisms of, licensing software like iLok—of which there is plenty—to recognize that possibility. Where the recording engineer of yesteryear might be forced to contend with a damaged tape head or electrical fault, today's recording engineer confronts arcane error messages generated by licensing managers that prevent the use of software for which the engineer has paid handsomely.

Many, though not all, players in the market for high-end recording software seem to have settled on this mix of benefits and burdens. But history and logic suggest that the public would not countenance the use of such systems to control distribution and use of all digital media. Perzanowski and Schultz, for example, describe DRM and its legal empowerment in the Digital Millennium Copyright Act ("DMCA") as, "from the perspective of the public, . . . an unmitigated disaster."[47] Criticism of DRM, on grounds ranging from its interference with consumer rights and expectations to ways in which it impedes global economic development and poses intolerable security risks, has been widespread for decades.[48] Those criticisms, vital and correct from the beginning, hold no less force today.

45. *See What Is iLok?*, NEURAL DSP, https://support.neuraldsp.com/help/what-is-ilok [https://perma.cc/4URS-4DGB].

46. *See, e.g.*, *How To Resell My Product/License?*, ARTURIA, https://support.arturia.com/hc/en-us/articles/4405741338642-How-to-resell-my-product-license- [https://perma.cc/WRS6-3AKQ (staff-uploaded archive)] (describing how to unregister Arturia software and transfer serial number and unlock code to new owner); *Can I Sell My Licenses?*, NEURAL DSP, https://support.neuraldsp.com/help/can-i-sell-my-licenses [https://perma.cc/3P4X-MNGX] (describing use of iLok License Manager to transfer licenses for Neural DSP software).

47. PERZANOWSKI & SCHULTZ, *supra* note 6, at 132.

48. *See, e.g.*, *Digital Rights Management: A Failure in the Developed World, a Danger to the Developing World*, ELEC. FRONTIER FOUND. (Mar. 23, 2005), https://www.eff.org/wp/digital-rights-management-failure-developed-world-danger-developing-world [https://perma.cc/4UE8-R6EY] (criticizing DRM on various grounds); Cory Doctorow, *What Happens with Digital Rights Management*

Beyond that, it is hard to imagine consumers accepting DRM systems like those used by resalable recording software in exchange for the ability to sell all or part of their media collection. Activating and deactivating licenses for a relative handful of software programs acquired and used over the course of months, if not years, is a far cry from doing the same with licenses to each song in one's personal media library. ReDigi's relatively small userbase supports that intuition: months after Capitol Records brought suit, it could boast only of "more than 100,000 users."[49] By way of comparison, users of both Apple's and Spotify's music services number in the hundreds of millions.[50]

But hope springs eternal. NFTs and blockchain technology have risen to prominence in discussions of how to enable digital first sale. The reality falls well short of the ambition. Zachary Catanzaro, for example, sees NFTs as the solution to ReDigi's problems, arguing that they enable the transfer of ownership in a particular phonorecord without requiring "a concomitant act of reproduction."[51] In his view, the rightsholder could create an NFT associated with a unique phonorecord stored on a server; whoever possesses the NFT would be authorized to stream that phonorecord, and would merely need to transfer the NFT to enable a purchaser to access the phonorecord.[52] Yet there is no apparent reason why the rightsholder would operate such a system or resort to a blockchain to implement it. Presumably, if Universal Music Group (the world's largest record label)[53] wanted to create a system allowing resale of its digital music, it would want to maintain complete control over every aspect of that system rather than depend on a decentralized blockchain. Such an assumption is warranted, among other reasons, by the fact that Universal subsidiary Capitol Records was the plaintiff in the lawsuit that put an end to

in the Real World?, GUARDIAN (Feb. 5, 2014, 9:52 AM), https://www.theguardian.com/technology/blog/2014/feb/05/digital-rights-management [https://perma.cc/H3WR-QTEY] (noting that Doctorow has "been writing about 'digital rights management' (DRM) for years in this column" and criticizing, among other things, the security risks posed by DRM systems).

49. Jennifer Alsever, *ReDigi: Sell Your Unwanted MP3s*, INC. (May 29, 2012), https://www.inc.com/magazine/201206/jennifer-alsever/redigi-john-ossenmacher.html [https://perma.cc/HXN6-7PCD].

50. *See* Ashley King, *Apple Hits an Impressive 745 Million Paying Subscribers—But How Many Belong to Apple Music?*, DIGIT. MUSIC NEWS (Oct. 31, 2021), https://www.digitalmusicnews.com/2021/10/31/apple-q4-2021-financials-apple-music-paying-subs/ [https://perma.cc/W6FN-B726 (staff-uploaded archive)] (reporting 745 million paying subscribers to Apple's services, including Apple Music, and 381 million Spotify users, including 172 million paying subscribers).

51. Zachary L. Catanzaro, *Fixing ReDigi: NFT Tethered Sound Recordings*, HARV. J. SPORTS & ENT. L. (forthcoming 2023) (manuscript at 28) (on file with the North Carolina Law Review).

52. *Id.*

53. *See* Dylan Smith, *What Are the Biggest Record Labels? Here's a Quick Rundown*, DIGIT. MUSIC NEWS (June 18, 2021), https://www.digitalmusicnews.com/2021/06/18/biggest-record-labels-of-2021/ [https://perma.cc/6CHV-DCDV (staff-uploaded archive)] (reporting that Universal Music Group commands thirty-two percent market share in the music industry).

ReDigi.[54] It is unlikely that Sony Music Entertainment or Warner Music Group would follow Catanzaro's recommendation either.[55]

Sebastian Pech contends that "[b]lockchain technology and smart contracts can strike a balance between the interests of right holders and users."[56] In his view, blockchains could solve the problem of sellers retaining copies of digital works:

> If individual copies of a work are registered on a blockchain, every time someone accesses the file, it can be checked whether this particular copy has already been used by another person. This can ensure that a file is only used by one person at a time and can therefore preclude the dissemination of unauthorized copies.[57]

Foremost among the problems with such a system is that nobody would put up with it. It was not so long ago that a combination of consumer dissatisfaction and government attention led Apple to drop the DRM it used that limited music purchased on iTunes to playback only on iPods.[58] Left unexplained is why consumers would now be content to wait for playback to begin every time they wanted to listen to a song until software could verify the license status with a record on a blockchain.

Perzanowski and Schultz likewise pin their hopes on the blockchain, advancing a similar argument to Pech:

> As a comprehensive and up-to-date record of transactions, [the blockchain] allows anyone to verify transfers of ownership and catch fraud before it happens. So when you go to buy your ebook, you—or more likely, some software on your device—would check whether the seller actually owns it. If they already sold it to someone else or never owned it in the first place, that would be reflected in the ledger, and the transaction would be canceled. . . . Relying on the block chain technology pioneered by bitcoin, we can envision a marketplace for digital assets. In that marketplace, consumers could buy, sell, lend, and trade the ebooks, music, movies, applications, and games they buy—and even virtual objects they discover or craft, like the Jade Rabbit, a powerful weapon in the video game *Destiny*. Those transactions would be secure and

54. *See Our Labels & Brands*, UNIVERSAL MUSIC GRP., https://www.universalmusic.com/labels/ [https://perma.cc/8Z3E-4W92].

55. These "Big Three" labels control nearly seventy percent of the music market. *See* Smith, *supra* note 53.

56. Pech, *supra* note 5, at 41.

57. *Id.*

58. *See, e.g.*, Laura Sydell, *EMI Music Goes DRM-Free in a Deal with Apple*, NPR (Apr. 2, 2007, 4:00 PM), https://www.npr.org/2007/04/02/9293489/emi-music-goes-drm-free-in-a-deal-with-apple [https://perma.cc/3PYZ-44P4].

> verifiable, guarding against cheating that could harm both consumers and IP rights holders.[59]

Both contentions suffer the same flaw: they treat verifiable chain of title as the only challenge digital first sale must overcome. But chain of title is not, and never has been, the problem. This proposal has no bearing on the essential problem of retained copies. As will become clear in Part II, the blockchain lacks any ability whatsoever to guard against retention of copies.[60] At most, like any database of title holders it might hinder the ability of one person to sell more than one copy, and thereby slightly slow the cratering of the market for that particular work. But an original buyer who purchases a song for one dollar faces no technological obstacle to reselling it for ninety cents while retaining their own copy. Whoever purchased from that seller likewise faces no technological obstacle to reselling for eighty cents, and so on down the line. The blockchain does nothing to alter this analysis, and thus nothing to alter the conclusion that digital first sale cannot be made workable without unacceptable DRM.

D. *Digital First Sale's Regressiveness*

The case for digital first sale relies on a regressive approach to property and ownership (a trait shared with the case for NFTs). The drive to create "unique" digital objects that one owns, rather than licenses, is, at best, a futile quest. For digital first sale, that quest's appeal was easier to understand in the infancy of digital media—the late 1990s and early 2000s, an era dominated by Napster and iPods. In the modern market, the drive for digital first sale makes little sense.

The dollars-and-cents argument for digital first sale is, for its proponents, one of serious policy importance: "By opening up secondary markets, the exhaustion principle promotes access to cultural works. More people can read books, watch films, and play games when used copies, rentals, and lending drive down the cost of access."[61] But this argument from access does not hold up to developments in the market for digital media.

Take the market for music. The price of an album rose steadily from the mid-1980s until piracy and the rise of digital distribution torpedoed the market for album sales.[62] In 1999, the year of Napster's founding, the average price of

59. PERZANOWSKI & SCHULTZ, *supra* note 6, at 190–91.

60. Nor does the blockchain provide some missing technological ingredient to solve the problem of chain of title. That problem is solved by nothing more complicated than a database, and electronic databases long predate the rise of digital media. Indeed, the supposedly novel uses of NFTs can be—and usually have been—carried out without any resort to a blockchain. *See infra* Section III.B.

61. PERZANOWSKI & SCHULTZ, *supra* note 6, at 27.

62. *See, e.g.*, Marc Hogan, *How Much Is Music Really Worth?*, PITCHFORK (Apr. 16, 2015), https://pitchfork.com/features/article/9628-how-much-is-music-really-worth/

an album was approximately $23.02 (in 2022 dollars).[63] For that same $23.02 in 2022, a user could purchase a minimum of two months of Spotify,[64] Apple Music,[65] YouTube Music,[66] or another streaming service.[67] For the cost of six albums in 1999—perhaps seventy-five songs—today's music fan can purchase a year of access to more than 80 *million* songs.[68] While there is ample room for critique of the streaming industry and its impact on musicians, the value proposition for consumers, as compared to the latter days of the CD era, is unbelievable.[69] A consumer could neither command a sufficient resale price nor obtain a sufficient secondhand discount to alter that calculation in the slightest.

A familiar objection to streaming from the consumer standpoint is that, once a consumer stops paying for a streaming service, they retain no access to the music they listened to on that service.[70] As Perzanowski and Schultz note, "Not everyone wants to rent their music."[71] But today's music purchaser also obtains far greater value than before the era of digital distribution. In 2020, the average price paid for an album on Bandcamp was a mere nine dollars ($10.26 in 2022 dollars).[72] For that price, users obtain the ability both to stream their purchases via the Bandcamp app and to download DRM-free digital files of

[https://perma.cc/BHG2-E3WB] (discussing changes in the average cost of music across various formats).

63. I derive this price by taking the $18.39 average price (in 2015 dollars) reported by Hogan, *id.*, and adjusting that amount to 2022 dollars using the U.S. Bureau of Labor Statistics CPI Inflation Calculator, *CPI Inflation Calculator*, U.S. BUREAU LAB. STATS., https://www.bls.gov/data/inflation_calculator.htm [https://perma.cc/LCR2-HXD6] [hereinafter *CPI Calculator*]. In particular, I use April 2015 (the month in which Hogan's article was published) and August 2022 (at the time of this writing, the most recent available) as the points of comparison.

64. *See Spotify Premium*, SPOTIFY, https://www.spotify.com/us/premium/ [https://perma.cc/XD8E-JWTS].

65. *See* APPLE MUSIC, https://www.apple.com/apple-music/ [https://perma.cc/XD8E-JWTS].

66. *See* YOUTUBE MUSIC, https://music.youtube.com/music_premium [https://perma.cc/FGL8-AQ73].

67. *See, e.g.*, TIDAL, https://tidal.com/pricing [https://perma.cc/7B5Z-LWTL].

68. *See, e.g.*, *About Spotify*, SPOTIFY, https://newsroom.spotify.com/company-info/ [https://perma.cc/32CC-TK7U] (advertising access to "over 80 million tracks"); APPLE MUSIC, *supra* note 65 (advertising access to "over 100 million tracks").

69. For essentially the same reason, the argument that, absent digital first sale, digital goods cannot legally be loaned to a friend or family member retains little force. Indeed, most streaming services make family plans available at a significantly reduced cost per user. *See, e.g.*, *Spotify Premium*, *supra* note 64 [https://perma.cc/XD8E-JWTS] (advertising a $15.99-per-month family plan offering access to six "family members living under one roof"); APPLE MUSIC, *supra* note 65 (offering similar plan for $14.99 per month).

70. This discussion, like this objection, elides "free" ad-supported versions of streaming services, which present complicated issues apart from digital first sale.

71. PERZANOWSKI & SCHULTZ, *supra* note 6, at 54.

72. *See* Jon Caramanica, *How Much Is an Album Worth in 2020: $3.49? $77? $1,000? Maybe $0*, N.Y. TIMES (Aug. 19, 2020), https://www.nytimes.com/2020/08/19/arts/music/albums-price.html [https://perma.cc/U7L2-STFN (staff-uploaded, dark archive)] (reporting on variations in selling price of albums). The adjustment to 2021 dollars follows the same method as above, adjusting the figure from August 2020 to August 2022. *See CPI Inflation Calculator*, *supra* note 63.

those purchases.[73] In terms of convenience and sound quality, that purchase is strictly superior to CDs, much less vinyl records or cassettes.[74] Paying less than half the price seems a more than fair exchange for a version the user cannot resell.[75]

E. *Exhaustion and Control*

Digital first sale, at least as explicated by Perzanowski and Schultz, is not a free-standing policy goal. Rather, it is a key component of their argument on the larger principle of "digital exhaustion"—"the notion that an IP rights holder relinquishes some control over a product once it sells or gives that product to a new owner."[76] First-sale doctrine neatly implements the exhaustion principle for physical media, and to great effect. Perzanowski and Schultz rightly celebrate the role first sale has played in American copyright law for over a century, and identify a host of issues beyond mere resale that they trace to the absence of a digital exhaustion principle:

> The most immediate consequence of nonownership is the long list of substantive rights we lose. The prohibitions found in most [End User License Agreements] and enforced by most DRM contrast starkly with the default rules of private property. You can't resell a product you don't own. You can't lend it, give it away, or donate it. You can't read, watch, or listen on unapproved devices. You can't modify or repair the devices you use.[77]

Elsewhere, scholars note other harms flowing from the weakening of the exhaustion principle, including the potential to contract away fair-use rights,[78]

73. *See, e.g.*, *Bandcamp for Fans*, BANDCAMP, https://bandcamp.com/fans [https://perma.cc/Y2BS-ZAEX].

74. Bandcamp permits users to choose from among various file formats when downloading, not all of which compare favorably to CDs in terms of sound quality. But formats providing equivalent quality are among those made available to the purchaser, and the price paid is not affected by the choice of format.

75. Perzanowski and Schultz resist this suggestion, arguing, in the context of the market for books, that "[w]hen you can pay $8.99 for an ebook instead of $22.99 for a hardcover, it seems like an easy call. But those low prices are misleading. If you can't resell your books, you can't recoup any of your costs." *See* PERZANOWSKI AND SCHULTZ, *supra* note 6, at 134. But the e-book is substantially cheaper at least in part *because* it cannot be resold. In pricing physical copies of copyright goods, sellers understand that some number of eventual consumers will procure the work secondhand, and price the new version accordingly. In any event, I would be interested to learn the location of the bookstore that bought used books for sixty percent of the list price, a far higher price than I have ever been able to obtain.

76. *Id.* at 25.

77. *Id.* at 6, 24.

78. *See, e.g.*, Molly Shaffer Van Houweling, *The New Servitudes*, 96 GEO. L.J. 885, 947 (2008) (noting that an individual's choice to accept a restriction on their ability to make fair use of a copyrighted work "may be enough to satisfy her but not enough to compensate society for the forgone benefits it might have received had she instead found a way to exercise her fair use rights").

imperil individual privacy,[79] hinder scientific progress,[80] impede development of new creative works,[81] and threaten important societal norms.[82]

Whether the restrictions imposed by the lack of a digital exhaustion principle represent sound policy tradeoffs is a difficult, and disputed, question,[83] although I agree that the law should authorize most of the activities identified.[84] But even if one concedes the policy issues, treating digital media as personal property does not strike a suitable balance.

Put simply, ownership is overkill to achieve every one of the policy goals Perzanowski and Schultz identify save only the ability to resell digital media—the policy goal that this subpart demonstrates cannot be achieved and is not worth pursuing. On every other front, the issue is not ownership but control. Individuals want, and should have, control over when, where, and how they view or listen to their digital media. They want, and should have, control over the maintenance of the devices on which they do so. Perzanowski and Schultz are correct to argue that "[t]he basic principle of exhaustion—the notion that owners have rights that are not contingent on copyright holder permission—can and should survive the transition to a digital copyright economy."[85] Implementing those rights through a digital first-sale right unnecessarily imperils the marketability of digital media, and necessarily saddles that media with the very obstacles to access and choice that they resist.

Law and technology can give individuals the right to own, and therefore sell, their digital media.[86] Law and technology can also give individuals control over their digital media. But we cannot have both. NFTs do nothing to alter that conclusion.

79. *See, e.g.*, Julie E. Cohen, *DRM and Privacy*, 18 BERKELEY TECH. L.J. 575, 580 (2003) (noting that DRM technologies threaten privacy both "by directly constraining private behaviors related to intellectual consumption and by enabling creation of detailed and permanent records of such consumption").

80. *See, e.g.*, Pamela Samuelson, *Anticircumvention Rules: Threat to Science*, 293 SCI. 2028, 2028 (2001) (analyzing threatened claims against academic researchers and the threat posed to scientists generally by legal protection for information "protected by encryption and other technical measures").

81. *See, e.g.*, Julie E. Cohen, Lochner *in Cyberspace: The New Economic Orthodoxy of "Rights Management,"* 97 MICH. L. REV. 462, 557 (1998) ("If libraries may not make digital works available to the public free of direct charge, there are some potential creators who will never see them.").

82. *See, e.g.*, *id.* at 558 (noting that "a regimented system of usage rights may undermine societal norms that have developed over time to mediate the boundary between private and public rights in creative and informational works").

83. *See, e.g.*, John F. Duffy & Richard Hynes, *Statutory Domain and the Commercial Law of Intellectual Property*, 102 VA. L. REV. 1, 8 (2016) (noting that the first-sale doctrine "disappoints both champions and skeptics of broad IP rights").

84. *See infra* Section III.D.

85. PERZANOWSKI & SCHULTZ, *supra* note 6, at 33.

86. Although, as discussed above, I doubt such a solution would find success in the market given the DRM that would need to be involved.

II. EXPOSING NFTS

The quest for digital first sale is, avowedly, a quest to treat digital goods just as we treat their analog counterparts. Where earlier technologies and advocacy efforts have failed, many believe NFTs will succeed. But what are they? At this point, the internet teems with NFT explainers, and for good reason: intuition will not carry one far on this subject, and the technical workings that make NFTs possible are complex. Unfortunately, the relatively opaque nature of NFTs provides fertile ground for misunderstanding, overclaiming, and total falsehood. This part begins by discussing popular and optimistic explanations of the NFT phenomenon, the uses of NFTs, and the desirability thereof. It then proceeds to provide a more thorough explanation of the relevant technical details and analysis of their implications for the supposed utility of NFTs.

A. *The Proponents' Case*

1. The Many Wonderful Uses of NFTs

The essential claim behind most NFT promotion is that NFTs provide, for the first time, a way to create and own unique digital objects; in essence, to create digital property that is as rivalrous as tangible property. As Joshua Fairfield puts it, "It took over two decades to develop a technology that brought uniqueness back to the internet, by which digital assets were no longer fully duplicatable with the click of a button."[87] Indeed, in his view, NFTs are so promising that if they "had existed at the time of the internet's founding, legal interests in personal property would have translated as seamlessly as did contractual or intellectual property interests."[88] Zachary Catanzaro argues that NFTs can succeed where ReDigi failed.[89] If, as Houser and Holden contend, "[t]he promise of NFTs extends to virtually every industry,"[90] it should come as no surprise that NFTs have been touted as a potential enabling technology for a digital first-sale right.

These claims are vital to the market for NFTs of digital art, which, to date, have been the most prominent variety of NFTs. For instance, a story discussing the early NFT series "CryptoPunks" ran with the subheadline, "[y]es, you can

87. Fairfield, *supra* note 2, at 1313; *see also id.* at 1266 ("Nonfungible tokens can be used to create digital artwork that can be bought, sold, and owned like a physical sculpture, or a database of real estate in which ownership is managed by electronic deeds that can be passed from one person to another with low or no transaction costs.").

88. *Id.* at 1312.

89. *See generally* Catanzaro, *supra* note 51 (proposing tethering sound recordings to NFTs).

90. Houser & Holden, *supra* note 3, at 35.

actually own these digital creations."[91] It proclaimed, with reference to an image of a particular CryptoPunk, that somebody owns "the picture itself. You can, of course, download a version, but that's just a copy. Someone owns the original. It is art, and it has an owner."[92] More recently, Christie's echoed this notion in promoting its auction of Beeple's "EVERYDAYS: The First 5000 Days," sold as an NFT by Christie's for more than sixty-nine million dollars, claiming that "[t]he recent introduction of [NFTs] and blockchain technology has enabled collectors and artists alike to verify the rightful owner and authenticity of digital artworks."[93] Likewise, the leading NFT marketplace OpenSea notes that "it's clear we already have tons of digital stuff," but asks the question that has plagued computer users and copyright scholars for decades: "[T]o what extent do we 'own' these digital things?"[94] With NFTs, the story goes, true ownership of things like digital art is, at last, possible.[95] This accrues to the benefit of artists, according to the MakersPlace NFT marketplace, because such marketplaces "[e]stablish an unalterable record of your digital creations and reach the fans and collectors that want to support your practice."[96]

Digital art is not the only use case for NFTs, and true ownership is not the only boon supposedly brought to the table. For example, the Ethereum project—the blockchain that hosts the vast majority of NFTs—claims several functions and benefits of NFTs:

> NFTs and Ethereum solve some of the problems that exist in the internet today. As everything becomes more digital, there's a need to replicate the properties of physical items like scarcity, uniqueness, and proof of ownership. Not to mention that digital items often only work in the context of their product. For example you can't re-sell an iTunes mp3

91. Jason Abbruzzese, *This Ethereum-Based Project Could Change How We Think About Digital Art*, MASHABLE (June 16, 2017), https://mashable.com/article/cryptopunks-ethereum-art-collectibles [https://perma.cc/U4Y3-RUAK].

92. *Id.*

93. *See, e.g.*, *Beeple's Opus*, CHRISTIE'S, https://www.christies.com/features/Monumental-collage-by-Beeple-is-first-purely-digital-artwork-NFT-to-come-to-auction-11510-7.aspx [https://perma.cc/6D5F-WPDM].

94. Devin Finzer, *The Non-Fungible Token Bible: Everything You Need To Know About NFTs*, OPENSEA (Jan. 10, 2020), https://opensea.io/blog/guides/non-fungible-tokens/ [https://perma.cc/3ZBE-P34C].

95. Depending on one's view, some of the excitement over NFTs reads more as a threat. For example, one crypto artist proclaimed to Bloomberg that "[w]hat Bitcoin did for money, [NFTs are] going to do for art." Jason Schreier, *Gaming Crypto-Artists Court Controversy While Cashing in on NFTs*, BLOOMBERG (Mar. 9, 2021, 6:02 PM), https://www.bloomberg.com/news/articles/2021-03-09/gaming-crypto-artists-court-controversy-while-cashing-in-on-nfts [https://perma.cc/NS59-ECM8].

96. *How It Works*, MAKERSPLACE, https://makersplace.com/creators/ [https://perma.cc/J9DJ-5TAM].

> you've purchased, or you can't exchange one company's loyalty points for another platform's credit even if there's a market for it.[97]

The proposed uses of NFTs are myriad. Ethereum lists examples such as unique items used in a video game, event tickets, and deeds for physical items.[98] The project also touts the decentralizing capabilities of NFTs. Because the underlying blockchain technology is decentralized, the reasoning goes, so too is the NFT market running on the blockchain: there is no "need for intermediaries because the network agrees that your NFT exists and belongs to you. And it's on chain so anyone can check it."[99] The project suggests that one could even use one's NFTs as collateral for loans in the world of decentralized finance ("DeFi"). Houser and Holden suggest that NFTs "offer incredible opportunities which could serve to make government more efficient, food and drug products safer, and provide a method to create immutable records while protecting the data contained therein."[100]

Decentralization is among the primary goals of most cryptocurrencies and technologies, like NFTs, built on blockchains. For example, the avowed goal of Bitcoin "was to eliminate the need for a middle man or centralized authority in completing and settling financial transactions."[101] So, too, with NFTs—gone will be the days of gallery gatekeeping, substantial auction-house cuts, and other intermediary costs.[102]

2. Proponents' Characterizations of the Technology

The proponent's case for NFTs builds on description of what NFTs are, in turn building on descriptions of how they are created. Thus, for instance, MakersPlace notes the frequently asked question "[w]hat am I selling?" and responds that "[y]ou're selling a signed and limited edition copy of your digital creation to be owned."[103] OpenSea likewise states that NFTs "are unique, digital items with blockchain-managed ownership."[104]

97. *Non-Fungible Tokens (NFT)*, ETHEREUM (Oct. 4, 2021), https://ethereum.org/en/nft/ [https://perma.cc/NBW9-AK5Y] [hereinafter *Non-Fungible Tokens*].

98. *Id.* Indeed, in a statement that wildly overclaims while still constituting a more accurate description of NFTs than is provided elsewhere in its guide, the Ethereum project proclaims that "NFTs *are* essentially deeds." *Id.* (emphasis added).

99. *Id.*

100. Houser & Holden, *supra* note 3, at 36.

101. Evans, *supra* note 5, at 233.

102. *See, e.g.*, Thompson, *supra* note 1.

103. *See Frequently Asked Questions*, MAKERSPLACE, https://makersplace.com/faq/ [https://perma.cc/V7QY-9G33].

104. Hamish Barnes, *The Beginner's Guide to Creating & Selling Digital Art NFTs*, OPENSEA BLOG (Feb. 25, 2021), https://opensea.io/blog/guides/the-beginners-guide-to-creating-selling-digital-art-nfts/ [https://perma.cc/H4XP-FKUV].

These descriptions offer little information about the complex technological workings at play in the creation and dissemination of NFTs. The process is popularly known as "minting." The Ethereum project provides a lengthy, if unclear, discussion. It notes that NFTs are "minted from digital objects as a representation of digital or non-digital assets."[105] The minting is done "through smart contracts that assign ownership and manage the transferability of the NFTs"; "from a high level, [minting] has the following steps that it goes through": (1) "Creating a new block," (2) "[v]alidating information," (3) "[r]ecording information into the blockchain."[106] Exhaustive detail is available elsewhere in the Ethereum documentation, but for its basic explanation, the project is content to more or less leave it at that. NFT marketplaces provide even less explanation of the technical underpinnings of NFTs, preferring to offer sellers easy-to-understand forms to fill out while handling the code behind the scenes.

Fairfield provides further explanation. He begins by noting that the Ethereum blockchain is, in effect, "a large, decentralized computer."[107] This enables development of software that runs on the Ethereum blockchain, including so-called "smart contracts." Such programs can create tokens that include information such as:

> [A] hash of the token's transaction history, a series of basic standard functions and features, like the transfer function, and functions for determining the number and type of tokens in an owner's wallet, or (in the case of NFTs) a URL to find a file related to the token—the artwork the token represents, for example, and a hash of the artwork as proof.[108]

Thus, Fairfield states, "[A]n NFT might convey an ownership interest in a piece of digital art, an asset in an online game, a card in a collectible trading card game (think rare baseball cards here), or a plot of land in a virtual world."[109] In his view, the only technical shortcoming of NFTs at this point "is that the technological implementation of NFTs leaves room for those who sell NFTs to exert lingering control over a fully bought and paid for asset," such as by including in the governing smart contract "kickbacks paid to the original content creator for downstream sales."[110]

105. *Non-Fungible Tokens*, *supra* note 97.
106. *Id.*
107. Fairfield, *supra* note 2, at 1271.
108. *Id.* at 1272.
109. *Id.*
110. *Id.* at 1278–80.

B. *The Technology and Disutility of NFTs*

Countless guides to NFTs, whether popular or scholarly, claim to explain the relevant technology and thus the salient characteristics of NFTs. As they tend to be authored by promoters and true believers, they tend *not* to provide an accurate or useful explanation. It is therefore necessary to discuss in some detail the technological underpinnings of NFTs. Such an explanation necessarily negates essentially every touted benefit of NFTs.

1. Cryptographic Underpinnings

NFTs and other blockchain technologies leverage cryptography in almost all aspects of their design. Thus, to understand how blockchains (and NFTs) work requires understanding a few key concepts in cryptography. Foremost among these is the "hash function"—a mathematical function that takes any input, of any length, and transforms it into an output of a fixed length.[111] While blockchains may implement different functions,[112] they all rely heavily on hashes.

A cryptographically secure hash function must possess a few additional features that make its output hard to reverse engineer or otherwise crack. First, it must be resistant to hash collisions; that is, it should limit, to the maximum extent possible, the chance that two different inputs will produce the same output.[113] Among the uses of cryptographic hashes is determining that two copies of a file are identical. If it were feasible to find different inputs that yield the same hash, that use would be precluded.

Second, it must be difficult to the point of infeasibility to determine the input to the function given its output.[114] In other words, the function only works one way: it transforms a given input into a particular output, but cannot take the output and reproduce the input. This feature is vital to the use of hashes to verify identity, as discussed in more detail below.

Third, and least intuitively, the function must be "puzzle friendly." Many blockchains implement "proof-of-work" consensus algorithms. Such algorithms

111. ARVIND NARAYANAN, JOSEPH BONNEAU, EDWARD FELTEN, ANDREW MILLER & STEVEN GOLDFEDER, BITCOIN AND CRYPTOCURRENCY TECHNOLOGIES: A COMPREHENSIVE INTRODUCTION 2 (2016).

112. The Bitcoin blockchain, for example, uses the SHA-256 algorithm. *See* Adam Hayes, *Target Hash*, INVESTOPEDIA (June 29, 2021), https://www.investopedia.com/terms/t/target-hash.asp [https://perma.cc/9DL7-34U4]. The Ethereum blockchain uses the Keccak-256 algorithm, standardized as part of SHA-3. *See Glossary*, ETHEREUM, https://ethereum.org/en/glossary [https://perma.cc/K37K-MY6V].

113. *See* NARAYANAN ET AL., *supra* note 111, at 2. Narayanan et al. note that "no hash functions have *proven* to be collision resistant. The cryptographic hash functions that we rely on in practice are just functions for which people have tried really, really hard to find collisions and haven't yet succeeded." *Id.* at 3.

114. *Id.* at 5.

are discussed in detail below, but, at a high level, consist of puzzles of the following type: given a particular, relatively small range of possible outcomes of the hash function, find an input to the function that produces an output within that range.[115] A hash function is "puzzle friendly" if "there's no solving strategy for this puzzle that is much better than just trying random values."[116] If such a strategy could be discovered, the discoverer would be able to outcompete other blockchain participants in racing to solve the puzzle and thus obtain significant power over verifying transactions, among other things.

A hash function satisfying these three properties has many uses. For example, it provides an excellent means of comparing two different inputs to determine if they are identical. Suppose that an individual, Erin, comes into possession of an executable file purporting to be the installer for the official Ethereum implementation. Erin is eager to begin validating transactions but is concerned that this file might be a virus-laden impostor. If, as is the case here, the developers provide the output of a hash function run on the official version of the file,[117] Erin can run the same hash function using their copy of the file as input and verify that they obtain the same hash. As long as the hash algorithm is collision-resistant, a match confirms that Erin's file is identical to the official version. The hash, then, can be thought of as a fingerprint—a unique identifier inextricably tied to its source.

The other key cryptographic concept vital to operating (and understanding) blockchains is the digital signature. As described by Narayanan et al., a digital signature must possess two critical properties: that "only you can make your signature, but anyone who sees it can verify that it's valid," and that "the signature . . . be tied to a particular document, so that the signature cannot be used to indicate your agreement or endorsement of a different document."[118] Such a system is vital to the security of blockchain systems, among others.

Digital signatures require several building blocks in the form of algorithms.[119] They rely on pairs of "keys"—one public, one private—generated by an algorithm. A signing algorithm uses the private key to sign a particular message, yielding a signature that is sent along with the message. True to its name, the private key must, for security purposes, be kept private by the individual using it to sign messages. The individual distributes their public key far and wide, however. A third algorithm, the verification algorithm, takes the

115. *See* Hayes, *supra* note 112.

116. *Id.* at 9.

117. *See, e.g.*, *Download Geth - Nemata (v1.10.25)*, GO – ETHEREUM, https://geth.ethereum.org/downloads/ [https://perma.cc/R2GF-TC6A] (listing, among other things, the MD5 hash of various versions of the Go-language Ethereum implementation).

118. NARAYANAN ET AL., *supra* note 111, at 15–18.

119. This overview of digital signatures draws on the explanation provided by Narayanan et al. *See id.* at 15–18.

message, the signature, and the public key of the purported sender to verify that the message was, in fact, signed by the purported sender. This sequence, a subset of the functions of public-key cryptography, works in ways that are reminiscent of hashes, and indeed usually involve hashes.[120] Like hash functions, the signing algorithm only works one way: the private key can be used to sign a given message and produce a verifiable signature, but none of the message, the signature, or the public key can be used to reproduce the private key.[121] Digital signatures, when properly implemented, therefore provide a robust means for authenticating the sender of a message, whether it be a routine email or an instruction to transfer cryptocurrency. Blockchains also use public/private key pairs as part of their account mechanisms. In particular, a user's "wallet" on the Ethereum blockchain is simply their key pair, and their blockchain address is derived from their public key.[122]

2. Blockchains

NFTs, as currently designed, exist on blockchains and rely on blockchain technology for their purported benefits. While most NFT activity at this point occurs on the Ethereum blockchain, they do not depend in any way on Ethereum, and many other blockchains host NFTs.[123] Thus, this section provides a general overview of blockchain technology.

First come the blocks. At the most basic level, a block is simply a collection of data.[124] That data generally consists of records of transactions—transfers of items from one address to another, often with associated information.[125] For example, a simple Bitcoin transaction record might include the address of the sender, the amount of Bitcoin the sender is transferring, and the address of the recipient.[126] An NFT transaction is largely similar, except that the NFT is transferred rather than an amount of cryptocurrency. A party wishing to engage

120. As a practical matter, typically the digital signature is created by signing the hash of the message rather than the message itself.

121. The precise mathematics of how public-key cryptography works are well beyond the scope of this Article. For a thorough explanation of the type of digital signature used by both the Bitcoin and Ethereum blockchains, see Don Johnson, Alfred Menezes & Scott Vanstone, *The Elliptic Curve Digital Signature Algorithm*, 1 INT'L J. INFO. SEC. 36 (2001).

122. *See Ethereum Accounts*, ETHEREUM, https://ethereum.org/en/developers/docs/accounts/ [https://perma.cc/R3V3-KZAC].

123. *See, e.g.*, Finzer, *supra* note 94.

124. *See, e.g.*, *What Is Blockchain Technology?*, IBM, https://www.ibm.com/topics/what-is-blockchain [https://perma.cc/F6Y3-BPLC].

125. *Id.* Thus, as described by the Ethereum project, "Blocks are batches of transactions." *Blocks*, ETHEREUM, https://ethereum.org/en/developers/docs/blocks/ [https://perma.cc/9XZS-HB43].

126. *See, e.g.*, *How Do Bitcoin Transactions Work?*, BITCOIN.COM, https://www.bitcoin.com/get-started/how-bitcoin-transactions-work/ [https://perma.cc/VPP2-UZ2H]. Various services allow a user to view blockchain transactions. *See, e.g.*, *Bitcoin Transaction*, BLOCKCHAIN, https://www.blockchain.com/btc/tx/988bd9209e580662056555505a76dfd21e7e43b2e171b4094916f5dc2975d449 [https://perma.cc/28ZC-UUGZ].

in a blockchain transaction sends a message containing the transaction details to the relevant blockchain network for inclusion in a block.[127] This message must be signed with the user's private key to ensure that the party creating the transaction—i.e., the party sending cryptocurrency, an NFT, or other asset—is authorized to do so.[128] The size of each block, and thus the number of transactions it contains, varies across blockchains both in absolute terms and in how it is determined.[129]

Second come the chains. In addition to bundles of transactions, each block contains a pointer to the previous block in the chain.[130] The purpose of the chain is to provide tamper-resistance—the source of the renowned immutability of information stored on the blockchain. Blockchains achieve this by using a "hash-pointer" to the previous block in the chain. That is, the pointer included in each block is not merely the address of the preceding block, but a cryptographic hash of the preceding block.[131] Anybody can verify a block's integrity by hashing it and comparing it to the header of the subsequent block.[132]

A simplified example helps to understand the basic operation of a blockchain. Imagine a new blockchain with only three blocks. Block one records the creation of ten units of the cryptocurrency AliceCoin by its founder, Alice. Block two records the transfer of five units from Alice to each of Barb and Chris. Block three records Barb's transfer of two units to Derrick. Suppose that Chris now wishes to maliciously record a transfer of Barb's five units to Chris. Chris may attempt to promulgate to the network a different block two that records the transfer of those units to Chris. However, the hash of Chris's fraudulent block will not match the hash recorded at the beginning of block three.[133] Honest "nodes"—machines participating in the network by, for example, processing transactions and hosting the blockchain—will recognize that Chris's proposed block has been tampered with and will not include it on the chain, thus preventing Chris's attempted theft. As a result, any transaction included in a block cannot be retroactively changed and is effectively immutable, so long as honest nodes predominate.

127. *How Do Bitcoin Transactions Work?*, *supra* note 126.

128. *See, e.g.*, *Ethereum Accounts*, *supra* note 122.

129. The Bitcoin blockchain determines block size based on the amount of data contained in the block, with an effective limit of 4 MB. *See, e.g.*, *Block Size*, RIVER FIN., https://river.com/learn/terms/b/block-size/ [https://perma.cc/3T6U-2U9R]. The Ethereum blockchain determines block size based on the transaction fees associated with all transactions in the block. *See, e.g.*, *Blocks*, *supra* note 125.

130. NARAYANAN ET AL., *supra* note 111, at 11.

131. *Id.*

132. *Id.*

133. The fraudulent transaction would also include a verifiably false signature so long as Chris does not have access to Barb's private key. If Chris had such access, Chris would have been able simply to send a message to the network transferring Barb's units to Chris with the appropriate signature, highlighting the importance of maintaining the security of private keys.

3. Decentralization and Mining

Ensuring the honesty of nodes is a major focus in the design of a blockchain, particularly given that decentralization is an avowed goal of most blockchain technologies.[134] The problem is trust. Centralization is one possible solution to the problem of trust: if a blockchain is run by an organization that all its users find trustworthy, that blockchain can be maintained entirely by computers controlled by that organization. For blockchain designers with serious ambitions, such as creation of globally usable currency, however, there is not—and likely cannot be—such an organization. The blockchain must therefore be maintained by a decentralized network of computers, each controlled by anybody with the desire and technical ability to run that blockchain's software.

Nobody would use a blockchain full of fraudulent blocks. The addition of a block to the blockchain, then, requires establishing trust that the anonymous computer supplying the block has faithfully executed the transactions contained in the block. The basis of that trust is twofold: it relies on the cryptographic underpinnings and the design of the mechanism of consensus that allows all of the decentralized nodes to agree on the state of the blockchain.

Cryptography provides an efficient way for nodes to verify that a given block contains only valid transactions and accurately identifies the previous block. The transactions can be verified by validating their associated digital signatures. The identity of the previous block is validated by computing the hash pointer for that block and comparing it to the hash pointer given in the proposed block.[135]

Each block on a blockchain is supplied by a single node, creating another opportunity for distrust to creep into the system: What if the latest block is supplied by a dishonest node? If the dishonesty is apparent, perhaps in the form of the inclusion in the block of a transaction that cannot be validated, the node supplying the next block will ignore the fraudulent block and treat the last honest block as last in the chain. Subsequent honest nodes will continue the honest chain, and the fraudulent block will not become part of the blockchain. Crisis averted.

134. The foundational Bitcoin whitepaper, for example, stresses "the inherent weaknesses of the trust based model" of transactions over the internet and proposes a "peer-to-peer" solution that resolves those weaknesses. *See* SATOSHI NAKAMOTO, BITCOIN: A PEER-TO-PEER ELECTRONIC CASH SYSTEM 1 (2008), https://bitcoin.org/bitcoin.pdf [https://perma.cc/GW64-SXBL (staff-uploaded archive)]. Likewise, the foundational Ethereum whitepaper hails the use of Bitcoin's "underlying blockchain technology as a tool of distributed consensus," and expressly avows that "[t]he intent of Ethereum is to create an alternative protocol for building decentralized applications." *See* Vitalik Buterin, *Ethereum Whitepaper*, ETHEREUM (Feb. 17, 2023), https://ethereum.org/en/whitepaper/ [https://perma.cc/9HTX-2BP2].

135. *See How Do Bitcoin Transactions Work?*, *supra* note 126.

But what if a substantial number—indeed, a majority—of the nodes are controlled by a single malicious actor? Blockchain design addresses this risk in numerous ways, including decentralization, incentives, and often proof-of-work mechanisms.

A centralized blockchain, or one with only a few nodes, is relatively vulnerable to takeover by a malicious actor. With more active nodes, under the control of a larger number of actors, takeover becomes more difficult. As of August 2022, the Bitcoin blockchain featured more than 14,000 nodes, with an average of 14,180 active nodes over the previous year.[136] Ethereum features a similarly robust 9,137 nodes.[137] A malicious actor would thus need to bring thousands of nodes to bear on these blockchains to command a majority.

How do blockchain developers induce people to run nodes? Most blockchains, Bitcoin and Ethereum included, provide a reward to the node that mines each block.[138] Additionally, all transactions on these block chains are subject to transaction fees, which are paid to the node creating the block including the transaction.[139] So long as these fees and rewards exceed the cost of creating blocks, nodes will stay on the network. Moreover, they incentivize honest behavior by the nodes: since the mining rewards and transaction fees are included in the block, a node submitting a fraudulent block will receive neither. Subsequent blocks, recognizing the fraud, will not recognize that block and thus will not reflect the rewards and fees claimed by the dishonest node.

This leads to the last piece of the general blockchain design puzzle: How does the network determine which node will create the next block? Bitcoin and many other blockchains rely on a proof-of-work mechanism, popularly known as "mining";[140] for its first eight years, Ethereum also used this approach.[141] The precise mechanics of each blockchain's proof-of-work algorithm vary, but all rely on the puzzle-friendly properties of hashing algorithms discussed above. Proof-of-work algorithms in use today follow roughly this design: First, the

136. *See* BITNODES, https://bitnodes.io/dashboard/?days=365 [https://perma.cc/4BNE-4C4Q] (reporting number reachable nodes on August 2, 2022, and average number of nodes).

137. *See Ethereum Node Tracker*, ETHERSCAN, https://etherscan.io/nodetracker [https://perma.cc/6K2Y-Y3HV] (reporting 9,137 active Ethereum nodes on August 2, 2022).

138. For Bitcoin, the reward per block is currently 6.25 bitcoin; the reward was initially 50 bitcoin and is halved every 210,000 blocks. *See* Jake Frankenfield, *Block Reward*, INVESTOPEDIA (July 23, 2021), https://www.investopedia.com/terms/b/block-reward.asp [https://perma.cc/PSX2-2AG4]. Ethereum rewards vary with the total amount of Ether "staked" by validators. *See The Ethereum Merge: What It Means for the Network*, BLOCKNATIVE (Aug. 4, 2022), https://www.blocknative.com/blog/ethereum-merge-proof-of-stake [https://perma.cc/2JT5-4WVP] (describing Ethereum block reward structure).

139. *Id.*

140. *See id.*

141. *See, e.g.*, David Yaffe-Bellany, *Crypto's Long-Awaited 'Merge' Reaches the Finish Line*, N.Y. TIMES (Sept. 15, 2022), https://www.nytimes.com/2022/09/15/technology/ethereum-merge-crypto.html [https://perma.cc/3S2B-SCFJ (staff-uploaded, dark archive)] (reporting on Ethereum's switch from proof-of-work to proof-of-stake consensus mechanism).

blockchain sets a low target value. A mining node creates a block of transactions, then combines those transactions with a header and a "nonce,"[142] then hashes the combination of the latter two. If the value of the hash is lower than the target value, the proof-of-work algorithm is satisfied. If the value of the hash is higher than the target value, the node increments the nonce and tries again. The first node to assemble a valid block with a valid nonce wins the race: it has "mined" the new block, which is added to the blockchain.[143] By design, it is exceedingly unlikely that any given nonce will result in a hash lower than the target value. Because the hash functions (and larger proof-of-work algorithms) are puzzle-friendly, the optimal method to find a valid nonce is simply to try as many nonces as possible, as quickly as possible.[144] Trying enough nonces quickly enough to have a reasonable chance of winning the race requires an enormous amount of computing power. However, once a single node has found a valid nonce, it is trivial for other nodes to verify that nonce's validity, as they merely have to run the proof-of-work algorithm once, with the supplied nonce, to determine if it in fact falls under the target value.[145] The purpose of the proof-of-work mechanism, as described by Narayanan et al., is to "approximate the selection of a random node by instead selecting nodes in proportion to a resource that we hope that nobody can monopolize"—computing power.[146] This both enables decentralization of determining which node proposes the next block and diminishes the possibility that a malicious actor could come to dominate the network by cheaply spinning up large numbers of nodes.[147]

The principal downside of proof-of-work consensus mechanisms is that—again, by design—they intentionally waste incredible amounts of computing power. Blockchain nodes engaged in proof-of-work are not running simulations of proteins to help develop new medical treatments for COVID-19 or scanning radio-telescope signals for hints of extraterrestrial life.[148] Instead, they compete

142. "In cryptography, the term *nonce* is used to refer to a value that can only be used once." NARAYANAN ET AL., *supra* note 111, at 7 (emphasis in original).

143. *See id.* at 41.

144. *Id.*

145. *See id.* at 42–45.

146. *Id.* at 41.

147. *Id.* It is interesting to note, however, that domination by a malicious actor—a so-called fifty-one percent attack—is unlikely to result in long-term success for that actor. Narayanan et al. contend that such an attack would not succeed in stealing cryptocurrency from a particular address, for instance, because honest nodes would recognize the invalid transaction in a block and refuse ever to acknowledge that block. Such nodes would continue mining from the last valid block, leading to a fork in the blockchain—one branch laden with known invalid blocks created by a malicious actor, and the other containing only valid blocks. No reasonably attentive user would continue to transact on the malicious chain. *See id.* at 48–49.

148. These are the goals of the Folding@home and SETI@home projects, respectively, which leverage users' otherwise idle computer processors to carry out those tasks. *See Start Folding*, FOLDING@HOME, https://foldingathome.org/start-folding/ [https://perma.cc/ZP5Y-7UEA]; SETI@HOME, https://setiathome.berkeley.edu/ [https://perma.cc/N4NV-6UMX].

in a series of one-off guessing games predominantly, if not exclusively, for their owners' financial benefit. In doing so, they consume a horrifying amount of electricity, to the great detriment of the environment.

Many advocate the use of an alternative consensus mechanism, known as proof-of-stake—the mechanism to which Ethereum switched in September 2022.[149] Such a model works by requiring nodes that wish to participate in creating blocks to first stake some amount of their holdings. Ethereum, for example, requires any transaction-validating node to stake thirty-two Ether, and maintain a staked balance of at least sixteen Ether.[150] Validating nodes are grouped into "committees" of 128 nodes, and one node in each committee is randomly chosen to create a block.[151] The remaining nodes in the committee are assigned to validate the proposed block. The node creating the block receives a reward only once a sufficient number of nodes have validated that block; the validating nodes also receive a small reward.[152] Nodes are penalized if they create invalid blocks or fail to participate in the validation process.[153] In an attempt to balance incentives to stake more but maintain decentralization, the weight given to a validating node's vote in the validation process depends on how much it has staked, but only up to a maximum of thirty-two Ether.[154]

4. "Smart Contracts" and Tokens

A "smart contract" is not a contract. It is a program: nothing more and nothing less.[155] Because smart contracts are essential to the creation and distribution of NFTs, and because not all blockchains support smart contracts, the remainder of this part focuses on the Ethereum blockchain. Smart contracts are a special type of account: like individual users, they can hold assets and send transactions.[156] When and how they do so is governed by their underlying code, but operations are generally triggered by transactions sent to the smart contract's blockchain address.[157]

149. *See, e.g.*, Yaffe-Bellany, *supra* note 141.

150. *See, e.g.*, *Validator FAQs*, STAKING LAUNCHPAD, https://launchpad.ethereum.org/en/faq [https://perma.cc/WQ6F-WSUK].

151. *See, e.g.*, Andrey Sergeenkov & Toby Bochan, *How Does Ethereum Staking Work?*, COINDESK (Sept. 22, 2022), https://www.coindesk.com/learn/2021/08/11/how-does-ethereum-staking-work/ [https://perma.cc/48C4-J73C] (describing structure of Ethereum's proof-of-stake implementation).

152. *Id.*

153. *Id.*

154. *See Validator FAQs*, *supra* note 150.

155. Ethereum's own documentation acknowledges this. *See Introduction to Smart Contracts*, ETHEREUM, https://ethereum.org/en/developers/docs/smart-contracts/ [https://perma.cc/W5XF-NBAM] (stating that "[a] smart contract is simply a program that runs on the Ethereum blockchain").

156. *Id.*

157. *Id.*

That code is run on the Ethereum Virtual Machine ("EVM").[158] As part of the process of creating blocks, nodes execute transactions invoking smart contracts according to the rules and design of the EVM.[159] Nodes include the results of running smart contracts in blocks alongside other transactions.[160]

Among other uses, smart contracts can be used to create and govern tokens on the blockchain. Tokens can include, for one recursive example, other cryptocurrencies, such as "USD Coin."[161] Ethereum maintains a standard, ERC-20, for tokens of this type.[162] Anyone with the resources to devise a suitable smart contract (and whatever other technologies might be required) can deploy that smart contract to the Ethereum blockchain. The smart contract will then mint and distribute tokens according to its design. Smart contracts thus create and govern the distribution of NFTs.

5. The NFT Itself

NFTs leverage every aspect of blockchain technology, from the cryptographic primitives up through the execution of smart contract code by the EVM. Yet for all that, they turn out to be disappointingly simple, particularly in light of the relentless hype and high price tags often associated with them.

Although adherence to standards is not strictly required, most NFTs bought and sold on leading exchanges comply with ERC-721. ERC-721 sets forth a standard for smart contracts intended for use in transferring NFTs.[163] It includes standard interfaces for actions such as transferring ownership of NFTs

158. *See, e.g.*, *Ethereum Virtual Machine (EVM)*, ETHEREUM, https://ethereum.org/en/developers/docs/evm/ [https://perma.cc/Y3Q6-CAZG].

159. *See, e.g.*, Wei-Meng Lee, *Understanding Blockchain: A Beginners Guide to Ethereum Smart Contract Programming*, CODE MAG. (Apr. 26, 2021), https://www.codemag.com/Article/1805061/Understanding-Blockchain-A-Beginners-Guide-to-Ethereum-Smart-Contract-Programming [https://perma.cc/6UHV-4SWT].

160. *Id.*

161. USD Coin is a cryptocurrency available on several blockchains, including Ethereum, that is supposedly always redeemable at the rate of one U.S. dollar for one USD Coin. *See, e.g.*, *Introducing USD Coin (USDC)*, COINBASE, https://www.coinbase.com/usdc [https://perma.cc/N9RP-QGJZ].

162. *See, e.g.*, *ERC-20 Token Standard*, ETHEREUM, https://ethereum.org/en/developers/docs/standards/tokens/erc-20/ [https://perma.cc/9S3U-TB2Y].

163. "ERC-721" stands for "Ethereum Request for Comments 721," following Ethereum's convention for "application-level standards and conventions, including contract standards such as token standards." *See* Martin Becze & Hudson Jameson, *EIP-1: EIP Purpose and Guidelines*, ETHEREUM IMPROVEMENT PROPOSALS (Oct. 2015), https://eips.ethereum.org/EIPS/eip-1 [https://perma.cc/5X6G-GBV7]. Ethereum Improvement Proposal 721 sets forth the details of the ERC-721 standard. *See* William Entriken, Dieter Shirley, Jacob Evans & Nastassia Sachs, *EIP-721: Non-Fungible Token Standard*, ETHEREUM IMPROVEMENT PROPOSALS (Jan. 2018), https://eips.ethereum.org/EIPS/eip-721 [https://perma.cc/E3B6-GEBE]. An updated standard, ERC-1155, that allows smart contracts to issue multiple types of tokens (such as fungible and non-fungible) is also gaining traction. *See ERC-1155 Multi-Token Standard*, ETHEREUM, https://ethereum.org/en/developers/docs/standards/tokens/erc-1155/ [https://perma.cc/995G-B9TD].

from one address to another, determining the current owner of a given NFT, and creating or destroying a given NFT, as well as optional elements such as the inclusion of metadata about the NFT.[164]

Thus, at last, the resolution to the multi-million-dollar question: What is an NFT? Formally, in the case of ERC-721, it is the resource identified by the pairing of a particular smart contract address and a unique "tokenID" produced by that smart contract.[165] An example—Beeple's record-smashing "EVERYDAYS"—illuminates the details. To create the NFT sold by Christie's, a transaction had to be conducted with a smart contract, in this case the "MakersTokenV2" smart contract.[166] The transaction called a specific function within the smart contract, passing along values for the owner of the resulting token (a wallet address controlled by Beeple), the total supply of the token to create (one), the ID of the collection to which it belongs (zero), a path for metadata about the token, and the number of releases of the token (one).[167] As a result, Beeple became the owner of an NFT with the token ID 40913 created by the MakersTokenV2 smart contract, which he subsequently transferred to the winning bidder.[168] Even the notion that he "transferred" the token to another is somewhat attenuated. The NFT is an immutable record on the distributed ledger that is the blockchain. Transferring it does not move or alter the NFT in any sense; rather, it adds a subsequent entry on the ledger averring that ownership of the NFT has changed. The "EVERYDAYS" NFT always and forever amounts to the token ID, the number of editions, the identification of a particular wallet address as its creator, and the path to metadata about the work. Nothing more.

Notable by its absence in this transaction is the work itself. "EVERYDAYS" is a digital image, 21,069 pixels square and just over 319 megabytes in size.[169] The only information in the transaction creating the NFT concerning the work itself, rather than its transfer, is the metadata path. That

164. *See* Entriken et al., *supra* note 163.

165. *See id.* A "tokenID" is "a unique uint256 [i.e., 256-bit unsigned integer] ID." *Id.*

166. This transaction is viewable on the Etherscan service. *Transaction Details*, ETHERSCAN, https://etherscan.io/tx/0x84760768c527794ede901f97973385bfc1bf2e297f7ed16f523f75412ae772b3/advanced [https://perma.cc/JU6H-7FBD].

167. *Id.*

168. Specifically, on March 13, 2021, Beeple transferred the NFT via the MakersTokenV2 contract to a wallet that then transferred the token to the wallet of "Metakovan." *See Transaction Details*, ETHERSCAN, https://etherscan.io/tx/0xa342e9de61c34900883218fe52bc9931daa1a10b6f48c506f2253c279b15e5bf [https://perma.cc/2RDH-D9GF]. Metakovan is the *nom de crypto* of Vignesh Sundaresan, a crypto investor and entrepreneur. *See, e.g.*, Robert Frank, *Crypto Investor Who Bought Beeple's NFT for $69 Million Says He Would Have Paid Even More*, CNBC (Mar. 30, 2021, 12:08 PM), https://www.cnbc.com/2021/03/30/vignesh-sundaresan-known-as-metakovan-on-paying-69-million-for-beeple-nft.html [https://perma.cc/89ZJ-9JPR].

169. *See EVERYDAYS: The First 5000 Days*, CHRISTIE'S, https://onlineonly.christies.com/s/first-open-beeple/beeple-b-1981-1/112924 [https://perma.cc/NWK4-EZUD] [hereinafter *EVERYDAYS*].

path points not to the image itself but a file in JavaScript Object Notation ("JSON") format including metadata about the image. Both the metadata file and the image itself (when finally located) are stored on the InterPlanetary File System ("IPFS"), a decentralized storage system not directly accessible through a web browser.[170] The metadata file to which the NFT links contains a smattering of additional information, including the title of the work, its type ("object"), a link to the image via a MakersPlace interface to the IPFS, a description of the work, and a cryptographic hash of the image.[171] With this information, at last, one may download a copy of "EVERYDAYS," or check that a copy they downloaded elsewhere is identical to the "unique" work sold by Christie's.[172]

"EVERYDAYS" is not unique in the threadbare nature of its associated NFT. For NFTs of visual art, reference to a metadata file that contains a link to the art stored elsewhere is the norm, for the simple reason that storing art on the Ethereum blockchain encounters technical and economic obstacles ranging from complicated to insurmountable. The root of the problem is that Ethereum is specifically designed to disincentivize storage of large amounts of data because of the fear of making it too difficult for nodes to store the full blockchain.[173] All actions on the Ethereum blockchain incur transaction fees, paid in units called "gas." It costs nearly as much gas (20,000) to store a mere thirty-two bytes of data as it does (21,000) to conduct a transaction.[174] "EVERYDAYS," at 319.2 MB, would require so much gas to store on the

170. *See, e.g.*, *What Is IPFS?*, IPFS DOCS, https://docs.ipfs.io/concepts/what-is-ipfs/ [https://perma.cc/6XZA-GRC2]. Several websites provide an interface to the IPFS, however. *Id.* Files stored on IPFS are located based on a cryptographic hash of their contents, hence the somewhat ungainly location of the metadata file for "EVERYDAYS," which may be viewed at *EVERYDAYS: The First 5000 Days*, IPFS, https://ipfs.io/ipfs/QmPAg1mjxcEQPPtqsLoEcauVedaeMH81WXDPvPx3VC5zUz [https://perma.cc/9V4H-FM4N].

171. *See id.* The metadata file also identifies "beeple" as the creator, links to a smaller-size "preview" version of the image, and includes the date and time the file was created and technical information about the hash algorithm used to produce the hash listed in the file.

172. *See EVERYDAYS*, *supra* note 169. One need only check the SHA-256 hash of their version of the image against the value listed in the metadata file.

173. *See Decentralized Storage*, ETHEREUM, https://ethereum.org/en/developers/docs/storage/ [https://perma.cc/TB2S-G3PZ] (noting that "when it comes to large amounts of data, that isn't what Ethereum was designed for," because "[i]f the chain were to expand to large amounts of data (say 5TBs) it wouldn't be feasible for all nodes to continue to run"). As of August 2022, the full size of the Ethereum blockchain was approximately 834 GB, varying with the client software used. *See Ethereum Full Node Sync (Default) Chart*, ETHERSCAN, https://etherscan.io/chartsync/chaindefault [https://perma.cc/3J8R-8AE2].

174. *See* GAVIN WOOD, ETHEREUM: A SECURE DECENTRALISED GENERALISED TRANSACTION LEDGER 27 (2022), https://ethereum.github.io/yellowpaper/paper.pdf [https://perma.cc/H6QZ-EJAP] (listing gas costs of various Ethereum operations). The "SSET" fee is paid for the "SSTORE" operation, which is the applicable operation for storing data on the blockchain and its fee must be paid for each 256 bit (32 byte) "word" stored. *See id.* at 34.

Ethereum blockchain that it would shatter the block-size limit, among other obstacles.[175] But even if it were technically possible to store it on the blockchain, it would be economically infeasible. At the gas price paid to mint the "EVERYDAYS" NFT, and at the price of Ethereum in U.S. dollars at that time, it would have cost $56,816,880.91 to store the actual image on the blockchain.[176]

A counterexample further illuminates this problem. The "CryptoPunks" project is a collection of 10,000 programmatically generated characters, each represented by a 24 x 24 pixel image (also programmatically generated).[177] When launched in 2017, these images—at an approximate size of a whopping 200 bytes, less than the storage space required for the text of a single Tweet—were still too big to be stored on the Ethereum blockchain.[178] However, in August 2021, Larva Labs, the creators of CryptoPunks, found a way to compress the CryptoPunks enough to store them all on the blockchain, albeit at the cost of 73 million gas, at the time worth approximately $11,597.[179] That it took such a long time to find a technically and economically feasible way to store such minuscule NFT images on the blockchain further illustrates why most NFTs include a mere pointer to the associated work.

6. The Many Failings of NFTs

NFTs are not what their proponents say they are. Distilled to their essence, they are inscrutable listings of blockchain addresses, token IDs, and perhaps a link to metadata. They are functionally almost identical to the order confirmations produced by essentially every online retailer and service provider in existence. Each produces a numerical token generated by software, whether

175. Ethereum block size is variable, but targets 15 million gas expended per block, with a hard cap at 30 million gas per block. "EVERYDAYS" would fill 6,809.6 blocks if every one of them was at the 30 million gas limit.

176. The transaction in which this NFT was minted paid a gas price of 156 Gwei (0.000000156 Ether), and Ether's price in U.S. dollars that day was approximately $1,782.83. *See Transaction Details*, ETHERSCAN, https://etherscan.io/tx/0x84760768c527794ede901f97973385bfc1bf2e297f7ed16f523f75412ae772b3 [https://perma.cc/UMV4-EWQM].

177. *See CryptoPunks*, LARVA LABS, https://www.larvalabs.com/cryptopunks [https://perma.cc/Y6AY-5WBR].

178. *Id.* The size estimate is based on downloading a handful of individual images of punks. *See, e.g.*, *CryptoPunk 1*, LARVA LABS, https://larvalabs.com/cryptopunks/details/1 [https://perma.cc/VLL9-YGU7] (193 byte image). The official image containing all 10,000 CryptoPunks is only 848 KB, less than three percent of the size of "EVERYDAYS." *See CryptoPunks*, LARVA LABS, https://www.larvalabs.com/public/images/cryptopunks/punks.png [https://perma.cc/73SU-6CPK].

179. *See On-Chain Cryptopunks*, LARVA LABS, https://www.larvalabs.com/blog/2021-8-18-18-0/on-chain-cryptopunks [https://perma.cc/MD2V-63HK]. The dollar cost of this development is estimated based on the average gas price on August 18, 2021, and the lowest price of Ether in U.S. dollars that day. *See Ethereum Average Gas Price Chart*, ETHERSCAN, https://etherscan.io/chart/gasprice [https://perma.cc/38LV-APT8]; *Ethereum Price History*, ETHEREUM PRICE, https://ethereumprice.org/history/ [https://perma.cc/C78F-MN3E].

it be an NFT's "token ID" or an Amazon purchase's confirmation number. Like the token ID, the confirmation number must be unique to serve any purpose.[180] And, like the NFT, the order confirmation has no inherent utility; it is only useful when used to locate substantive information stored elsewhere.

Full understanding of NFTs calls into question practically every one of their proposed uses. Even those uses that might exist are at odds with decentralization and do not actually require NFTs with all their cryptographic complexity. This section analyzes several of the touted features and uses of NFTs, revealing their essential lack of utility.

a. NFTs Are Not Unique Digital Works

The primary point of alignment between proponents of digital first sale and NFTs is that NFTs supposedly constitute rivalrous digital objects. Unfortunately, enabling the sale of unique, original copies of digital art works, analogous to the sale of an original painting, is a goal NFTs cannot accomplish. For while the case can be made that ownership of an NFT is ownership of a unique item, all that one can be said to own is a string of hexadecimal digits that decode, at best, to a pointer to a resource stored somewhere else.

But the idea that an NFT is unique in the sense of an individual, authentic piece of art is untrue even if one is inclined to stretch the term to include resources linked in the NFT.[181] By nature and design, NFTs are infinitely replicable by anybody possessing an interest and a transaction hash. At this very moment, I have copies of "EVERYDAYS," the metadata linked from its token, and the transaction creating the token itself stored on multiple devices. These copies are identical in every respect to the ones "owned" by Metakovan. Every one of the thousands of active Ethereum nodes likewise possesses identical copies of the NFT and the transaction creating it, and some number of the hundreds of thousands of IPFS nodes possess identical copies of the work itself.[182] While it is possible for an NFT to link to resources that are protected from public view,[183] the NFT itself must *always* be freely accessible if it is to be placed on a public blockchain like Ethereum. And if the purchaser of such an

180. At the very least, the confirmation number must be unique in connection with some identification of the purchaser, just as the unique identifier for any given NFT is the combination of its token ID and the address of the smart contract that produced it.

181. Such a stretch is unwarranted for reasons including that, depending on where that link leads, the resources may change or disappear over time. *See, e.g.*, Finzer, *supra* note 94 (noting that "off-chain" information can be changed and can "disappear from its original source").

182. *See* Molly Mackinlay, *IPFS Project Focus for 2020*, IPFS BLOG & NEWS (Feb. 10, 2020), https://blog.ipfs.io/2020-02-10-our-focus-for-2020/ [https://perma.cc/TRF2-7YVS] (reporting that hundreds of thousands of nodes "participat[e] in the IPFS Network daily").

183. For instance, MakersPlace proclaims that it "stores your files in a secure location only you (creator) and future owners can access upon purchase." *See FAQ*, MAKERSPLACE, https://makersplace.com/faq/ [https://perma.cc/V7QY-9G33].

NFT wants to show anybody else the work they so enjoyed, they necessarily expose it to widespread copying. This is the unchangeable nature of digital copies.

There is also no technological obstacle to an individual minting additional NFTs following the sale of a supposedly limited run. If Beeple would like to sell another "EVERYDAYS" NFT, whether on the Ethereum blockchain or elsewhere, he need only send a transaction to a compatible smart contract pointing to the work. The NFT would receive a different tokenID, might well be issued from a different smart contract, and could feature different metadata if Beeple wished. But the work referred to by the NFT would still be "EVERYDAYS," identical in every respect to the work "sold" by Christie's. The only obstacles to this are reputational and, presumably, contractual—one would think that Christie's required an agreement that Beeple not mint additional NFTs of the work. The "unique" nature of the NFT depends on a real contract, not blockchain technology.

Indeed, an unscrupulous seller would face little difficulty in selling multiple "unique" NFTs of the same work to different buyers, so long as neither the transactions nor the work itself came to widespread attention. Here, the precise, deterministic qualities of hashes work against the buyer. Hash functions are exceptionally useful in establishing that two copies of a digital file are precisely identical. But they are useless in establishing that two visually identical digital images are in fact the same work. Hash functions operate on the sequential bits of a file rather than the visual output generated when that file is processed by image-viewing software. It takes little effort to devise methods to alter those sequences of bits in ways that generate completely different hashes without any perceivable change to the visual output, such as altering the file's metadata or making an imperceivable change to the color of one of the millions of pixels in the image.[184] The seller could thus truthfully

184. Although I have no formal training in computer science, I was quickly able to concoct four different methods to make trivial modifications to "EVERYDAYS" to produce different SHA-256 hashes without any perceivable change to the image itself. Each began with the "official" JPG version of the image, retrieved from the IPFS address given in the NFT metadata, and each resulted in a hash bearing no resemblance to the hash of the original or, indeed, any of the other modified versions. First, I converted the file from JPG format to PNG format. This conversion does not change the visual appearance of the image because the PNG format employs lossless compression. Second, to replicate a method that could be used by the creator of the image, I created an intermediate version of the file in the image-editing program Affinity Photo, saved in that program's native project format. I exported an unaltered version of that intermediate file to JPG. I then changed the color value (expressed by the amount of red, green, and blue in the pixel, with a range of 256 values for each component) of the top-left pixel in the image (one of 443,902,761 pixels in the image) by incrementing the blue component by one. Third, I changed the EXIF metadata embedded in the file by adding the value "1" to the previously empty "Comment" field. Fourth, I inserted four bytes of meaningless data into the file in a way that does not alter the display of the image or the metadata when viewed by conventional image-viewing software.

represent that the image referred to in NFT metadata has a unique hash, and the buyer would have no way to determine whether any other NFTs pointing to visually identical works existed—especially if sold on platforms that restrict viewing to the owner recorded on the blockchain.

Above, I suggested somewhat glibly that NFTs are, at best, receipts. This, too, proves to be an overstatement. Nothing in the NFT or the transaction sending it to a new owner recites the consideration, if any, paid for the NFT. Indeed, viewing the transactions to and from the blockchain address used by Beeple to mint the "EVERYDAYS" NFT does not reveal any influx of Ether approaching the value of the sixty-nine-million-dollar winning bid, nor does such an analysis of the Metakovan address to which ownership was transferred reveal any such payment.[185] An order confirmation email from any online retailer contains substantially more information about the transaction than an NFT would.

b. NFTs Lack Inherent Utility or Worth

NFT boosters herald NFTs as immutable, unique objects with a wide range of uses. In doing so, they generally fail to acknowledge that, while the NFT may be immutable, it is dependent on other technology to do *anything*, and that technology is not only mutable but generally subject to centralized control.

For example, Fairfield promotes the potential of NFTs to allow ownership of items in digital card games. In physical versions of such games (Fairfield looks to *Magic: The Gathering*), players may sell or trade cards that prove particularly useful. NFTs, Fairfield contends, enable such games to "translate[] seamlessly into an online platform," citing as an example the NFT-enabled game *Gods Unchained*.[186] But this comparison overlooks a critical distinction between physical and digital games. A game like *Magic: The Gathering* is played using physical cards according to a set of rules both knowable and actually known by the players. Nothing more than cards and players is required. But digital games like *Gods Unchained* cannot be played without using software—software in the exclusive control of the game's developers, who can change it at any time, in any way, for any reason. Such changes could include how the game processes NFT-based assets. Thus, while any given NFT-card remains immutable, how it functions in the game is subject to the developers' whim.

185. See *Transactions for Beeple*, ETHERSCAN, https://etherscan.io/txs?a=0xc6b0562605d35ee710138402b878ffe6f2e23807 [https://perma.cc/2HNZ-UW4], and *Transactions for Metakovan*, ETHERSCAN, https://etherscan.io/txs?a=0x8bB37fb0F0462bB3FC8995cf17721f8e4a399629 [https://perma.cc/V8DZ-4NQF], both of which show Etherscan transaction lists for the addresses used in creation and transfer of "EVERYDAYS" NFT by Beeple and Metakovan, respectively.

186. *See* Fairfield, *supra* note 2, at 1277.

And there is always the possibility that, for whatever reason, the developer simply stops providing access to the game, rendering all the NFT-based assets worthless.

So, too, with proposed use cases like event ticketing. In this scenario, an event promoter mints NFT tickets rather than issuing tickets in a more traditional way. The governing smart contract transfers NFT tickets to the blockchain wallets of buyers, who may sell or otherwise transfer their tickets if they wish. Anybody with one of the NFT tickets in their wallet then presents their NFT via mobile device to gain admission to the event.[187] So far, so good. But nothing prevents the event promoter from declining to admit any given ticketholder. Perhaps the promoter determines that a certain ticket was wrongfully transferred and disallows its use for entry. Perhaps the promoter oversells the venue and ceases admitting persons with valid tickets once capacity is reached. The fact that the ticket is an NFT instead of a slip of paper is of no import to the bouncer.

The problem, again, is that NFTs are nothing more than entries on a distributed ledger. They are in no sense self-executing; any use that depends on more than mere viewing of the ledger entry must be enabled by some other action or technology. That fact necessarily imperils the avowed goal of decentralization behind most major blockchains. Any utility to be derived from NFTs relies on off-chain technology controlled, in most cases, by a single entity. As an example, the decentralized nature of the Flow blockchain does nothing to protect the holder of the "Derrick Rose Layup (Feb 28 2020)" NFT, with an asking price of one million dollars, if the NBA decides to pull the plug on its Top Shot platform and remove the video clip to which the NFT points.[188] Decentralization inexorably gives way to centralized control.

In an ironic turn for digital first-sale proponents pinning their hopes on NFTs, this gravitational pull owes in part to copyright. Any work of art sold as an NFT is copyrighted from the moment of its creation; the creator need do nothing for copyright to apply. And the law is quite clear that owning a

187. *See How Does NFT Work for Ticketing?*, YELLOWHEART, https://helpcenter.yh.io/kb/en/article/how-does-nft-work-for-ticketing [https://perma.cc/V6LQ-BB5C].

188. *See Derrick Rose*, NBA TOP SHOT, https://nbatopshot.com/listings/p2p/a494c64e-9e93-418c-8934-f331ee47a39b+6750704f-3ac0-411e-ae52-807306b3d8d3 [https://perma.cc/5LAS-HY6D] (noting two versions of this NFT for sale with a "lowest ask" of one million dollars). Notably, the transaction minting this NFT does not itself point to the associated video. Top Shot NFTs are created in stages—first, a transaction creates a new set of tokens with a particular "setID"; subsequent transactions then add plays to those sets, each with a particular "playID." Individual NFTs are finally minted in transactions that merely assign a "momentID"—the equivalent of a "tokenID"—and refer to the "setID" and "playID" associated with the NFT. The transaction minting each NFT contains no usable reference to the video clip displayed on the Top Shot website when viewing that "moment." *See TopShot*, FLOWSCAN, https://flowscan.org/contract/A.0b2a3299cc857e29.TopShot [https://perma.cc/WS9P-GCX7].

particular copy of a work grants no interest in the copyright to that work.[189] Even if one is inclined to stretch the bounds of an NFT to include the visual work to which it refers, ownership of that NFT confers nothing more than, perhaps, a nonexclusive right to copy and display the work.[190] To confer the exclusive rights—to confer *ownership*—requires a writing, and that writing must be very specific about what rights are being transferred.[191] As one court has noted, the law's protections in this regard extend to protecting authors from themselves if need be, and the law "imposes a rigid default in favor of letting creators retain their interests in copyrighted work."[192] NFT purchasers will therefore generally lack the legal capacity to establish decentralized repositories of works to counteract the possibility of, for example, the NBA terminating its NFT service. Control over recorded ownership of a ledger entry provides no benefit if the subject of that entry vanishes.

c. NFTs Do Not Prove Authenticity

To the extent that authenticating the source of an NFT matters in a particular transaction, it represents another force against decentralization. As with all blockchain transactions, none of the data included in the minting or transfer process conveys anything about the source of that data or the parties' identity. In other contexts, cryptocurrency proponents trumpet the anonymity of blockchain transactions—only the wallet addresses of the participants appear on the ledger. Yet somehow NFTs are heralded as providing immutable proof of authenticity, a claim that sits in obvious tension with the inherent anonymity of the blockchain. In reality, to determine authenticity requires resort to external, non-blockchain sources in all cases.

Take, once more, "EVERYDAYS." Little information can be found in the transaction creating the NFT. It was initiated from the address 0x981f0bd6909901caeafc49177c229ae091bbd492 and invoked the smart contract at the address 0x2a46f2ffd99e19a89476e2f62270e0a35bbf0756. The

189. *See* 17 U.S.C. § 202 (providing that "[o]wnership of a copyright . . . is distinct from ownership of any material object in which the work is embodied," and that "[t]ransfer of ownership of any material object, including the copy or phonorecord in which the work is first fixed, does not of itself convey any rights in the copyrighted work embodied in the object").

190. *See* Katya Fisher, *Once upon a Time in NFT: Blockchain, Copyright, and the Right of First Sale Doctrine*, 37 CARDOZO ARTS & ENT. L.J. 629, 632 (2019) (noting that rights of the copyright holder may be assigned "on a nonexclusive basis" without a writing).

191. *See* 17 U.S.C. § 204 (providing that "a transfer of copyright ownership . . . is not valid unless an instrument of conveyance, or a note or memorandum of the transfer, is in writing and signed by the owner of the rights conveyed or such owner's duly authorized agent"); *see also* James Grimmelmann, Yan Ji & Tyler Kell, *Copyright Vulnerabilities in NFTs*, MEDIUM (Mar. 21, 2022), https://medium.com/initc3org/copyright-vulnerabilities-in-nfts-317e02d8ae26 [https://perma.cc/V843-G6JN] (discussing the complexities of transferring copyright in the context of NFT transactions).

192. Tjeknavorian v. Mardirossian, 56 F. Supp. 3d 561, 565 (S.D.N.Y. 2014).

raw input data of the transaction is, to the eye, incomprehensible.[193] Parsing that input through the smart contract yields a little more information: the owner of the NFT is identified as the address 0xc6b0562605D35eE710138402B878ffe6F2E23807, and the supply, number of releases, collection ID, and metadata path are provided.

Who is behind these addresses? By design, that cannot be determined solely by reference to the blockchain. Analysis of transactions from the initiating address reveals that it has engaged in thousands of similar invocations of the same smart contract, from which it can be inferred that the initiating address is a wallet under the control of the system minting these NFTs. A reference to "MakersToken" in the comments embedded in the source code of the smart contract likewise suggests the identity of the smart contract's creator. But there is nothing in the transaction or on the blockchain to identify the owner.

Several key elements of authenticity are not—and cannot be—established by the minting transaction or the resulting NFT. At most, the NFT might include representations (or point to a metadata file containing them) on these factors—representations that might very well be false. Beginning with the work itself, the NFT cannot establish that the work to which it refers is original or unique. It can only point to a location. It cannot establish who created the work but can only identify a supposed creator or owner of the NFT itself. It cannot even establish that it is the only NFT associated with the particular work. The extent of such assurance is that that particular transaction is minting only one NFT of a particular work.

In the case of "EVERYDAYS," we know that the first owner is Beeple, not because of the NFT itself, but because the Christie's page listing it for sale lists the same wallet address as that given for the owner in the minting transaction.[194] We know that "EVERYDAYS" is Beeple's work both because Beeple and Christie's say it is and because, in this particular case, it is a collage of thousands of works Beeple posted over the years. We know that it is unique only because Christie's says "[t]his work is unique," and we assume that statement is true and will remain so.[195] NFT proponents laud the technology's potential to demonstrate provenance, but in reality the reverse is true: only

193. The input data is in the form of a long hexadecimal string: 0x6ee17a78000000000000000000000000c6b0562605d35ee710138402b878ffe6f2e23807000000000
00000000000000000000000000000000000000000000000000000100000000000000000000000000
00000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000a0000000000000000000000000000000000000000000000000000000000
00000010000000000000000000000000000000000000000000000000000000002e516d50416
7316d6a7863455150507471734c6f4563617556656461654d4838315758445076507833564 3357a557a0
00000000000000000000000000000000000.

194. *See supra* note 169.

195. *Id.*

through the representations of creators and sellers, made anywhere but on the blockchain, is it possible to verify the authenticity of a work referred to by an NFT.

And thus the gravitational pull of centralization arises again. If the provenance of a work referred to by an NFT matters to a buyer, it must be established by some entity with sufficient reputation to make the necessary representations. To build that reputation requires standing behind those representations and paying out when they prove inaccurate. Few existing entities fit the bill, and it is no small matter for new entrants to try to compete with the likes of Christie's.

d. Immutability As Double-Edged Sword

Blockchain immutability is all well and good right up until the moment somebody makes a mistake. Take, for example, any of the endless stream of scams cropping up in which unwitting crypto-asset holders are relieved of their digital wallets.[196] By design, it is nigh-impossible to unwind such transactions—it can happen only when a majority of nodes on the blockchain agree to "fork" the chain to reallocate the lost assets. Such an action proves so controversial, and so momentous, that in the history of Ethereum it has been done only *once*, to unwind the misappropriation of approximately fifty-five-million-dollars' worth of Ether, representing slightly more than five percent of the entire market capitalization of Ether at the time.[197] No such recourse would be available in a typical fraudulent transaction. Given the decentralized, anonymous nature of the blockchain, pursuing the fraudster via legal action is likely to prove an exercise in futility.

Immutability claims victims even in situations involving no wrongdoing. One need only lose one's wallet. While losing an ordinary wallet is certainly a

196. Molly White provides an invaluable, regularly updated repository of stories on such scams. *See* Molly White, WEB3 IS GOING JUST GREAT, https://web3isgoinggreat.com [https://perma.cc/4SEC-6EWV]. In one notable example, an attacker exploited the platform Wormhole, which provides a means for holders of one cryptocurrency to transact in another. The attacker caused the minting of 120,000 "wrapped" Ether on the Solana blockchain, worth approximately $325 million at the time, and exchanged it with Wormhole for more than 90,000 Ether, worth approximately $250 million. *See* Corin Faife, *Wormhole Cryptocurrency Platform Hacked for $325 Million After Error on GitHub*, VERGE (Feb. 3, 2022), https://www.theverge.com/2022/2/3/22916111/wormhole-hack-github-error-325-million-theft-ethereum-solana [https://perma.cc/236M-G3YF].

197. *See, e.g.*, *The History of Ethereum*, ETHEREUM, https://ethereum.org/en/history/ [https://perma.cc/FKS9-V6AS] (noting all forks of the Ethereum blockchain, including the 2016 "DAO fork"); Matthew Leising, *The Ether Thief*, BLOOMBERG (June 13, 2017), https://www.bloomberg.com/features/2017-the-ether-thief/ [https://perma.cc/B6HK-WFZA] (discussing the "DAO hack"); *Ether Market Capitalization Chart*, ETHERSCAN, https://etherscan.io/chart/marketcap [https://perma.cc/S6QC-R2QJ] (reporting a total Ethereum market capitalization of $1,030,570,811.51 on July 20, 2016, the day of the DAO fork).

frustrating experience, it can be resolved—payment cards cancelled and reissued, IDs reprinted, and so on. But the loss of the private key behind a crypto wallet, or the password for the private key, cannot be remediated. By design, *nobody* can do anything with assets tied to a given wallet unless they control that wallet, nor can the private key behind the wallet be reset or cracked.[198] Thus, in one extreme case in 2013, James Howells inadvertently threw away a hard drive containing the private key associated with his Bitcoin holdings, which he obtained by mining in the very early days of the Bitcoin blockchain.[199] Near the end of 2021, the holdings secured by that key were worth approximately $550 million, and Howell had been engaged in a years-long battle with city government seeking permission to excavate the area of the local landfill where the drive is believed to reside.[200] Unless and until Howell succeeds in his quest to excavate and sort through "forty thousand tons of waste,"[201] find the drive, and recover its data, those Bitcoins will be of no use to anybody.

III. AGAINST DIGITAL GOODS AS PROPERTY

Decades into the era of digital media, the question of how law ought to respond remains open. Proponents herald NFTs, and digital first sale more broadly, as the wave of the future. Yet there is little novelty or advancement to be found in the record or prospects of the technology and the doctrine many hope it will resuscitate. Rather, they merely rely on convoluted technological means to bring forward the market logic of the past. While the NFT market remains in its infancy, it is easy to project the unsurprising result that the financial benefits of these systems flow primarily to the same groups as always, with the costs borne primarily by those who stand to gain the least. For artists, the value proposition of NFTs is no better than hoping to find a wealthy patron, land a major-label record deal, release a video that goes viral, or win any of a host of other lotteries into which they have always been forced. Indeed, the NFT lottery is even worse, due to high up-front costs and the volatile, illiquid currency in which the winner is paid.

198. Moreover, if developments in cryptography render the lost key recoverable or the lost password breakable, they would also obviate the entire design of existing blockchains and instantly render all such assets worthless. *See, e.g.*, Anthony Clarke, *Why Quantum Computing Isn't a Threat to Crypto . . . Yet*, COINTELEGRAPH (Sept. 9, 2022), https://cointelegraph.com/news/why-quantum-computing-isn-t-a-threat-to-crypto-yet [https://perma.cc/2VJ7-5MDL] (noting that "[i]f the current cryptographic hash algorithms ever get cracked, hundreds of billions of dollars worth of digital assets will be left vulnerable to theft from malicious actors").

199. D.T. Max, *Half a Billion in Bitcoin, Lost in the Dump*, NEW YORKER (Dec. 13, 2021), https://www.newyorker.com/magazine/2021/12/13/half-a-billion-in-bitcoin-lost-in-the-dump [https://perma.cc/7J9E-LLNL (staff-uploaded, dark archive)].

200. *Id.*

201. *Id.*

Beyond the world of creative works, NFTs supposedly enable a variety of novel functions, such as event ticketing and the opportunity to own and trade rare items in video games. But all of this has been done before, with the attempts often abandoned for reasons wholly unrelated to technological feasibility. The blockchain does not suddenly enable these functions; it does not even make them easier to deploy. The only significant difference in the NFT version is the decentralized nature of the blockchain, but any benefit that decentralization of the ledger might confer vanishes with the effective recentralization required for any use of tokens beyond mere transfer. Worse, the unregulated free-for-all currently taking place in the NFT market threatens to visit a variety of familiar harms upon the public. In the cases of event ticketing and video-game item trading, for example, experience teaches that scalping and labor exploitation are inevitable.

The overall scorecard for NFTs is bleak. Artists do not benefit by buying complicated, expensive tickets to yet another lottery that very few of them will win, with a prize value subject to massive instability. Consumers do not derive additional utility from adding a layer of complexity to transactions and functions that could and do exist without the blockchain.

Who, then, does win? Primarily, the same people who have already won. Popular artists need not worry about the up-front costs of issuing NFTs. They can be reasonably certain of recouping those costs quickly, weather the loss if their NFT offerings do not succeed, and hold resulting cryptocurrency reserves through exchange-rate volatility. But even they are secondary beneficiaries. The real money flows to the intermediaries and the speculators. NFT marketplaces, cryptocurrency exchanges, and mining nodes extract substantial cuts from every aspect of NFT transactions. Meanwhile, well-resourced cryptocurrency investors place bets by buying into those intermediaries as well as buying individual NFTs.

The implications of the turn to NFTs go beyond the merely financial. Inherent in the nature of the exchange, and explicitly stated by many NFT proponents, is a turn toward treating creative works primarily as investment products. Artists, authors, and musicians are exhorted to treat their works as securities, and their audience as potential investors with a financial stake in the success of the work. This capitalization of art echoes the troubling drive toward universal commodification.

Whether evaluated in conjunction with NFTs or some heretofore unknown technology, the complete exhaustion pushed by proponents of digital first sale proves unsuitable to achieve most of their salutary policy goals. But that is not to say that the law in this area should remain unchanged. A number of limitations on the exclusive rights of copyholders are in order in a digital-dominated world.

This part explores how law ought to respond to the rise of digital media, NFTs, and calls for a digital exhaustion principle. It begins by discussing various social costs imposed by treating digital goods as property, primarily through the lens of the nascent market for NFTs. It then addresses the implementation of an exhaustion principle that achieves important policy objectives but does not extend to broadly permit resale of digital media.

A. *Startup and Exit Costs*

It takes cryptocurrency to earn cryptocurrency. As discussed in Part II, blockchain design requires paying an array of fees to process a transaction, depending on the nature and contents of the transaction. To mint an NFT on the Ethereum blockchain, for instance, requires paying gas fees to execute the transaction with the smart contract that handles the minting, as well as gas fees for storing information about the NFT on the blockchain. If one wishes to mint their NFT through an NFT marketplace, they may face a different fee structure determined by that marketplace that incorporates the gas fees the marketplace incurs.

The actual dollar cost of minting an NFT varies considerably due to Ethereum's market-based approach to determining transaction costs. Ethereum's design sets a fixed amount of gas that must be purchased for each of the various methods of interacting with the block chain. The price of the gas, however, is split into two components. The "base fee" is programmatically determined based on comparing the size of the previous block in the chain to the target block size.[202] This fee is "burned," meaning it is paid to nobody.[203] The "priority fee" is an incentive payment to nodes to induce them to include a given transaction in a block; the operators of mining nodes are free to determine the minimum priority fee they will accept.[204] The precise fees necessary to conduct a transaction therefore fluctuate constantly. But they can be quite high—in excess of $1,000 in some cases.[205]

In an effort to entice people to list with them, some marketplaces advertise gas-free minting and listing.[206] These offerings leverage a so-called "lazy minting" approach. This method allows users to create NFTs and offer them

202. *See Gas and Fees*, ETHEREUM, https://ethereum.org/en/developers/docs/gas/ [https://perma.cc/6VVT-EHPK] (describing gas fee computation).

203. *Id.* In particular, the base fee is sent to an address that nobody can access.

204. *Id.*

205. *See* Aaron Mak, *How Much Money People Have Made—or Lost—Selling Farts, Blog Posts, and Cat Tweets as NFTs*, SLATE (Mar. 23, 2021), https://slate.com/technology/2021/03/nfts-fees-rarible-opensea-auction-profit.html [https://perma.cc/V548-ZYHL].

206. *See, e.g.*, *What Are Gas Fees on OpenSea?*, OPENSEA, https://support.opensea.io/hc/en-us/articles/1500006315941 [https://perma.cc/99PX-2CQT] (listing "Gas-Free Actions" including "[m]inting a new NFT," "[c]reating a collection," and "[l]isting an NFT" either at a fixed price or for auction).

for sale without paying any up-front gas fees.[207] Marketplaces accomplish this not by fronting the gas fees themselves but by *not actually minting the NFT* until it is sold.[208] Thus, no gas fees are incurred until the time of sale.

Of course, these transactions are not actually "gas-free." Rather, they shift the time for determination and payment of transaction costs, explicitly building them into the price of the purchase.[209] Nor do they remove all up-front costs. OpenSea, for example, charges a fee to "initialize" new user accounts.[210] That fee fluctuates with the price of gas as well, and has been reported to range from $70 to $300.[211] And gas fees can arise from a wide variety of other marketplace actions, such as canceling a listing or a bid, and transferring funds to and from other blockchains on which "gas-free" minting is available.[212]

The situation gets worse when one needs to cash out one's crypto holdings. Extreme volatility is a hallmark of cryptocurrency value. That volatility vitiates the contention that NFTs offer a vital path forward for artists, musicians, and others who seek to make a living through producing creative works. A crypto wallet full of Ether, in most circumstances, is not particularly helpful when one needs to buy groceries or pay rent, medical bills, emergency costs, and the like. To be useful in these situations, the Ether must be converted to fiat currency. Cryptocurrencies' massive volatility means that the need to cash out at a moment's notice could lead to substantial losses.

207. *See, e.g.*, Alex Atallah, *Create NFTs for Free on OpenSea*, OPENSEA BLOG (Dec. 29, 2020), https://opensea.io/blog/announcements/introducing-the-collection-manager/ [https://perma.cc/G54X-ES95]; Tom Farren, *Rarible Introduces Zero-Cost NFT Minting Feature*, COINTELEGRAPH (Oct. 18, 2021), https://cointelegraph.com/news/rarible-introduces-zero-cost-nft-minting-feature [https://perma.cc/KY84-SZH4].

208. Farren, *supra* note 207.

209. On OpenSea, for example, who pays the gas fee depends on the type of sale: buyers pay the gas fees for "fixed-price items," while sellers pay them when selling via auction. *See Who Pays the Gas Fees?*, OPENSEA, https://support.opensea.io/hc/en-us/articles/360061699514-Who-pays-the-gas-fees- [https://perma.cc/GE76-N2MW].

210. *See What Fees Do I Pay for My First Listing?*, OPENSEA, https://support.opensea.io/hc/en-us/articles/1500003246262 [https://perma.cc/4BG5-YHBN].

211. *See* Lee Stanton, *How To Sell NFTs On OpenSea*, ALPHR (Feb. 13, 2022), https://www.alphr.com/opensea-how-to-sell/ [https://perma.cc/2YF7-5F9L] (describing fees charged by OpenSea in connection with NFT minting and sale).

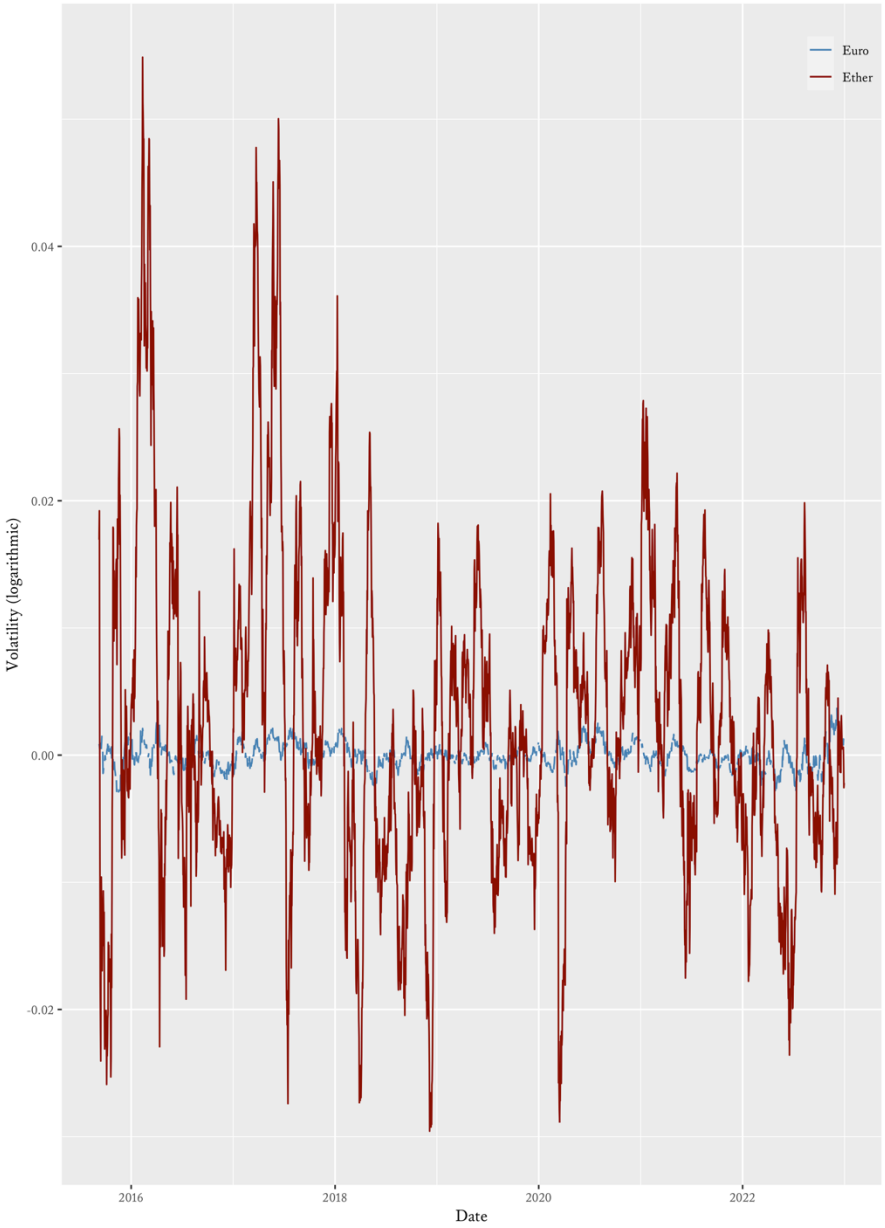
212. *See supra* note 206. This last gas fee provides another example of marketplace fee-hiding. OpenSea touts the Polygon blockchain as providing "gas free" purchase and sale of NFTs, but conducting transactions on Polygon requires users to transfer funds from the Ethereum blockchain to Polygon (thereby incurring gas fees), and incurring gas fees again when transferring funds back to Ethereum, in addition to engaging in a convoluted "two-stage process that takes up to 4 hours to complete." *See How Do I Withdraw Funds from Polygon?*, OPENSEA, https://support.opensea.io/hc/en-us/articles/4401888867091-How-do-I-withdraw-funds-from-Polygon- [https://perma.cc/2LWZ-GG7C]; *see also How Do I Purchase NFTs on Polygon?*, OPENSEA, https://support.opensea.io/hc/en-us/articles/1500012889322-How-do-I-purchase-NFTs-on-Polygon- [https://perma.cc/W9TL-ENFB].

To assess cryptocurrency volatility, I analyzed historical exchange-rate data for Ether to U.S. dollars ("USD") and Euros to USD.[213] The data covers the span from August 7, 2015 (the first date on which the available data shows a price for Ether in terms of USD), to December 31, 2022. The difference in volatility is staggering: over the full span, the volatility of Ether's value in terms of USD was nearly fourteen times that of the Euro's.[214] Anybody who might need ready access to fiat currency thus undertakes incredible risk by transacting in Ether.

213. I obtained Ether-USD price data from Etherscan's repository of statistics on Ethereum, and Euro-USD price data from the European Central Bank's Statistical Data Warehouse. *See Ether Daily Price (USD) Chart*, ETHERSCAN, https://etherscan.io/chart/etherprice [https://perma.cc/CBV2-HENW]; *Statistical Data Warehouse*, EUR. CENT. BANK, https://sdw.ecb.europa.eu/ [https://perma.cc/QX8Q-ETH6]. Etherscan provides a single daily value for Ether in terms of USD. The ECB provides both an average daily price, which I used for calculations based on the daily exchange rate, and end-of-period data, which I used for calculations based on the monthly exchange rate. *See Dataset: EXR - Exchange Rates*, EUR. CENT. BANK, https://sdw.ecb.europa.eu/datastructure.do?conceptMnemonic=EXR_SUFFIX&datasetinstanceid=120#cl [https://perma.cc/X4YL-2XY9].

214. To calculate exchange rate volatility, I follow the common approach of taking the standard deviation of the moving average of the first difference of the natural logarithm of the exchange rate. *See, e.g.*, Peter Clark, Natalia Tamirisa & Shang-Jin Wei with Azim Sadikov & Li Zeng, *A New Look at Exchange Rate Volatility and Trade Flows—Some New Evidence*, 2004 IMF POL'Y PAPERS 1, 9 (2004) (noting that "[t]he most widely used measure of exchange rate volatility is the standard deviation of the first difference of logarithms of the exchange rate"); Augustine C. Arize, Thomas Osang & Daniel J. Slottje, *Exchange-Rate Volatility and Foreign Trade: Evidence from Thirteen LDC's*, 18 J. BUS. & ECON. STATS. 9, 11 (2000) (using such a measure); *cf.* Dimitrios Serenis & Nicholas Tsounis, *A New Approach for Measuring Volatility of the Exchange Rate*, 1 PROCEDIA ECON. & FIN. 374, 376 (2012) (noting that "[m]ost empirical studies have utilized the standard deviation of the moving average of the logarithm of the exchange rate"). In particular, using a 30-day moving average, I find the standard deviation of the Ether–USD exchange rate data to be 0.0129, compared to a standard deviation of the Euro–USD exchange rate data of 0.000951.

Figure A. Comparison of Ether/USD and Euro/USD Exchange-Rate Volatility



Viewed in more practical terms, one's luck in timing the conversion of Ether to USD could prove enormous financial consequence. In the worst case, a person with exquisitely unfortunate timing stood to lose $3,816.56 for each

unit of Ether bought and sold solely due to fluctuations in the exchange rate. In comparison, the largest potential loss per unit converting from Euros to USD during the period analyzed was approximately twenty-nine cents.[215] For the unlucky Ether converter, that loss would constitute a seventy-nine percent drop in value, compared to twenty-three percent for the Euro converter.

Such volatility makes Ether an extremely risky store of value for anybody who might need to convert it into a more useful currency in short order. But it is of less concern to those who are in a position to hold Ether speculatively. For those with the means to gamble, unfathomable returns have been available—from an average price of a mere ninety-four cents in 2015 to a high opening price of $4,810.97 on November 8, 2021, an increase of 511,705%. For those who purchased Ether at 31 cents during its August 2014 "initial coin offering,"[216] selling at that record high would have netted a return of 1,551,826%.[217] But few possess the resources to buy and hold significant amounts of such a volatile asset. Artists, generally, are not among them.

B. *NFTs Repeat Historical Mistakes*

NFTs, we are told, enable far more than buying and selling unique digital art. In the latter half of 2021, for example, popular attention turned to the use of NFTs in games. *Axie Infinity* has attracted perhaps the most buzz. Fairfield lauds the potential of what he contends "is likely to be a fruitful play-to-earn space of gaming."[218] And according to Fairfield, "the success of [*Axie Infinity* and the unrelated CryptoKitties project] represents not only the excitement around NFTs but also the promise of future applications."[219] To the contrary, however, its rise traces a familiar, foreboding arc.

The elevator pitch for *Axie Infinity* is that "it's *Pokémon* on the blockchain."[220] Players field teams of "Axies" in turn-based battle against each

215. These amounts represent the largest potential drawdown in the dataset, i.e., the largest difference between any particular daily rate and any subsequent daily rate. For Ether, that loss could have been achieved by an individual purchasing Ether on November 8, 2021 (at $4,810.97 per Ether), and converting to USD on June 18, 2022 (at $994.41 per Ether). For Euros, the largest potential loss could have been achieved by purchasing on February 15, 2018 (at $1.25 per Euro), and converting to USD on September 28, 2022 (at $0.96 per Euro).

216. *See Ethereum*, COINDESK, https://www.coindesk.com/price/ethereum/ [https://perma.cc/7QQM-67BB] (reporting that, during Ethereum's initial coin offering in August 2014, "[s]ome 50 million ETHs were sold at a price of $0.31 per coin").

217. These figures omit transaction fees and taxes, and assume the ability to find sufficient willing buyers at the highest historical price.

218. Fairfield, *supra* note 2, at 1277.

219. *Id.* at 1275.

220. Casey Newton, *How* Axie Infinity *Is Turning Gaming on Its Head*, VERGE (Oct. 13, 2021), https://www.theverge.com/2021/10/13/22725083/axie-infinity-sky-mavis-blockchain-economy-game-pokemon [https://perma.cc/7QQM-67BB]; *see also* Fairfield, *supra* note 2, at 1276 (describing *Axie Infinity* as "an MMORPG version of *Pokémon*, except every monster is different").

other.[221] Each Axie is an NFT stored on the game's blockchain.[222] To build out their roster of Axies, players can breed their existing Axies to generate offspring.[223] But because each Axie is an NFT, players are also encouraged to buy and sell them on the blockchain. *Axie Infinity*, then, is more than just a game: it is an opportunity to earn money. Given the prominence of this feature on the game's official website, the money-making opportunity may in fact be the game's primary purpose. Upon visiting axieinfinity.com, one is greeted with three banners: "$3.6Bn Traded on our in-house marketplace"; "$820,000 The most expensive Axie ever sold"; and "2,800,000 Daily active players."[224] Games like *Axie Infinity* thus fulfill the aspirations of both NFT and digital first-sale proponents, such as Fairfield's notion that "[p]layers who are used to pouring thousands of dollars into their games will now be able to retain productive ownership over in-game items and see money return for their time put in."[225] More than that, according to some, these types of games present vital economic opportunities for people in the Global South. According to *Axie Infinity*'s developers, "25 percent of its players have never had a bank before, meaning their *Axie* wallets are the first financial services they've been able to access."[226] A partner at the venture-capital firm Andreesen Horowitz (which has, of course, invested in *Axie Infinity*), stated that "in some places in the Philippines, people are paying their rent with the game's SLP token."[227] According to one report, nearly fifty percent of *Axie Infinity*'s players hail from the Philippines and Venezuela, where COVID lockdowns "have forced many into irregular work."[228]

Alarm bells ought to be ringing, for several reasons. First, the opportunity for labor exploitation in this type of game could not be more apparent. Far from the cheerful tale of providing people's first access to financial services, the situation of the *Axie Infinity* worker evokes the company town and company scrip—payment arrangements designed to keep workers beholden to their

221. *See* Axie Infinity *Alpha Guide! Battles!*, LUNACIAN (Jan. 8, 2020), https://axie.substack.com/p/axie-infinity-community-alpha-guide [https://perma.cc/FL54-E5N5]. The game features additional modes, discussion of which is not pertinent.

222. *Id.*

223. *Id.*

224. A screen capture of this page as it existed on August 2, 2022, is on file with the *North Carolina Law Review*.

225. Fairfield, *supra* note 2, at 1277; *see also* PERZANOWSKI & SCHULTZ, *supra* note 6, at 191 (extolling the possibilities of a blockchain-based "marketplace for digital assets," such as "virtual objects consumers discover or craft, like the Jade Rabbit, a powerful weapon in the video game *Destiny*").

226. *See* Newton, *supra* note 220.

227. *Id.*

228. Vittoria Elliott, *Workers in the Global South Are Making a Living Playing the Blockchain Game* Axie Infinity, REST WORLD (Aug. 19, 2021), https://restofworld.org/2021/axie-infinity/ [https://perma.cc/4M6M-PGXZ].

employers.[229] Such practices have been illegal in the United States since 1938;[230] in this regard, blockchain-based "innovations" lack novelty even in their methods of exploitation.

Second, all of this has happened before, and in recent memory. Take, for example, gold farming in *World of Warcraft*. Broadly, gold farming is the practice of obtaining in-game currency and items and selling them on a (usually unauthorized) secondary market.[231] Tai and Hu observe that "gold farmers, . . . as a marginalized player group, have no legal recognition in Chinese society and must negotiate a living in a volatile game environment caught in between the fast-changing industry and an unpredictable transaction mechanism, coupled with ever-present government regulators."[232] The practice first came to widespread attention in connection with *World of Warcraft*—one of the most popular video games of all time, and one in which gold farming ran rampant.[233] The conditions in which gold farmers obtained gold and gear for their employers to sell were lacking, to say the least.[234] Indeed, in some cases prisoners were forced to engage in *World of Warcraft* gold farming.[235] Meanwhile, in *Axie Infinity*, player-workers "are often sponsored by managers or guilds, who fund their entry into the game—a high barrier, with current costs that can go upwards of $1,500—in exchange for a cut."[236] The early reporting on *Axie Infinity* suggests exactly these types of harms loom on the horizon.[237] That is cause for concern, not celebration.

229. *See, e.g.*, James Gray Pope, *Labor's Constitution of Freedom*, 106 YALE L.J. 941, 981 (1997) (discussing the exploitative role of company stores and company scrip in the U.S. mining industry).

230. *See, e.g.*, Fleming v. Pearson Hardwood Flooring Co., 39 F. Supp. 300, 303 (E.D. Tenn. 1941) (holding scrip payments in violation of the Fair Labor Standards Act of 1938).

231. *See, e.g.*, Zixue Tai & Fengbin Hu, *Smart Play: Social Stereotypes, Identity Building, and Counter Narratives of Gold Farmers in China*, *in* WOKE GAMING 83 (Kishonna L. Gray & David J. Leonard eds., 2018) (defining "gold farming as the practice of playing networked online games with the specific purpose of harvesting virtual loot, in-game currency, and other game assets that are then sold to other players or vendors for real money").

232. *Id.* at 82–83.

233. *See, e.g.*, Julian Dibbell, *The Life of the Chinese Gold Farmer*, N.Y. TIMES MAG., June 17, 2007, at 36.

234. *Id.* (reporting, among other things, on gold-farmers Li Qiwen, who "earn[ed] an effective wage of 30 cents an hour," and Min Qinghai, who, "in two years of 84-hour farming weeks, . . . has rarely stepped outside for longer than it takes to eat a meal").

235. *See, e.g.*, Danny Vincent, *China Used Prisoners in Lucrative Internet Gaming Work*, GUARDIAN (May 25, 2011), https://www.theguardian.com/world/2011/may/25/china-prisoners-internet-gaming-scam [https://perma.cc/XT4B-JEGR].

236. *See* Elliott, *supra* note 228.

237. That reporting also does not suggest the imminent arrival of the relatively professionalized and humane conditions of gold-farming studios in China today as described by Tai and Hu. *See* Tai & Hu, *supra* note 231, at 86–96 (reporting results of site visits and interviews conducted at studios throughout China). Rather, it is in line with the "disaggregated, anarchic, and individualized underground cottage craft" that characterized the "early years" of gold farming in China. *Id.* at 86.

Last, even assuming labor conditions improve over time, it bears emphasis that trading of the kind at the heart of *Axie Infinity* does not in any way require resort to the blockchain. There is no call for the technological complexity of the blockchain to enable what boils down to a simple online transaction. Nothing more than contracts—permissive license terms from the rightsholder and sellers' own terms of service—is required.

Examples abound. More than a decade ago, for instance, Valve Software introduced the ability for players of its popular game *Team Fortress 2* to trade cosmetic items.[238] Not long after, they introduced a "Community Market" system on their game store and distribution service, Steam, that allowed players to buy and sell those items, and eventually items from other games as well.[239] The Steam Community Market remains active today, without a blockchain in sight.[240] Making virtual items tradable was not an idea in search of an enabling technology, but a design choice to be made by developers. Some who created these types of systems came to regret it, as when Blizzard Entertainment decided to shut down the in-game, real-money auction house it had implemented in *Diablo 3* because it "undermines Diablo's core game play."[241] Others, as in the case of Perzanowski and Schultz's hope of using the blockchain to enable trading gear for use in the game *Destiny*, consciously and explicitly decided not to incorporate any such system.[242] *Axie Infinity*, with its explicit emphasis on the opportunity for financial gain, suggests that a market for in-game items makes sense primarily when the real game is profiting off of labor exploitation.

238. *See, e.g.*, Dan Pearson, Team Fortress 2 *Gets In-Game Store*, GAMESINDUSTRY.BIZ (Oct. 1, 2010), https://www.gamesindustry.biz/articles/2010-10-01-team-fortress-2-gets-an-in-game-store [https://perma.cc/R8GX-CY55].

239. *See* James Plafke, *Valve's Steam Community Market Could Change How We Pay for—and Play—Video Games*, EXTREMETECH (Dec. 14, 2012), https://www.extremetech.com/gaming/143314-valves-steam-community-market-could-change-how-we-pay-for-and-play-video-games [https://perma.cc/R8GX-CY55]. One notable difference between the Steam Community Market and the likes of *Axie Infinity* is that the proceeds of any sale on the former go to a Steam Wallet and may only be spent on games and items sold through Steam. *See id.*

240. *See Community Market*, STEAM, https://steamcommunity.com/market/ [https://perma.cc/GZU9-YJYA].

241. *See* Bo Moore, *Why* Diablo*'s Auction House Went Straight to Hell*, WIRED (Sept. 20, 2013), https://www.wired.com/2013/09/diablo-auction-house/ [https://perma.cc/3JLP-7DZ4] (quoting a "Blizzard production director" on the reason that Blizzard decided to remove the auction house).

242. *See Bungie Weekly Update*, BUNGIE (Aug. 22, 2014), https://www.bungie.net/en/News/Article/12054/7_bungie-weekly-update---08222014 [https://perma.cc/RF2X-WJYN] (confirming, two weeks before the release of *Destiny*, that players would not be able to trade items).

C. *Securitizing Creativity*

NFT proponents exhort artists to securitize their work,[243] and go so far as to contend that "NFTs could finally make copyright obsolete."[244] Frye hails NFTs as

> great for authors, because . . . they get paid upfront, whether or not the works they create turn out to be successful. . . . Realizing the value of a work in the copyright market typically requires a distributor, who claims a substantial share of the revenue. The NFT market enables authors to connect directly with their investors.[245]

His focus is the art market—a market in which Amy Adler has convincingly argued "copyright is nearly irrelevant."[246] Turning the focus to other creative industries shows that NFTs are more problem than solution.

As with visual art, several well-known musicians struck big with NFT releases, such as Grimes's six-million-dollar NFT collection[247] and Kings of Leon's NFT album release accumulating more than two million dollars in its first week of release.[248] Scores of artists have followed suit,[249] and extravagant claims about blockchain's importance to the music industry are not hard to find.

Many of those claims build on proposals to use tokens to, in effect, securitize music releases. One early, well-funded entrant in this space, Royal, pitches their service as one in which customers "can purchase . . . streaming royalties in the form of 'tokens,' directly from the artist."[250] Artists determine how many "limited digital assets"—blockchain-based tokens—to issue and what

243. *See, e.g.*, Frye, *supra* note 4, at 351 (stating that "NFTs seem to work because they enable authors to securitize their careers under the guise of selling their works" and that "[t]he NFT market is really a securities market with authors as the companies and works as particular categories of shares").

244. *Id.* at 342. As has been noted by Dotan Oliar et al., "Most agree that the fundamental goal of copyright law is to strike a balance between incentivizing authors to create, on the one hand, and disseminating creative works widely to the public, on the other." Dotan Oliar, Nathaniel Pattison & K. Ross Powell, *Copyright Registrations: Who, What, When, Where, and Why*, 92 TEX. L. REV. 2211, 2238 (2013). In service of that goal, copyright "provide[s] a market entitlement to creators that would allow them to exclude non-payers from accessing their works, and thus enhances financially motivated creators' ability to appropriate the returns." *Id.* at 2241.

245. Frye, *supra* note 4, at 351.

246. Amy Adler, *Artificial Authenticity: Art, NFTs, and the Death of Copyright*, 98 NYU L. REV. (forthcoming 2023) (manuscript at 8) (on file with the North Carolina Law Review).

247. *See* Marc Hogan, *11 Indie Musicians on How They're Navigating the NFT Wave*, PITCHFORK (May 10, 2021), https://pitchfork.com/features/article/11-indie-musicians-on-how-theyre-navigating-the-nft-wave/ [https://perma.cc/44JA-PWLH].

248. *See* Sam Moore, *Kings of Leon Have Generated $2 Million from NFT Sales of Their New Album*, NME (Mar. 12, 2021), https://www.nme.com/news/music/kings-of-leon-have-generated-2million-from-nft-sales-of-their-new-album-2899349 [https://perma.cc/Z5U8-SHAN].

249. *See, e.g.*, Hogan, *supra* note 247 (noting that, "judging by Pitchfork's news inbox, NFT drops might start outnumbering new album releases").

250. *See* ROYAL, https://royal.io [https://perma.cc/NVP8-MSV4].

percentage of their royalties will be paid to the holder of each LDA.[251] As one report put it, "The idea is to take the traditional record industry model, in which the label might keep 80 percent of all future royalties, and flip it to one where the artist keeps 80 percent."[252] Additional purported benefits of the Royal model include that it "promote[s] remix culture" by providing a potential remixer the opportunity to buy into the original, thereby incentivizing the original's creator to authorize the remix, and that "fans become marketers," because they take a financial stake in the success of a particular work.[253]

In short, as Frye argues is the path forward,[254] the Royal model converts songs to securities and invites the general public into the creative and business processes of the artist. No longer will it be exclusively the province of the record label to instruct an artist to make their work more audience friendly. Now the artist can hear that from fans themselves, whether it is Kings of Leon at the contractually mandated preshow hangout at any concert they ever again perform with buyers of their "golden ticket" NFTs,[255] or, in the more ordinary case, the drummer at the merchandise table just trying to sell t-shirts to cobble together enough money for gas to get to the next show. A detailed exploration of the potential impact on musicians is beyond the scope of this Article. However, it bears noting that musicians have begun to raise concerns about the type of relationship fostered by models like Royal's.[256]

In any event, as should be clear by this point, none of this depends in any way on the blockchain. One-sided royalty arrangements are creatures of contract and of the historically powerful position of major labels, achieved in an era of prohibitively high production, manufacturing, and distribution costs. Today's independent musician can market their music widely without any need

251. *See* Danny Nelson, *3LAU Raises $16M To Tokenize Music Royalties for Artists and Fans*, COINDESK (Aug. 26, 2021), https://www.coindesk.com/business/2021/08/26/3lau-raises-16m-to-tokenize-music-royalties-for-artists-and-fans/ [https://perma.cc/A4H2-L6MN].

252. *See* Casey Newton, *Is the Music Industry's Future on the Blockchain?*, VERGE (Nov. 24, 2021), https://www.theverge.com/22800746/music-industry-royalties-blockchain-crypto-royal-paradigm [https://perma.cc/H4AS-YQEJ].

253. *See id.*

254. *See* Frye, *supra* note 4, at 351.

255. *See* Samantha Hissong, *Kings of Leon Will Be the First Band To Release an Album as an NFT*, ROLLING STONE (Mar. 3, 2021), https://www.rollingstone.com/pro/news/kings-of-leon-when-you-see-yourself-album-nft-crypto-1135192/ [https://perma.cc/DR85-E3XF].

256. For example, the musician Nika Roza Danilova, who performs as Zola Jesus and sold a few NFTs early in 2021, stated that "when you own the rights, you are embedded in the success or failure of the music. . . . You have an invested interest in the music, not just emotionally or metaphorically. It's literally financial investment. And at that point, when finances are involved, there are expectations involved." *See* Matt Levin, *How NFTs Could Change the Music Industry . . . for Better or Worse*, MARKETPLACE (Nov. 2, 2021), https://www.marketplace.org/2021/11/02/how-nfts-could-change-music-industry-better-worse/ [https://perma.cc/VY9V-VEWV]. Danilova also noted that, in selling NFTs of her music, "[t]hey weren't being sold for the quality of the art or the intention of the art. . . . They were being sold as miniature banks or stocks." *Id.*

for a record label or a blockchain. They may, for instance, sign up for a free account on Bandcamp to sell their music; after Bandcamp's cut and payment processing fees, "82% on average" of the payment goes to the artist.[257] As to selling ownership shares in the work itself, that, too, is a creature of contract. Existing competitors of Royal do not rely on a blockchain approach.[258]

The best that can be said for NFTs in this context is that they might provide a mechanism apart from copyright that enables the type of securitization sought by Frye.[259] But if securitization is the goal, NFTs are a drastically inferior implementing mechanism compared to existing copyright and contract law. Investors who buy in via ordinary contracts cannot lose their stake because of a lost password. They do not face enormous exchange-rate risk. A hit is a hit; a smart contract is not a contract.

D. *A Limited Digital Exhaustion Principle*

It is difficult to overstate the promise of digital media. From anywhere with an internet connection, we have ready access to nearly the entire history of film, literature, and recorded music. We can purchase those works at prices well below what we might pay for physical copies, stream them for even less, and in many cases borrow them from a library at no cost. This is possible for the simple reason that perfect digital copies of works can be transferred almost instantaneously and at effectively no cost. Scarcity in media can be consigned to the past.

In focusing on creating a market for resale of digital goods, or on turning art into securities, proponents of both digital first sale and NFTs lose sight of these benefits. In the case of NFTs, the reason is clear: promoting NFTs as unique digital property, thereby introducing artificial scarcity, enables rent seeking (in the optimistic case) and fraud (in the usual case). They achieve the worst of both physical and digital media: buyers receive no tangible object; face serious limitations on when, where, and how they can engage with the media; and can easily lose access to what would otherwise be a fungible digital good.

The appropriate path for law to take with respect to NFTs is equally clear: it should do nothing beyond enforcement. There is no reason to rewrite copyright law to accommodate what amounts to a very complicated method of bookkeeping. Contract law is just as equipped to handle the sale of NFTs, with or without an interest in the underlying copyrights, as it is any other online transaction. Fraud is fraud. NFTs enable nothing new; they require no modification of law.

257. *See Bandcamp for Artists*, BANDCAMP, https://bandcamp.com/artists?from=hpartists [https://perma.cc/VY9V-VEWV].

258. *See* Levin, *supra* note 256 (discussing Royal competitor Vezt, which "doesn't operate on blockchain technology yet, but the company is experimenting with it").

259. *See supra* note 233 and accompanying text.

The exhaustion principle is another matter. As discussed throughout this Article, a digital first-sale right goes too far. But many of the goals sought by advocates for such a right are laudable, and to achieve them requires legal change.[260] Whether acquired via sale or license, the ability to choose when, where, and how to interact with digital media should be unaffected. But the right to do so is routinely impaired by license agreements and DRM.[261]

Changes to copyright law can help to achieve the goals of portability and interoperability. Currently, the Digital Millennium Copyright Act prohibits circumventing DRM, subject to exceptions established every few years via rulemaking by the Librarian of Congress.[262] While beneficial, this process is insufficient. Individuals should be free to remove technological restrictions on, for instance, their ability to read an e-book on the device of their choice, or to save backup copies to guard against the possibility that the seller ceases providing access to the e-book.[263] Those abilities should not be contingent on the risk of successfully asserting a fair use defense if the rightsholder decides to make an example of the reader.[264] An amendment to the DMCA expressly permitting individuals to remove DRM from content they have lawfully acquired would remove much of the uncertainty created by the current regime.

260. Such changes will need to come via legislation because they would require courts to stray too far from both precedent and the apparent judicial understanding of the purpose of the exhaustion principle. As Duffy and Hynes argue, courts do not appear to view the purpose of that principle as

> based on a federal policy to limit the economic power of IP rights," but rather as "merely a limit on statutory domain: Courts are not trying to forbid IP owners from achieving particular business goals; they are trying to impose some limits on the reach of IP statutes so as to prevent the displacement of other areas of law.

See Duffy & Hynes, *supra* note 83, at 54.

261. *See* PERZANOWSKI & SCHULTZ, *supra* note 6, at 6.

262. The DMCA contains multiple prohibitions involving circumventing DRM. Most broadly, it bars any person from circumventing DRM that controls access to a work. *See* 17 U.S.C. § 1201(a)(1)(A) (providing that "[n]o person shall circumvent a technological measure that effectively controls access to a work protected under this title"). It also separately prohibits creating and distributing tools intended to circumvent either access controls or copying controls. *See id.* §§ 1201(a)(2), (b)(1). By way of limitation on these prohibitions, the DMCA directs "the Librarian of Congress, upon the recommendation of the Register of Copyrights," to determine via rulemaking exceptions to that prohibition when "persons who are users of a copyrighted work are, or are likely to be in the succeeding 3-year period, adversely affected by the prohibition under subparagraph (A) in their ability to make noninfringing uses under this title of a particular class of copyrighted works." *Id.* § 1201(a)(1)(C).

263. In a too appropriate example, in 2009, Amazon remotely deleted e-book copies of Orwell's *1984* from customers' Kindle e-readers that had been "added to the Kindle store by a company that did not have rights to them." Brad Stone, *Amazon Erases Orwell Books from Kindle*, N.Y. TIMES (July 17, 2009), https://www.nytimes.com/2009/07/18/technology/companies/18amazon.html [https://perma.cc/6UH7-JUME (staff-uploaded, dark archive)].

264. Indeed, existing case law suggests that a fair use defense for such conduct, sometimes referred to as "space-shifting," would be unlikely to succeed. *See, e.g.*, Disney Enters., Inc. v. VidAngel, Inc., 869 F.3d 848, 862 (9th Cir. 2017) (noting that "[t]he reported decisions unanimously reject the view that space-shifting is fair use under § 107").

Individuals would no longer be locked into one firm's suite of content and devices. For example, an Amazon Kindle user with a large library of Kindle e-books (which are delivered in a format that can only be read on Kindle devices and apps) would be free to switch to another firm's e-book reader if they so desired. Indeed, competition law likely also has a role to play in returning control over reading, viewing, and listening habits.

To return briefly to the dispositive issue in *ReDigi*, the rise of digital media calls into question the Copyright Act's continuing distinction between the reproduction and distribution rights.[265] After all, with digital media, every distribution is necessarily a reproduction.[266] From a legal perspective, to fully enable the type of device-shifting and backup activities noted above requires jettisoning the reproduction right with respect to reproductions of digital media created for personal use. But as a practical matter, such a change is arguably unnecessary. Authorized or not, no rightsholder will be able to detect the proliferation of copies on an individual's personal computer or home network. Indeed, detection only becomes likely in the event that an individual's computer is subject to intrusive DRM of the type needed to enable digital first sale. In the absence of a legitimate market for resale of such copies, it seems unlikely there would be any significant impact on the primary market. The need for revision of the DMCA is more pressing, however, as it both casts doubt on the lawfulness of any particular attempt to remove DRM, and prohibits the dissemination of tools designed for removing DRM.[267] And some limitation of the reproduction right may yet be necessary to forestall attempts to hold providers of DRM removal technology from being deterred by the threat of lawsuits alleging contributory copyright infringement.[268]

A thorough discussion of the contours of such legal reforms is for another day. Here, I intend to offer a starting point: it is technologically irrelevant whether we own or license our digital media. By leaving behind the right to resell, it can become legally irrelevant as well.

265. *See generally* Christina Mulligan, *Copyright Without Copying*, 27 CORNELL J.L. & PUB. POL'Y 469 (2017) (arguing that the reproduction right is no longer necessary and should be eliminated).

266. *See, e.g.*, Capitol Recs., LLC v. ReDigi Inc., 910 F.3d 649, 657 (2d Cir. 2018) (holding that "the eventual receipt and storage of [a] file in ReDigi's server, as well as in the new purchaser's device . . . does involve the making of new phonorecords" and therefore constitutes a reproduction).

267. *See supra* note 262 and accompanying text.

268. *See, e.g.*, Metro-Goldwyn-Mayer Studios, Inc. v. Grokster, Ltd., 545 U.S. 913, 939 (2005) (finding, with respect to claim for contributory copyright infringement, that "evidence of unlawful objective is given added significance by [the] showing that" providers of file-sharing software did not "attempt[] to develop filtering tools or other mechanisms to diminish the infringing activity using their software").

CONCLUSION

Today, as ever, artists occupy a precarious place in the world. The advent of digital media has made it easier than ever to make one's work available to the public—and to a larger segment of the public than ever. But it has also made it more difficult to get anybody to pay for that work. The solution offered by proponents of digital first sale, as well as by those proselytizing NFTs, would have artists diversify by embracing the securitization of their work in a system that exposes them to massive financial risk, primarily for the benefit of players already in possession of unimaginable resources. Consumers, for their part, receive nothing they do not already have, unless they are willing to endure technological roadblocks to accessing media, the likes of which they have never seen. If that be the cure, it is worse than the disease.

Art, and artists, have always been undervalued, with a disproportionate share of the monetary rewards going to a small segment of the population. That is no less true under the now dominant streaming model than it was in the era of physical goods. But using law and technology to saddle digital media with the restrictions of their analog counterparts will not improve the situation. To treat digital goods like physical goods needlessly drags outmoded notions into the future, impeding the enormous benefits brought by the move to digital media. It is time to find another way.