ON THE SHOULDERS OF GIANTS OR THE ROAD LESS TRAVELED?: AN EXPERIMENTAL APPROACH TO SEQUENTIAL INNOVATION IN INTELLECTUAL PROPERTY

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ABSTRACT

All creativity and innovation build on existing ideas. Authors and inventors adapt, improve, interpret, and refine the ideas that have come before them. The central task of intellectual property (IP) law is regulating this sequential innovation to ensure that initial creators and subsequent creators receive the appropriate sets of incentives. Somewhat surprisingly, patent and copyright law provide different solutions to this task: While copyright law assigns property rights over original and subsequent creativity to the original author, patent law splits property rights over inventions and their improvement between the original and subsequent inventors. Although many scholars have applied the tools of economic analysis to consider whether IP law is successful in encouraging cumulative innovation, that work has rested on a set of untested assumptions about creators' behavior. This Article reports three novel creativity experiments that begin to test those assumptions. In particular, we study how creators decide whether to borrow from existing ideas or to innovate around them.

Our data suggest that creators do not consistently behave the way that economic analysis assumes. Instead of rationally weighing the objective costs and benefits of different courses of action, creators instead were influenced by decision-making biases and individual preferences that often led to suboptimal and inefficient creative behavior. Many of our subjects chose to borrow when innovating was the optimal strategy, and even more chose to innovate when borrowing was the optimal strategy. We propose that these results may arise from strong personality differences that lead some people towards pioneering innovation and others towards tweaking innovation. Ultimately, we explain the implications of our data for innovation markets, IP doctrine, and the theory of the firm.

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INTRODUCTION

Human life is full of change. And yet there is one commonplace that is as true now as it was in Biblical times: "there is nothing new under the sun."[2] However original a new idea may seem, inevitably it is derived from previously existing ones.[3] All new authors and inventors stand on the shoulders of those who came before them. Their ability to do so, however, is affected by the existence of intellectual property (IP) rights protecting existing ideas.

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[2] *Ecclesiastes* 1:9.

[3] Throughout this article we use the term "ideas" to refer to the products of creative endeavor. This includes copyrightable works of authorship and patentable inventions.

When an idea is protected by a copyright or patent, others who want to use it for further development, evolution, and refinement must license the rights from their owner. Licensing is costly, and subsequent creators have to make decisions about whether to license existing IP rights or whether to create something that does not impinge upon those rights – an endeavor that may itself be costly when existing IP forecloses certain creative opportunities. In this way, IP law not only affects the pace of sequential innovation, but also its direction. At least at the level of theory, IP law affects innovators' decisions regarding whether to build upon existing IP rights, or whether to work around those rights.

This aspect of IP law[4] is a vital component of the law's aim: to optimize creative production by balancing incentives to current creators with access to their ideas for subsequent downstream creators. If the rights given to initial creators are too weak, incentives to create new ideas will likewise be insufficient. But if the rights given to initial creators are too strong, later development will be hindered in excess of what is required to sufficiently optimize first-stage creativity.

A wealth of scholarly literature has employed the tools of law and economics to explore sequential innovation and the proper balance between the interests of initial and follow-on creators.[5] This work has generally assumed that creators, whether first-comers or followers, are rational people who act to maximize their individual welfare. As yet, however, almost no research focuses on how creators actually make decisions associated with sequential innovation.[6] This Article describes a series of experiments doing just that.

In particular, the experiments reported in this Article explore how creators decide whether to borrow from existing ideas or to innovate around them. IP rights associated with existing ideas never cover the entire relevant creative field. There are always opportunities for others to work around existing rights in non-infringing ways. Which strategy is optimal—borrowing or innovating—depends on a number of factors including the costs of licensing the rights and the ease of working around those rights.

We are interested in how creators actually make these decisions. Are they successful rational judges of the costs and benefits of different options?

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[4] In this Article we focus exclusively on copyright and patent law to the exclusion of trademark and trade secret law.

[5] *See infra* notes 43-66.

[6] Two examples of this research are Kevin J. Bourdreau & Karim Lakhani, *'Open' Disclosure of Innovations, Incentives and Follow-on Reuse: Theory on Processes of Cumulative Innovation and a Field Experiment in Computational Biology*, 44 RES. POL. 4 (2015); Julia Brueggemann et al., *Intellectual Property Rights Hinder Sequential Information: Experimental Evidence* (2015), available at http://ssrn.com/abstract=2545950.

Or are they prone to systematic biases that distort their decisions? The results of our experiments suggest that the latter is more likely the case. In particular, we find that people's innovation decisions are not strongly influenced by objective assessment of the costs and benefits of their choices. Instead, creators' internal beliefs and preferences about innovation contexts matter much more. Many creators choose to innovate even though they would be much better off borrowing, and many other creators choose to borrow when doing so is clearly suboptimal.

Understanding how people choose whether to innovate or to borrow from others' creativity is important; this is one of the principal decisions that IP law is intended to influence. Existing IP laws shape sequential innovation based on a broad expectation that creators will act, on balance and over time, rationally. To the extent that creators deviate from these expectations, IP law will be inefficient, and it will fail to meet whatever innovation goals we have set for it. Our experiments will help deepen the law's understanding of how creators select between innovation and borrowing in the process of sequential innovation. That guidance could help the law better distribute resources and encourage innovation.

Part I of this Article discusses the economic theory of sequential innovation, and its regulation by IP rules. The findings of three novel experiments are described in Part II. Then, Part III explores the implications of these findings for IP law and policy.

I. REGULATING SEQUENTIAL INNOVATION

From an economic perspective, the regulation of sequential innovation is the central feature of intellectual property systems. When an author or inventor creates something new, that act often opens up multiple avenues for further creative development. Books can be made into movies. Pharmaceuticals can be refined for greater efficacy or reduced side effects. This kind of evolution, development, refinement, and interpretation lies at the heart of creativity and innovation – very few creative works of any importance spring into being fully formed in the first act that leads to their creation.

IP law regulates sequential innovation in a number of ways. Copyright and patent laws affect who is permitted to engage in sequential innovation, how they are permitted to do so, and the speed with which sequential innovation takes place. In so doing, these laws attempt to optimize creative production by balancing incentives to initial creators with access to subsequent creators. How well our IP laws strike this balance, though, depends on whether creators respond to incentives in the ways that the law assumes they do.

A. Incentives and Access in Intellectual Property Law

In a world without IP rights, sequential innovation would be straightforward: if an inventor had an idea for a way to improve a smartphone, she would simply create the new version and sell it. Or if a filmmaker thought that a book would make a good movie, he could just adapt the book into a screenplay, and then hire a cast and crew and shoot the movie. IP law, however, sets up barriers to the reuse of pre-existing works by granting to initial creators certain rights in the "downstream" uses of their creations. The law establishes these rights to make sure that the initial creators bother to make their works in the first place.[7]

According to the standard account of IP rights, creators require incentives to produce and disseminate their creations.[8] The standard account views inventions and expressive works as costly to produce but relatively cheap to copy and disseminate.[9] In the absence of IP rights, others could simply copy new works and inventions and sell them at the marginal cost of reproduction.[10] Because the marginal cost of reproduction does not include the initial creator's costs of research and development, she would never make any money selling works at marginal cost and would never bother to create in the first place.[11] By prohibiting others from copying the creation, IP allows the creator a chance to recoup her investment by selling the work for above the marginal cost of reproduction.[12]

But copyright and patent laws do more than prevent others from identically copying protected creations; they also prevent others from producing some similar or new versions of the protected creations. So in the example above, the author of a novel receives a copyright that covers exact duplication of the novel as well as "substantially similar" variations and other "derivative works", including translations, sequels, and movie versions of the novel. By producing these other versions or by licensing the rights to others, the novelist can make more money, and, thus, she receives a greater incentive to invest in creating the novel in the first place.[13]

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[7] *See* Mark A. Lemley, *The Economics of Improvement in Intellectual Property Law*, 75 TEX. L. REV. 989, 994 (1997) (hereinafter Lemley, *Economics of Improvement*).

[8] *See* WILLIAM M. LANDES & RICHARD A. POSNER, THE ECONOMIC STRUCTURE OF INTELLECTUAL PROPERTY LAW (2003).

[9] Mark A. Lemley, *Ex Ante versus Ex Post Justifications for Intellectual Property*, 71 U. CHI. L. REV. 129, 129 (2004) (hereinafter Lemley, *Ex Ante*).

[10] *Id*.

[11] See Christopher Buccafusco & Jonathan S. Masur, *Innovation and Incarceration: An Economic Analysis of Criminal Intellectual Property Law*, 87 S. CAL. L. REV. 275, 281 (2014).

[12] *Id*.

[13] According to Suzanne Scotchmer, initial creators need to be able to capture some of the value of sequential innovations because much of the value of the initial innovation may come from positive externalities associated with downstream products. That is, the social benefit conferred by the idea may be that it makes the creation of other ideas cheaper. If the initial

While some amount of IP protection is deemed essential for creative incentives, too much protection can harm creativity. IP rights create a number of significant social costs, both static and dynamic.[14] First, because owners can charge prices above the marginal cost of reproduction, some consumers who would have purchased the goods that embody the inventions and expressions at the competitive price will not be able to purchase at the supra-competitive price that will be charged when a copyright or patent creates market power.[15] Economists refer to this as deadweight loss.[16] Second, and more importantly for this Article, IP rights raise the cost of sequential innovation and risk creating dynamic inefficiencies.[17] Because copyrights and patents grant some level of control to initial creators over downstream uses of their creations, subsequent creators will have to negotiate with them in order to produce and market their new creations.[18] If Betty wants to make and sell her improved version of Alice's patented invention, Betty and Alice will have to spend time and money negotiating a licensing fee. Depending on how costly these negotiations are they will, at best, increase the price of the improved goods.[19] At worst, they will swamp the benefits that Betty could have realized from the improvement so that she cannot afford to make her improvement at all.[20]

Copyright and patent laws must strike a balance between the incentives given to initial creators and the opportunities for sequential innovation reserved for downstream creators. If the former are too low, the

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creator cannot capture some of this surplus, she may have insufficient incentives to invest in creating the idea in the first place. Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research and Patent Law*, 5 J. ECON. PERSPECTIVES 29, 31 (1991).

[14] *See* Lemley, *Economics of Improvement*, *supra* note 7, at 996 ("Granting authors and inventors the right to exclude others from using their ideas necessarily limits the diffusion of those ideas, and so prevents people from benefiting from them.").

[15] *Id*.

[16] *See* Glynn S. Lunney, Jr., *Reexamining Copyright's Incentives-Access Paradigm*, 49 VAND. L. REV.483, 497-98 (1996).

[17] Dan L. Burk, *Law and Economics of Intellectual Property: In Search of First Principles*, 8 ANN. REV. L. & SOC. SCI. 397, 402 (2012).

[18] Lemley, *Economics of Improvement*, *supra* note 7, at 998.

[19] *Id*. ("the existence of preexisting intellectual property rights imposes a positive cost on improvers that they would not otherwise face.").

[20] *See* Scotchmer, *supra* note 13, at 32 ("If the second innovator does not get all the surplus being bargained over, he will earn only a fraction of the new product's market value and presumably only a fraction of its social value, and this fraction may be less than the cost of developing it. Hence the incentive for an outside firm to develop second generation products can be too weak."). *See also* Stewart E. Sterk, *Rhetoric and Reality in Copyright Law*, 94 MICH. L. REV. 1197, 1207 (1996) ("At some point, giving authors additional copyright protection will reduce the supply of new works because the number of marginal authors deterred from creating by the high cost of source material will exceed the number encouraged to create by the increased value of a work associated with a marginal increase in copyright protection.").

orthodox model holds that nothing gets produced in the first place, but if they are too high, there will be insufficient development and evolution. The next section discusses the various doctrines that IP law uses to strike this balance.

B. Regulating Sequential Innovation

Legal doctrines about the length and breadth of copyrights and patents as well as laws about derivative works, the doctrine of equivalents, and fair use all regulate the process of innovation. The goal of these and other doctrines—and of IP systems as a whole—is to strike a balance between the incentives provided to initial creators and the opportunities left over for subsequent creators. In this sense, regulating sequential innovation is the principal problem of IP law.

For a simple example of how this balancing works, consider the length of time that an IP right lasts. The longer the right lasts, the more money the initial inventor can hope to make from her invention and, thus, the more incentive she has to invest in it in the first place.[21] From that point of view, it would seem like IP rights should last forever.[22] But from the perspective of long term growth and innovation, longer IP rights might create problems. The existence of the IP right increases the costs to competitors who want to make their own newer and better versions of the product. So the longer the right, the harder it is for newcomers to compete and innovate. IP law must set the duration of rights at a length that provides sufficient encouragement for initial creators without unduly burdening follow-on creators.[23]

Copyright law and patent law differ greatly in the ways that they approach problems of sequential innovation, and these differences affect how easy it is for others to reuse existing ideas. In some ways, copyright law is more protective of sequential innovations than is patent law. For example, copyright law does not impose liability on defendants who have

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[21] Of course, discounting for the present utility, the value of a dollar made on a work a century from now is not likely to provide much additional incentive for a creator today. *See* Stan J. Liebowitz & Stephen E. Margolis, *Seventeen Famous Economists Weigh in on Copyright: The Role of Theory, Empirics, and Network Effects*, 18 HARV. J. L. & TECH. 435 (2005); *see also* Shyamkrishnah Balganesh, *Foreseeability and Copyright Incentives*, 122 HARV. L. REV. 1569 (2009).

[22] The musician Sonny Bono thought so. *See* Arlen W. Langvardt, *The Beat Should Not Go On: Resisting Early Calls for Further Extensions of Copyright Duration*, 112 PENN ST. L. REV. 783, 791 n. 63 (2008) ("Sonny Bono had initially favored making copyright duration perpetual before learning that a move by Congress to grant perpetual copyright protection would run afoul of the "limited times" language in the Copyright Clause.").

[23] However, William Landes and Richard Posner have argued for copyright protection that could be renewed indefinitely, in order to address congestion externalities and address inncentives to invest in maintaining and exploiting copyrighted works, see William M. Landes & Richard A. Posner, *Indefinitely Renewable Copyright*, 70 U. CHIC. L. REV. 471 (2003).

independently created the same work without copying the plaintiff's work, while patent law imposes liability on all defendants who violate a right whether they copied from the plaintiff's invention or not.[24] Accordingly, if a new creator happens to hit independently upon a great idea that is covered by an existing copyright, she is free to use it.[25] Copyright law is also limited by its central doctrine distinguishing between original creative expression, which can be copyrighted, and unprotectable ideas.[26] This means that some kinds of creativity are simply ineligible for copyright protection because it is so essential to later creators.[27] Finally, copyright does allow some "fair uses" to be made of copyrighted works, which preserves some (uncertain and context-specific) innovation space for follow-on creativity.[28] No similar limitations to the rights of the original inventor exist in patent law.[29]

In other ways, however, copyright law grants a smaller share of the value from potential sequential innovation to the downstream creator than does patent law.[30] First, patent law provides relatively short terms (20 years from the filing date),[31] while copyright law provides incredibly long terms (often for the life of the author plus an additional 70 years).[32] This means that sequential innovators will be able to build on patented inventions much more rapidly than on copyrighted works.

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[24] *See* Clarissa Long, *Information Costs in Patent and Copyright*, 90 VA. L. REV. 465, 525-33 (2004).

[25] *See* Sheldon v. MGM Pictures, Corp., 81 F.2d 49, 54 (1936) ("if by some magic a man who had never known it were to compose anew Keats's Ode on a Grecian Urn, he would be an 'author,' and, if he copyrighted it, others might not copy that poem, though they might of course copy Keats's.").

[26] *See* 17 U.S.C. § 102(b) ("In no case does copyright protection for an original work of authorship extend to any idea, procedure, process, system, method of operation, concept, principle, or discovery, regardless of the form in which it is described, explained, illustrated, or embodied in such work.").

[27] Patent employs its own limitations designed to screen out essential building blocks of invention, such as the proscription against patenting laws of nature and products of nature. *See* Mayo Collaborative Svcs. v. Prometheus Laboratories, Inc., 132 S. Ct. 1289 (2012) (ruling on the patentability of laws of nature); Assoc. for Molecular Pathology v. Myriad Genetics, Inc., No. 12-398, 569 U.S. (2013) (on the patentability of products of nature).

[28] *See* 17 U.S.C. § 107. The existence of the fair use doctrine considerably broadens the scope for some kinds of follow-on creativity, especially when it engages in criticism, parody, or transformation of the existing work.

[29] *See* Julie E. Cohen & Mark A. Lemley, *Patent Scope and Innovation in the Software Industry*, 89 CAL. L. REV. 1, 6 (2001) (advocating for fair use-like rights for reverse engineering in patent law).

[30] In this Article, we focus on U.S. IP law and do not consider diverging allocations of IP rights on sequential innovation in foreign IP regimes.

[31] 35 U.S.C. § 154(a)(2).

[32] 17 U.S.C. § 302(a). This is the case for normal human authors. In the case of an anonymous work, a pseudonymous work, or a work made for hire, the copyright endures for a term of 95 years from the year of its first publication, or a term of 120 years from the year of its creation, whichever expires first. 17 U.S.C. § 302(c).

More importantly, though, the scope of the rights with respect to sequential innovation differ between copyright and patent law. An author of a copyrighted work obtains the exclusive right not just to make and distribute literal copies of the work but also to a wide range of other similar works. Thus, nonliteral but still "substantially similar" copies violate the owner's rights.[33] Even more broadly, the copyright owner obtains the exclusive rights to all actual or potential "derivative works" that arise from the copyrighted work, including all sequels, translations, recreations, and most other changes.[34] If someone writes a sequel to the *Rocky* movies, for example, she cannot obtain any rights in her sequel and is subject to a copyright lawsuit from Sylvester Stallone.[35] Accordingly, the would-be improver is effectively prevented from engaging in creating a new work until she has obtained the original copyright owner's permission.

By contrast, when it comes to the scope of rights and the ownership of follow-on innovation, patent law is much more liberal to sequential creators. First, patent law's counterpart to the derivative works right, the doctrine of equivalents, protects a narrower range of non-identical creations. Just as the scope of a copyright includes all works that are "substantially similar" to it, the scope of a patent extends to other inventions that are "insubstantially different" from it.[36] Despite the linguistic similarity of these standards,[37] patent's doctrine of equivalents gives patent owners a much narrower degree of control over variations on their work relative to copyright's rules regarding derivative works. Indeed, in recent years patent law's doctrine of equivalents has been narrowed substantially.[38] Moreover, when the downstream innovator's invention marks a sufficiently great

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[33] Nichols v. Universal Pictures Corp., 45 F.2d 119, 121 (2d Cir. 1930) (copyright law may not allow "plagiarist[s] [to] escape by immaterial variations"). The substantial similarity doctrine can extend protection to the work's plot, structure, characters, and "total concept and feel." Roth Greeting Cards v. United Card Co., 429 F.2d 1106, 1110 (9th Cir. 1970). *See* Lemley, *Economics of Improvement*, *supra* note 7, at 1016.

[34] 17 U.S.C. § 106.

[35] *See* Stallone v. Anderson, 1989 WL 206431 (C.D. Cal. 1989) (dismissing lawsuit of author who wrote an authorized script for a new Rocky movie against Stallone for using aspects of the script in his own sequel).

[36] Hilton Davis Chem. Co. v. Warner Jenkinson Co., Inc., 62 F.3d 1512, 1521-22 (Fed. Cir. 1995).

[37] *See* Martin J. Adelman & Gary L. Francione, *The Doctrine of Equivalents in Patent Law: Questions that Pennwalt Did Not Answer*, 137 U. PA. L. REV. 673 703-06 (1989) (discussing the differences between copyright's substantial similarity doctrine and patent's doctrine of equivalents).

[38] *See* John R. Allison & Mark A. Lemley, *The (Unnoticed) Demise of the Doctrine of Equivalents*, 59 STAN. L. REV. 955 (2007) (introduction of *Markman* claim construction hearings associated with substantial decline in application of doctrine of equivalents).

improvement over the original patent, although still technically infringing it, the "reverse doctrine of equivalents" kicks in to vitiate liability.[39]

Most importantly, patent law allows follow-on creators to obtain IP rights in new improvements that use and borrow from, and thus infringe, protected inventions.[40] For example, if an inventor thinks of a way to improve the fuel economy of an existing, patent-protected engine, he can obtain a separate patent on the improvement. The improver cannot make the improvement without infringing or licensing the original patent. And while the original inventor can keep making the original engine, he cannot incorporate the improvement without licensing it from the second inventor. The existence of these "blocking patents" means that both the initial inventor and the follow-on inventor must negotiate to produce the improved product.[41] This system of blocking patents gives both parties incentive to successfully complete negotiations if there is money to be made from the improved product.

For these reasons, and especially the last one, patent law is generally (but not inevitably) more supportive of follow-on innovators than copyright law is.[42] Would-be secondary inventors tend to face fewer challenges to sequential innovation than do would-be secondary authors. Why are the rules for improvements different in patent versus copyright? And do these doctrines efficiently balance rights between the two groups of creators?

C. The Economics of Sequential Innovation

The economic rationales for these doctrines have been richly studied. These rationales include the benefits of having a single party direct

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[39] According to the Supreme Court:

The patentee may bring the defendant within the letter of his claims, but if the latter has so far changed the principle of the device that the claims of the patent, literally construed, have ceased to represent his actual invention, he is as little subject to be adjudged an infringer as one who has violated the letter of a statute has to be convicted, when he has done nothing in conflict with its spirit and intent.

Westinghouse v. Boyden Power Brake Co., 170 U.S. 537, 568 (1898).

[40] Lemley, *Economics of Improvement*, *supra* note 7, at 1008-09.

[41] *See* Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839, 860 (1990) at 860 ("Two patents are said to block each other when one patentee has a broad patent on an invention and another has a narrower patent on some improved feature of that invention.").

[42] Lemley, *Economics of Improvement*, *supra* note 7, at 1129. He writes:

Comparing the treatment of improvers under patent and copyright law leads to a rather surprising result: copyright law is significantly more hostile to improvements than is patent law. What is surprising is not so much that the rules differ, but the way in which they differ. Copyright is traditionally thought to afford weaker, not stronger, protection than patent law, in part to compensate for the fact that copyrights are so much easier to obtain than patents and last so much longer. But in the context of improvements, the opposite result obtains. *Id.*

investment in a resource, the likelihood that the initial creator or a secondary creator will produce valuable improvements, and the possibility of reducing duplicative and wasteful research. Numerous authors have assessed the different incentive effects of the patent and copyright systems' approaches to sequential innovation, often coming to different conclusions.[43]

Edmund Kitch first addressed the economics of sequential innovation in 1977.[44] Kitch analogized inventions (his sole focus) to mining prospects,[45] and, accordingly, he emphasized the public goods nature of technological information. In the absence of patent rights, the knowledge embodied in an invention could be easily shared with others without the inventor's consent. In Kitch's view, this would lead, inevitably, to an inefficient use of the invention in the same way that commonly owned property, like a mine, pasture, or lake, would be inefficiently used. Acting selfishly, others would try to use the invention quickly and for personal profit without thought to its long-term value and sustainability.[46] IP rights solve this "tragedy of the commons," according to Kitch, by naming a manager of the invention and protecting his ability to efficiently use the invention.[47] Now, instead of allowing wasteful competing uses of an invention (such as when two competing firms attempt to develop improvements of the invention), the owner of the patent can direct and coordinate investments in sequential innovation in ways that will maximize the invention's value.[48]

As Mark Lemley points out,[49] although Kitch's analysis focused on patents its structure is most similar to current copyright doctrine.[50] Consider its application to the author of a children's story. In the absence of copyright protection for derivative works, once the story is published and deemed successful, others will quickly race to capitalize on its value. Various authors

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[43] *See* Merges & Nelson, *supra* note 41; Lemley, *Economics of Improvement*, supra note 7; Deepa Varadarajan, *Improvement Doctrines*, 21 GEO. MASON L. REV. 657 (2014); LANDES &. POSNER, supra note 8, at 108-115, 316-320 (2003); Scotchmer, *supra* note 13; *see also* Pamela Samuelson, *The Quest for a Sound Conception of Copyright's Derivative Work Right*, 101 GEO. L.J. 1505 (2013).

[44] Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265 (1977).

[45] *Id*. at 266.

[46] *Id*. at 274.

[47] *Id.* at 276 ("No one is likely to make significant investments searching for ways to increase the commercial value of a patent unless he has made previous arrangements with the owner of the patent. This puts the patent owner in a position to coordinate the search for technological and market enhancement of the patent's value so that duplicative investments are not made and so that information is exchanged among the searchers.").

[48] *Id.* ("the patent owner has an incentive to make investments to maximize the value of the patent without fear that the fruits of the investment will produce unpatentable information appropriable by competitors.")

[49] Lemley, *Economics of Improvement*, *supra* note 7, at 1014.

[50] *See supra* note 33.

might begin publishing sequels of the story, while other companies compete to get a movie version into theatres the quickest. Still others may make toys and clothing using the story's characters. All of this investment in design, development, and marketing is potentially wasteful. The world may not need any movie versions of the story, never mind three of them. Moreover, a rational movie studio knowing the kind of competition it will likely face from others may simply abandon the project altogether. According to Kitch, by giving a single entity ownership over the whole field of derivative works, IP law prevents both the wastefulness and the lack of incentives. Coordinated investment in ideas is better than rivalrous investment.[51]

Robert Merges and Richard Nelson were among the first to critique Kitch's theory of sequential innovation.[52] Where Kitch saw competitive investment in potential improvements as wasteful, Merges and Nelson viewed it as a spur to creativity. They worried that granting a large IP prospect right to a creator might lead to inactivity and underinvestment as the original creator rested on its laurels.[53] In addition, Merges and Nelson were skeptical that a single owner of a broad right would efficiently manage the various and unpredictable improvements that the idea might spawn.[54] Although the firm that invents a technology had one good idea, there is little reason to think that it will have the second, third, or fourth good ideas. Merges and Nelson thus favor a distributed approach to innovation that allows for many minds to tackle the possibilities created by a new idea.[55] While Kitch's prospecting inventor could certainly license all of these opportunities to others, in Merges and Nelson's account, the transaction costs of doing so would likely swamp the expected gains.[56]

Mark Lemley has also engaged in systematic analysis of IP improvement doctrines, and he too rejects the strong property rights approach favored by Kitch.[57] Lemley shares the concern that initial creators are not necessarily going to be the ones with the best ideas for improvement,[58] and

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[51] *See* Merges & Nelson, *supra* note 41, at 872.

[52] *Id*.

[53] *Id*. They explain, "For one thing, under rivalrous competition in invention and innovation there is a stick as well as a carrot. Block rivalry and one blocks or greatly diminishes the threatened costs of inaction. Kitch assumes a model of individual or firm behavior where if an action is profitable it will be taken, regardless of whether inaction would still allow the firm to meet its desired (but suboptimal) performance goals." *Id*.

[54] *Id*. at 873.

[55] *Id*. Because no one knows for sure what is likely to work, they argue, "the only way to find out what works and what does not is to let a variety of minds try." *Id*.

[56] Merges and Nelson support this contention by claiming that there is little evidence of this kinds of large scale licensing of IP rights to others. *Id*. at 874-75. For recent empirical evidence, see Robin Feldman & Mark A. Lemley, *Does Patent Licensing Mean Innovation*? (2015), available at http://ssrn.com/abstract=2565292.

[57] Lemley, *Economics of Improvement*, *supra* note 7.

[58] *Id*. at 1048.

he points out that it will be difficult for the optimal improvers to make themselves known to the owner of a broad IP right due to information disclosure problems.[59] Lemley adds to the list of objections to Kitch's scheme concerns about transaction costs,[60] uncertainty,[61] externalities,[62] strategic behavior,[63] and noneconomic incentives.[64] Ultimately, he proposes that copyright law should adopt a system that incorporates some aspects of blocking patents by altering its derivative works and fair use doctrines.[65]

These economic analyses of sequential innovation attempt to answer questions about the appropriate scope of IP rights and whether copyright and patent laws should operate under different principles. Underlying all of them are a series of, sometimes explicit but often implicit, assumptions. These include some normative assumptions about the goals of IP doctrine.[66] And they also include descriptive assumptions about the behaviors of creators. The next section addresses these.

D. A Behavioral Approach to Sequential Innovation

Although the topic of sequential innovation has received sustained attention from theoretically oriented law and economics scholarship, the behavioral factors that might affect how innovators respond to the ways that legal regimes structure incentives have hardly been studied. The economic approaches that exist in the literature have generally assumed that innovators

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[59] This is the problem known as Arrow's Information Paradox. See Kenneth J. Arrow, *Economic Welfare and the Allocation of Resources for Invention*, *in* THE RATE AND DIRECTION OF INVENTIVE ACTIVITY: ECONOMIC AND SOCIAL FACTORS 609, 614-16 (Richard Nelson ed., 1962). If a would-be improver cannot obtain property rights in the possible improvement, he cannot communicate to the patent owner without immediately rendering it valueless. If it is a good idea, the patent owner can simply usurp it for himself. Lemley, *Economics of Improvement*, *supra* note 7, at 1051.

[60] *Id*. at 1054-55. He writes:

> The presence of these costs in intellectual property licensing transactions leads to two types of first-order deviations from the efficient behavior predicted by economic models that do not account for transaction costs. First, some original inventors will inefficiently choose not to license potential improvers for their technology. This may happen either because the perceived value of the improvements is sufficiently small that it is overwhelmed by the transaction costs of licensing, or because the marginal value of having a third party (rather than the original inventor) develop the improvements does not outweigh the transaction costs of licensing. Second, some potential improvers who would seek a license for their improvements will no longer do so because of transaction costs.

Id.

[61] *Id*. at 1055-56.

[62] *Id*. at 1056-58.

[63] *Id*. at 1058-59.

[64] *Id*. at 1059-60.

[65] *Id*. at 1073.

[66] For example, is the goal faster progress towards a single optimal solution or slower development towards multiple optima? We discuss this issue *infra* note 158.

are rational actors who more or less accurately weigh the costs and benefits of behavior and respond predictably to the options provided.[67] Recent empirical research in the social sciences,[68] and even specific work in IP scholarship,[69] has questioned this assumption.

This Article begins to apply the insights of this behavioral literature to some questions of sequential innovation. We begin with one of the principal decisions at the heart of sequential innovation: whether the follow-on creator should borrow from the existing creations or strike out on her own and create something new. Of course, to a greater or lesser extent, all new creations borrow from already-existing works.[70] When the existing works are protected by IP rights, however, the secondary creator must decide whether to borrow from (and thus, usually, license) the existing works or whether to avoid the scope of the IP rights by creating something sufficiently different from the existing works. The specific question we are interested in, then, is how creators decide whether to license rights to existing IP or to "invent around" that IP by creating something that does not infringe the patent or copyright. For the remainder of this paper, we will refer to licensing IP as "borrowing" and inventing around IP as "innovating."[71]

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[67] *See e.g.* Lemley, *Economics of Improvement*, *supra* note 7, at 1022 ("In a private market economy, individuals will not invest in invention or creation unless the expected return from doing so exceeds the cost of doing so—that is, unless they can reasonably expect to make a profit from the endeavor.").

[68] See Russell B. Korobkin & Thomas S. Ulen, *Law and Behavioral Science: Removing the Rationality Assumption from Law and Economics*, 88 CAL. L. REV. 1051 (2000); Russell B. Korobkin, *The Endowment Effect and Legal Analysis*, 97 NW. L. REV. 1227, 1229 (2003) (hereinafter *Endowment Effect*); Samuel Issacharoff, *Can There Be a Behavioral Law and Economics*?, 51 VAND. L. REV. 1729, 1735 (1998); *See* Richard Thaler, *Toward a Positive Theory of Consumer Choice*, 1 J. ECON. BEHAV. & ORG. 39 (1980) (showing that people respond differently to a situation referred to as a "cash discount" than to an identical one labeled a "credit card surcharge"); Amos Tversky & Daniel Kahneman, The Framing of Decisions and the Psychology of Choice, 211 Sci. 453 (1981) (showing that people's preferences for an identical situation change depending on whether people imagine saving lives or allowing people to die); Christine Jolls, Cass R. Sunstein & Richard Thaler, *A Behavioral Approach to Law and Economics*, 50 STAN. L. REV. 1471 (1998).

[69] *See* Christopher Buccafusco & Christopher Jon Sprigman, *The Creativity Effect*, 78 U. CHI. L. REV. 31, 36–39 (2011); Christopher Buccafusco & Christopher Jon Sprigman, *Valuing Intellectual Property: An Experiment*, 96 CORNELL L. REV. 1, 23–25 (2010); Christopher Jon Sprigman, Christopher Buccafusco & Zachary Burns, *What's a Name Worth?: Experimental Tests of the Value of Attribution in Intellectual Property*, 93 B.U. L. REV. 1389, 1405–20 (2013).

[70] JULIE E. COHEN, CONFIGURING THE NETWORKED SELF: LAW, CODE, AND THE PLAY OF EVERYDAY PRACTICE 87 (2012) ("the well-known history of both classical and contemporary art forms illustrates the centrality of copying within creative practice.").

[71] In some respects, this borrow/innovate decision bears strong parallels with the make/buy decision that animates theory of the firm analysis. *See* Ronald Coase, *The Nature of the Firm*, 4 ECONOMICA 386 (1937). We are currently drafting an article that spells out these insights in more detail.

Borrowing and innovating are both important aspects of creativity. Although narratives of creativity stress "eureka" moments and pioneering achievements that seem wholly original, these stories do not accurately capture the creative process.[72] But more than just being descriptively inaccurate, this strict preference for novelty and innovation is also normatively unjustified. Extreme innovations are not always publicly valued.[73] And more important, in many situations innovation is socially costly. Although creating around existing ideas may produce new ones, they may not be better ones.[74] And the costs, in terms of time, research, and experimentation that are necessary to produce innovations may vastly exceed the price of a license to borrow from existing ideas. In these cases, borrowing is the optimal strategy. Sometimes it is better to take the road less traveled and other times it is better to stand on the shoulders of giants.[75] Therefore, it is important to know whether creators are choosing accurately between innovation and borrowing in different creative contexts – and whether the law is affecting that choice for better, for worse, or at all.

According to rational choice theory, a would-be creator, faced with this borrow/innovate decision, should compare the costs and benefits of borrowing with the costs and benefits of innovating. Borrowing entails a variety of costs including, primarily, licensing fees and transaction costs. Innovating, on the other hand, may involve substantial investments in research and experimentation that borrowing does not. Secondary creators must make tradeoffs between the respective costs of licensing fees versus R&D. Thus, if the costs of borrowing increase, all else equal, creators should be more likely to innovate.

In addition, because innovation always involves uncertainty, would-be innovators must consider the extent to which innovation may even be possible.[76] Sometimes developing a new idea that does not infringe the rights of existing ideas will be easy, but other times it will be incredibly difficult.

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[72] *See* JESSICA SILBEY, THE EUREKA MYTH: CREATORS, INNOVATORS AND EVERYDAY INTELLECTUAL PROPERTY (2015) (describing the responses of interviews with dozens of creators about the processes and motivators of creativity).

[73] *See* Jeanne C. Fromer, *A Psychology of Intellectual Property*, 104 NW. L. REV. 1441, 1479 (2010) ("In the arts, while the newness component of creativity is valued in our individualist culture, for typical audience members and in most artistic contexts—as explained herein—it is important that artists not stray too far from accepted conventions, a concern that is not present in scientific and engineering invention.").

[74] It is for this reason that we prefer to focus on "creating around" rather than on "improvements," as some scholars do.

[75] To seriously mix metaphors.

[76] Merges and Nelson explain, "In [Kitch's] models the 'fish' or the 'minerals' are out there and known (with perhaps some uncertainty) to all parties. But with the technological "prospects," and perhaps even real life mineral prospects, no one knows for sure what possible inventions are in the technological pool." Merges & Nelson, *supra* note 41, at 873.

Prior to experimenting, though, it can be incredibly difficult to figure out which situation pertains. We can think of the difficulty of innovating in terms of the proportion of the total "innovation space" that the existing IP-protected ideas cover.[77] In an emerging field, innovating may be relatively easy compared to a mature field where it is much harder to produce new work. For example, coming up with an improvement in the field of grand piano technology is hard these days, as most of the technological advances for this instrument were made in the 19th and early 20th century. [78] Compare this to the relative ease of coming up with the new instrument of the electroencephalophone, which uses brain waves to generate sounds.[79] Accordingly, the more innovation space that remains free to explore, the more likely follow-on creators should be to innovate rather than borrow.

An immense body of empirical research demonstrates that people often deviate from the predictions of rational choice theory when engaged in uncertain decision-making.[80] People overweigh some probabilities and underweight others.[81] They respond differently to situations that are identical except for slight differences in framing.[82] And they are sensitive to extraneous information that should not affect their decisions.[83] We are interested in the extent to which similar issues arise with respect to creators' innovate/borrow decisions.

Our experiments model two features of sequential innovation decision-making: variations in the cost of borrowing and variations in the scope of innovation. They allow us to test the assumptions that underlie the economic theories discussed above. We ask: (1) to what extent are creators' borrow-innovate decisions sensitive to the costs of borrowing IP; and (2) to what extent are creators' borrow-innovate decisions sensitive to the scope of the available solution space. To test the hypotheses generated by the rational choice account, we have designed a series of experiments in which subjects

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[77] Merges and Nelson refer to this as the "breadth of a prospect" that a given IP right covers. Ideas with lots of possible avenues for development are broad prospects, while those with few avenues are narrow. Merges & Nelson, *supra* note 41, at 880.

[78] *See* Wikipedia, Innovations in the Piano, http://en.wikipedia.org/wiki/Innovations_in_the_piano (Dec. 14, 2014).

[79] *See* Wikipedia, Electroencephalophone, http://en.wikipedia.org/wiki/Electroencephalophone (Sept. 30, 2014).

[80] *See* DANIEL KAHNEMAN, THINKING, FAST AND SLOW (2011) (surveying this research). For applications of this research to the law see Jolls et al., *supra* note 68.

[81] *See* Daniel Kahneman & Amos Tversky, *Prospect Theory: An Analysis of Decision under Risk*, 47 ECONOMETRICA 263 (1979).

[82] *See* Amos Tversky & Daniel Kahneman, *Judgment under Uncertainty: Heuristics and Biases*, 185 SCIENCE 1124 (1974).

[83] Nicholas Epley & Thomas Gilovich, *The Anchoring-and-Adjustment Heuristic: Why the Adjustments are Insufficient*, 17 PSYCHOL. SCI. 311 (2006) (noting that people's judgments of numerical quantities are biased by recent but unrelated numerical information).

are randomly assigned to conditions that differ according to the costs of borrowing and according to the available solution space.

II. EXPERIMENTS ON SEQUENTIAL INNOVATION

We ran a series of experiments designed to understand how people innovate subject to constraints on their choices. This Part describes those experiments and their results.

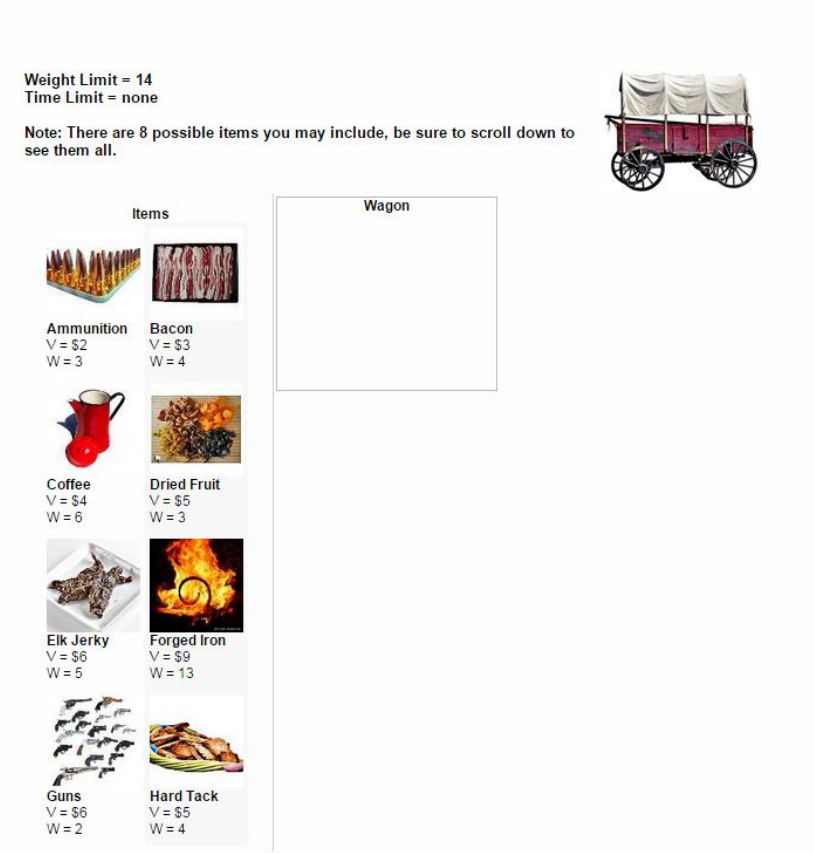
A. Experiment 1: Sensitivity to the Costs of Borrowing and Innovating

All of our experiments involve a computer-based creativity game derived from a type of combinatorial optimization math problem known as a "knapsack problem." Subjects are told to imagine that they are traders in the Old West.[84] Their goal is to fill their covered wagons with a selection of goods that has maximal value but that does not exceed the wagon's weight limit.[85] Subjects are told of the wagon's weight limit, then they are shown 12 items that may be placed in the wagon. Each item has a dollar value and a weight. Subjects are given a time limit (90 seconds in each of these experiments) in which to play the game. The game is scored based on the percentage of the maximum possible wagon value (i.e., if the maximum value of the wagon is $100 and the subject's solution is worth $80, she receives 80 points). Solutions that exceed the weight of the wagon receive zero points.

[84] We hoped that some subjects might recall the Oregon Trail computer game of the 1990s and treat our game similarly.

[85] We have used a similar version of this game in a recent paper. Christopher Buccafusco, Zachary C. Burns, Jeanne C. Fromer & Christopher Jon Sprigman, *Experimental Tests of Intellectual Property Laws' Creativity Thresholds*, 92 TEX. L. REV. 1921 (2014). To our knowledge, the first application of a knapsack problem to innovation research was in Debrah Meloso et al., *Promoting Intellectual Discovery: Patents versus Markets*, 323 SCIENCE 1335 (2009).

Figure 1: Wagon Practice Screen



Subjects are first given a simple version of the game (see Fig. 1) as practice to familiarize them with the task. This session was untimed and unpaid. In the live game, subjects were given 90 seconds to find a solution to a significantly harder problem. This time period is generally too short to allow subjects to calculate the correct answer.[86] Instead, they must rely on heuristics to reach an answer. This kind of heuristic problem-solving is similar to the kinds of innovation that take place in a number of fields, including computer science, biology, and engineering.

1. Experiment 1: Design

For our first experiment, we wanted to study how people respond to variations in the costs of innovating and borrowing. As we described above, borrowing from existing creations is typically costly, because those creations

[86] Knapsack problems are NP-hard problems which are hard to solve mathematically. *See* HANS KELLERER ET AL., KNAPSACK PROBLEMS (2004).

are covered by IP rights that must be licensed. Accordingly, as the cost of borrowing increases, we would expect that the rate of innovation will also increase, all else equal. This experiment manipulates the costs of innovating and borrowing in order to assess subjects' sensitivity to costs.

After the practice round but before they played the live game, subjects were told that another subject had already played the game. Subjects were told that they would be shown the other player's submission and that the subjects' payouts would be based on how many items from the other player's submission they chose to use in their submission. Subjects would receive a bonus for innovating—in this case, using two or fewer of the items from the other player's submission. They were told that their score would be calculated as follows:

Use 3 or more items	Use 2 or fewer items
SS	SS + X

SS indicates the subject's "submission score" as described above (percentage of maximum score). X is the size of the bonus for innovating. Subjects were not told about the quality of the given submission, but they could attempt to estimate it during gameplay.

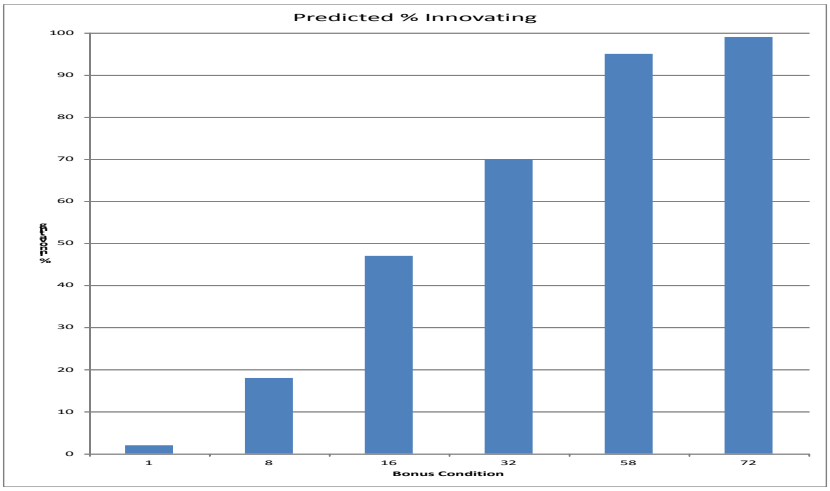
We ran six different conditions in which X equaled 1, 8, 16, 32, 58, and 72 additional bonus points for innovating. This method allows us to determine the implicit value that subjects place on borrowing versus innovating. In the standard sequential innovation setting, borrowing comes with the cost of a license fee. Here, instead of charging a fee to borrow, we paid subjects a bonus to innovate.[87] The payout structure can be viewed as an offer to the subject to innovate: *Are you willing to take X additional points in order to innovate instead of borrowing*? As the size of the bonus increases, the percentage of subjects choosing to innovate should also increase.

We are able to estimate a rational indifference range (albeit not a single indifference point) between borrowing and innovating by comparing the value of the available solutions that borrow to the value of the available

[87] In theory, this should have similar incentive effects, although the behavioral science research suggests that it may have different practical effects. Prospect theory predicts that people treat potential losses as more seriously than do equivalent sizes potential gains. That might affect the amount that they implicitly value the opportunity to innovate or borrow. *See* Amos Tversky & Daniel Kahneman, *Judgment under Uncertainty: Heuristics and Biases*, 185 SCIENCE 1124 (1974); Daniel Kahneman & Amos Tversky, *Prospect Theory: An Analysis of Decision under Risk*, 47 ECONOMETRICA 263 (1979).

solutions that do not borrow.[88] The range at which rational subjects should be indifferent between innovating and borrowing should fall between 10 to 20 additional points for innovating. Accordingly, we expected that very few subjects would be willing to innovate for only one bonus point and that almost all subjects would innovate when offered fifty-eight or seventy-two bonus points. In addition, innovation rates should be about 50% for conditions close to the indifference point.

Figure 2. Expected Results



After the subjects played the game, they were asked two comprehension questions to ensure that they understood how the rules and payoffs worked. In addition, subjects answered a number of demographic and follow-up questions regarding their age, gender, education, primary language spoken, and self-perceived mathematical ability. Subjects were also asked a general question about their risk tolerance,[89] and they completed a

[88] The precise indifference point depends on the assumptions on a rational subject's search strategy and heuristics employed. Possible heuristics include, among others, using items that have the highest weight; using items that have the highest ratio of value over weight; focusing on a random subset of potential solutions and selecting the best from this subset; or searching for an almost optimal solution instead of a perfect solution. For an in-depth treatment of approximation algorithms to knapsack problems, see KELLERER, *supra* note 86, at 29-42, 161-183. In general, subjects who are better at the game should be willing to accept less to innovate than are subjects who are not as good at the game.

[89] Subjects were asked: "Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?"

50-item personality inventory based on the "Big Five" theory of personality.[90]

2. Experiment 1: Results

Using Amazon Mechanical Turk, we recruited subjects to participate in the experiment on creativity.[91] Subjects were paid $0.50 as a show-up fee, and they were paid an additional $0.03 per point they scored in the game. The minimum payment was $0.50 and the maximum was $4.40. 603 subjects participated in the experiment. From this pool, we removed 10 subjects who failed an attention check at the end of the experiment. We also removed an additional 143 subjects who failed either or both of the comprehension questions that tested subjects' understanding of the rules and payouts. This left 489 subjects of whom 58.8% were male. There were no significant differences in the rates of being excluded between the conditions.[92]

Our data present an unusual picture of subjects' responsiveness to innovation incentives. Overall, 68.06% of the subjects chose to innovate rather than borrow. Surprisingly, however, we see almost no evidence of sensitivity to the magnitude of the offered innovation bonus. Although subjects offered only one additional bonus point chose to innovate at a marginally significantly lower rate than did those offered eight additional bonus points,[93] we see no significant differences in rates of innovation between any of the other conditions. Substantial increases in bonuses had no meaningful effect on innovation rates.

Table 1. Percentage Innovating per Bonus Condition

Condition	**+1**	**+8**	**+16**	**+32**	**+58**	**+72**
% Innovate	58.57	70.00	71.05	71.23	71.01	66.22

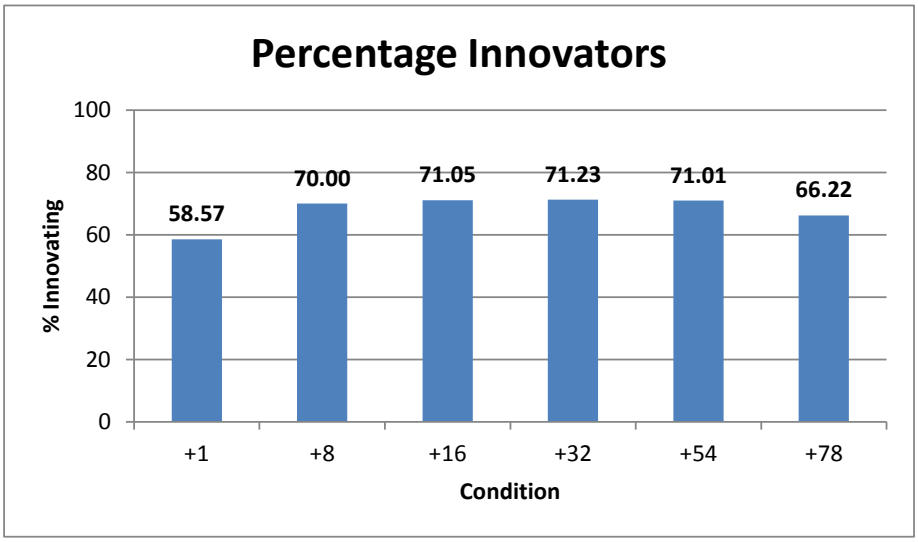
[90] We used a 50-item questionnaire from the International Personality Item Pool, http://ipip.ori.org. The precise questions were adapted from Ruth M. Stock et al., *Impacts of Personality Traits on User Innovation Success* (2015), http://ssrn.com/abstract=2467152.

[91] Subjects were recruited to "participate in a study on creativity."

[92] By condition, the number of subjects excluded for overweight wagons is:
+1 = 1; +8 = 4; +16 = 5; +32 = 4; +58 = 2; +72 = 1. All comparisons are non-significant.

[93] One tailed t-test, $p = 0.079$; two-tailed t-test, $p = 0.159$.

Figure 3. Percentage Innovating per Bonus Condition



In sum, our subjects were surprisingly unmoved by alterations in the size of the bonus provided for innovating. Although the bonus available for innovating increased starkly between conditions, subjects were unresponsive to these changes. Their insensitivity is striking at both the low and the high ends of the scale. At the +1 bonus level, 58.57% of our subjects chose to innovate even though the incentive to do so was minimal. The other player's submission was a good one (it scored 90% of the total points), so inventing around it was difficult. Faced with this difficulty, subjects should not have been willing to forego the opportunity to borrow in favor of a single point (equivalent to $0.03). Where we had expected to see little or no innovating, in fact, more than half of the sample chose to innovate. The inverse is true at the other end of the scale. Subjects in the +58 and +72 bonus conditions received what should have been entirely supernumerary incentives to innovate, yet barely more than two-thirds of subjects chose to do so. These subjects could have increased their payments significantly, by fifty percent or more. With this many bonus points at stake, subjects could have easily scored more by innovating, but many still decided not to.

These anomalies in the extreme conditions had significant effects on the payouts the subjects received. The nearly 60% of subjects who chose to innovate in the +1 condition scored significantly worse than did those who chose to borrow. And the subjects who chose to borrow in the +32, +58, and

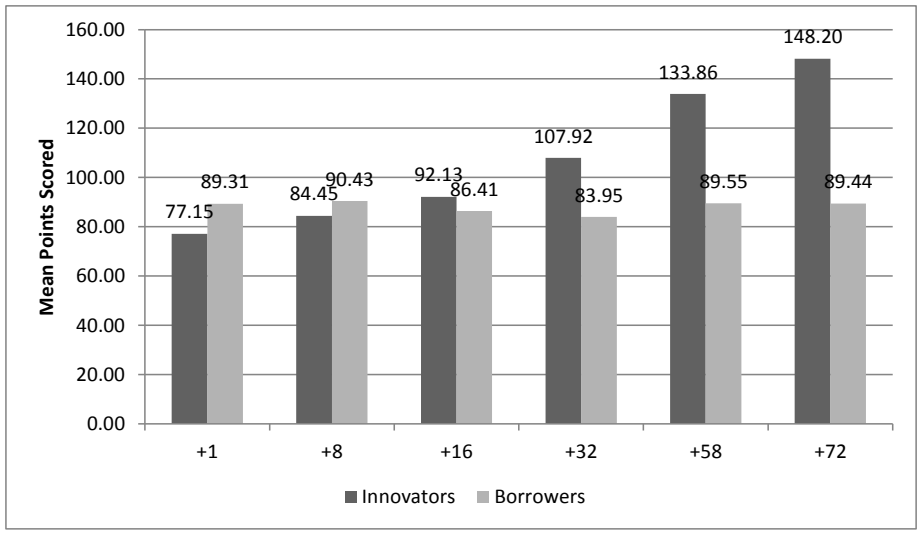
+72 bonus conditions received much smaller payouts than did those who innovated.[94]

Table 2: Mean Scores of Innovators vs. Borrowers by Condition

	+1	+8	+16	+32	+58	+72
Innovators	77.15***	84.45	92.13	107.92***	133.86***	148.20***
Borrowers	89.31***	90.43	86.41	83.95***	89.55***	89.44***

Note: The stars indicate that the mean scores of innovators and borrowers within a particular condition differ significantly. *** $p < 0.01$

Figure 4: Mean Scores of Innovators vs. Borrowers by Condition



Significant numbers of our subjects were leaving money on the table. Their innovate/borrow decisions were clearly suboptimal from the perspectives of both individual welfare and social welfare. The scope of the individual suboptimality is readily apparent. Subjects who chose unwisely had significantly lower returns.[95] We can also estimate the social loss by comparing the actual points scored for all players with the number of points that would have been scored had all of the players chosen optimally. We will assume that all of the players would have received the same scores as did

[94] As with all of the previous and subsequent analyses, these exclude the players who entered submissions that exceeded the wagon's weight limit. Because these players received zero points, entering their data into this analysis would have produced unnecessary variability. Players with overweight wagons did not different significantly between conditions. *See supra* note 92.

[95] *See* Table 2 and Figure 4, *supra*.

those who chose optimally. In the +1 condition, the combined score of Innovators and Borrowers was 8218. Had all the subjects borrowed, however, they would have scored 8931 points, an 8.67% increase.[96] In the +72 condition, the combined score of Innovators and Borrowers was 12,835. But had all of the subjects innovated, their combined score would have been approximately 14,820, a 15.46% increase. These differences represent estimates of the lost social welfare from suboptimal decision-making.

Given the magnitude of these effects, it is important to ask why our subjects were almost entirely unaffected by the size of the bonus offered for innovating and why so many of them made suboptimal decisions. One possibility is that they were simply not paying attention or trying terribly hard, and, thus, when confronted with the instructions, they breezed through the game without thinking. We have a number of reasons for doubting that this is the case. First, we discarded a number of subjects who failed the comprehension or attention questions. Moreover, previous experience with Mechanical Turk subjects suggests that they are generally well motivated to perform these kinds of tasks, especially when performance is linked with increased payment.[97]

Most importantly, though, subjects were asked a follow-up question about how easy they thought it was to find a solution that did not borrow two or more of the items from the other player's submission. We ran logistic regression analyses of these and other demographic and follow-up questions. The regression tables are reported in Appendix A. The easier that subjects thought it was, the more likely they were to innovate, suggesting that they were paying attention and responding rationally to the problem presented to them, at least within the context of their own beliefs.[98] Those subjects who were innovating were doing so because they thought it was relatively easy to do (whether it was or not). Accordingly, the decision to innovate in the +1 condition might have been driven by overconfidence in the subject's ability

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[96] We arrived at these figures by adding the points scored by Innovators with the points scored by Borrowers. To figure out the scores if everyone had played optimally, we assigned the mean score of the Borrowers to each of the Innovators.

[97] *See* Buccafusco et al., *supra* note 69. In addition, most of our subjects take the full ninety seconds to play the game, and their self-reported motivation to score well was generally high. Over 88% of our subjects reported that they were motivated or highly motivated to score well. If they were not trying hard they could simply move some items to the wagon and submit the game early.

[98] *See* Appendix A, Regressions 4 and 5. In all regression analyses of Experiment 1, the ease with which subjects believed they would be able to innovate was strongly correlated with whether they did, in fact, innovate. Interestingly, the easier subjects thought the game was in general the more likely they were to borrow rather than innovate. This makes sense: because innovating restricts the sample of items that can be used, it should be easier to find a solution when borrowing.

to find a non-infringing solution.[99] And the inverse is likely true for those who borrowed in the high bonus conditions. They may have been insufficiently confident of how easily they would be able to innovate and reap the large bonuses available.

A further and related possibility is that our subjects' insensitivity to the bonus size suggests that there may be individual differences between people's willingness to engage in innovation. Raustiala and Sprigman have discussed the differences between "tweakers," those who tend to make minor improvements on existing creations, and "pioneers," who prefer to attempt major innovations.[100] Pioneers tend to receive a lot of attention, because the scope of their innovations makes the value of their contributions seem obvious. But tweakers are important, too. Their efforts refine and improve the initial pioneering innovation, helping to figure out the best way to implement it. And by altering and adapting the innovation, tweakers point out its flaws and prepare the ground for the next pioneer.[101]

Although there have been volumes of papers published on the relationship between individual characteristics and creativity, as yet, we could find no research directed to distinguishing between the creativity of tweakers and pioneers. We examined responses to our follow-up questions to see if we could detect significant differences between the groups. In particular, we were interested in whether there are any specific demographic features of those people who innovated in the +1 bonus condition (where innovating was irrational) and of those people who borrowed in the +58 and +72 bonus conditions (where borrowing was irrational).

One possibility is that pioneers tend to be risk takers, while tweakers are more risk averse. Tweakers may be more cautious when confronted with uncertainty about the possibilities for innovating and, thus, prefer to borrow from and tinker with existing work. This hypothesis, however, is not borne out by our data. Subjects who reported that they were generally "fully prepared to take risks" did not innovate at significantly higher rates than did those who said that they "try to avoid taking risks."[102]

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[99] We have seen similar kinds of overconfidence affect creators' behavior in our earlier experiments. *See* Buccafusco & Sprigman, *The Creativity Effect*, *supra* note 69, at 42 (showing that overconfidence in the quality of their work drives creators to assign high value to it).

[100] KAL RAUSTIALA & CHRISTOPHER SPRIGMAN, THE KNOCKOFF ECONOMY: HOW IMITATION SPARKS INNOVATION 132-33 (2012).

[101] *Id*. at 137.

[102] *See* Appendix A, Regression 2. Risk preference was never close to statistically significant in any of the regression equations that we ran.

We used a single-item measure of risk preference taken from the following source. Thomas Dohmen et al., *Individual Risk Attitudes: Measurement, Determinants and Behavioral Consequences*, 9 J. EUR. ECON. ASSOC. 522, 525 (2011). Recent research on risk preference suggests that it is a complex concept that may vary across domains. Id. For example, people

In addition, we considered whether innovation behavior was predicted by variation in subjects' personality traits. According to the five-factor model of personality, variation along five different personality traits—openness to experience, extroversion, agreeableness, conscientiousness, and neuroticism—explains individuals' personality differences.[103] In particular, we focused on openness to experience and extroversion, because previous studies had shown these traits to be positively correlated with creativity.[104]

Interestingly, subjects who rated highly on openness to new experience did, in fact, innovate at significantly higher rates than did subjects who rated low on openness. In regression analysis of innovation behavior controlling for the five personality variables, as well as subject age and gender, higher openness scores were strongly correlated with increased likelihood of innovation.[105] None of the other personality factors was significantly correlated with innovation behavior.[106] A one point increase in openness on a scale of 1-10 predicted a 32.9% increase in likelihood of innovating.[107]

The relationship between openness to experience and innovation behavior makes sense. Individuals who rate highly on openness tend to have a preference for variety and change, and they tend to be intellectually curious. When faced with a creativity problem, then, it is not surprising that subjects high in openness chose to branch out in a new direction rather than continue down an already established path.

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may be willing to take risks with money at the betting table but unwilling to take risks with personal safety while driving a car. Because we included the lengthy personality inventory, we decided to use a smaller risk measure. Also, this research suggests that incentive-compatible techniques, where subjects are really engaging in risky behaviors, have better predictive value. Because our subjects were already engaging in one complex risky game, we decided not to have them play another incentive-compatible risk game. Further research using broader risk measures and incentive-compatible measures is desirable.

[103] *See* Paul T. Cost, Jr. & Robert R. McCrae, *Four Ways Five Factors Are Basic*, 13 PERSONALITY & INVID. DIFFERENCES 653 (1992) (discussing support for the five-factor model including observational studies, linguistic and cultural studies, and heritability studies).

[104] See Sun Young Sung & Jin Nam Choi, *Do Big Five Personality Factors Affect Individual Creativity? The Moderating Role of Extrinsic Motivation*, 37 SOC. BEHAVIOR & PERSONALITY 941 (2009); Ruth Stock et al., *supra* note 90. The 50-item measure that we used included 10 questions for each of the personality factors. Answers to these questions were used to compute factor scores using the methods described in Stock et al. Factor scores were then entered into the logistic regressions of innovation behavior reported in Appendix A.

[105] *See* Appendix A, Regression 3.

[106] When we include in the regression analysis controls for ease of solving the game and ease of innovating, the correlation with openness becomes non-significant and the correlation for extroversion becomes significant, but in the opposite direction than we had predicted. People who score higher in extroversion are more likely to borrow than to innovate, controlling for these other variables. We are unsure of what to make of this finding. *See* Appendix A, Regression 4.

[107] *See* Appendix A, Regression 3.

Our finding about the relationship between openness to experience and innovation behavior is important. Although previous research has repeatedly documented a relationship between openness and creativity,[108] we can find no studies that address our more nuanced question about the different approaches to creativity involved in tweaking versus pioneering. Both tweaking and pioneering involve creativity, but the kinds of creativity involved may be different. Our results suggest that it may be misleading to say that openness to experience and "creativity" are correlated; rather, openness to experience may be particularly associated only with the kind of creativity involved in pioneering development.

Although this finding about the relationship between personality and innovation behavior is interesting, it is important to understand it in light of the larger context of our study. When we consider the relative size of the effect of openness to experience in explaining innovation behavior it is much smaller than the size of the effect associated with subjects' beliefs about the ease of innovating.[109] So although the personality effect is statistically significant, it is not nearly as large as the effect of subjective belief.

B. Experiment 2: Sensitivity to the Source of Existing Ideas

Our first experiment explored whether subjects' innovation decisions were sensitive to the costs of borrowing or innovation. Our data indicate that subjects choose to innovate at a surprisingly high rate, and that their preference for innovating over borrowing is almost entirely unaffected by the relative costs of both choices. One possibility is that these results are merely an artefact of the experimental design based on the source of the provided submission. In the real world, follow-on innovators receive more information about existing ideas than in our first experiment. They may know, for example, whether the original innovator was a very talented and bright individual. In such case, follow-on innovators may consider it harder to "invent around" an existing idea and therefore decide to borrow rather than innovate. More generally, the higher the perceived quality of an original innovator, the less often follow-on innovators may decide to innovate, as they may find it harder to outperform the original innovator without borrowing his solution.

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[108] *See* Robert N. McRae, *Creativity, Divergent Thinking, and Openness to Experience*, 52 J. PERSONALITY & SOC. PSYCHOL. 1258 (1987); Paul Silvia et al., *Openness to Experience, Plasticity, and Creativity: Exploring Lower-order, High-order, and Interactive Effects*, 43 J. RES. PERSONALITY 1087 (2009).

[109] *See* Appendix A, Regressions 3 and 4. Regression 3, which only includes the personality factors and age and gender as variables, has a low R^2 value (0.029). This suggests that little of the variation in innovation behavior is predicted by this model. Consider also that the size of the coefficient for Ease of Innovating is much larger than the (non-significant) coefficient for Extroversion in Regression 4, which includes both.

In Experiment 1, we did not tell our subjects how strong the provided solution was. They were simply told that it had been entered by a previous participant in the experiment, presumably another Mechanical Turk subject. Perhaps, then, our subjects were using the previous participant's identity as a heuristic for estimating the quality of the given submission. If they tend to think that other Mechanical Turk subjects are not especially clever, and they infer from this that the given submission is of poor quality, this could explain the high innovation rates we detected. In Experiment 2, we therefore test whether subjects' decisions to innovate or borrow are influenced by the perceived quality of the original innovator.

1. Experiment 2: Design

Experiment 2 used the same Wagon creativity task and experimental software program as the previous experiment. While Experiment 1 manipulated the relative costs of borrowing versus innovating, this experiment manipulated the perceived quality of the original innovator. After going through the practice game, subjects were given the same instructions about the nature of the game and the distribution of points as in Experiment 1. Subjects were also told that they would receive an additional 16 points if their submission did not use three or more of the items from the existing submission. Instead, in three conditions to which subjects were randomly assigned, subjects were given different information about who had created the existing submission. In the baseline condition, subjects were told that the existing submission was randomly generated by a computer. In the second condition, subjects were informed that the submission was entered by a participant in a previous version of this study run on Mechanical Turk. In the third condition, subjects were told that the submission was entered by a participant in a previous version of this study that was run at MIT. For each condition, the provided submission was the same one that had been used in Experiment 1. Subjects then played the game, replied to comprehension questions, and answered a series of follow-up and demographic questions similar to those used in the previous experiment.[110]

As before, subjects were only given ninety seconds to assess the quality of the provided solution, decide whether they wanted to borrow or innovate, and then calculate and enter their own solutions. Given this short time period, subjects may not have been able to fully assess the value of the provided solution. It seem reasonable to hypothesize, then, that subjects could use the quality of the original innovator as a cue to determine the provided solution's quality and that this perceived quality would influence subject's decision to borrow or innovate. If this were the case, one should expect that subjects should innovate most in a condition in which the existing

[110] Experiment 2 did not include the 50-item personality inventory.

submission was purportedly generated by a computer; that the number of subjects innovating should decrease once the existing submission was purportedly generated by another subject whose quality is not further defined; and that the number of subjects innovating should be the lowest if the existing submission was purportedly created by an MIT student.

2. Experiment 2: Results

We recruited 303 subjects via Amazon Mechanical Turk to participate in this experiment. As in experiment 1, subjects were paid $0.50 for participating and $0.03 for each point they scored in the game. We excluded 73 subjected from the final data analysis for missing one or both of the comprehension questions, or missing an attention question. We also removed 18 subjects who went over the weight limit. This left us with 212 subjects. They remained equally distributed across the three conditions, had a mean age of 30.75, and 62.74% of them were male.

Our results do not confirm expectations that a higher perceived quality of the original innovator should prompt subjects to innovate less and borrow more. A superficial look at the descriptive data seems to suggest otherwise: the percentage of subjects choosing to innovate increases rather than decreases when moving from a computer-generated original submission over a submission generated by another subject to a submission created by an MIT student. However, a comparison of the three samples reveals that they cannot be said to be statistically different with a sufficient level of confidence.

Table 3: Innovation Rates by Condition

	Computer-Generated Condition	**Other Mturk Subject Condition**	**MIT Student Condition**
Innovation %	57.75%	59.72%	69.57%

(a) Computer-generated v. other subject: two-tail t-test, $p = 0.81$
(b) Computer-generated v. MIT student: two-tail t-test, $p = 0.15$
(c) Other subject v. MIT student: two-tail t-test, $p = 0.22$

Again, subjects' answers to follow-up questions reveal that the strongest predictor of their behavior was their perception of how easy it would be to innovate. The easier they thought it would be to innovate, the more likely they were to do so.[111] In addition, as subjects' perception of the given solution's increased, they increasingly decided to borrow.[112] This

[111] See Appendix B, Regression 4.
[112] *Id.*

conforms to rational expectations, as well, because the better they believe the given solution to be, the harder it will be to innovate.

Finally, despite the very different identities of those who supposedly provided the solutions, our subjects did not differ in how strong they thought the given solution was between conditions. Whether they were told that the solution was randomly generated or submitted by an MIT student, subjects thought the solution was about the same quality.[113] As a result, based on the data we found, we do not have strong evidence that the identity of the original innovator had a considerable influence on subjects' decisions to innovate or borrow.[114]

Experiment 2 provided valuable confirmation of the results generated in Experiment 1. First, innovation rates across the two experiments are similarly high (between 58 and 71 percent). This suggests that these rates are fairly stable, at least with respect to this experimental situation. Second, the results of Experiment 2 indicate that the high innovation rates we had previously found were not driven by heuristic assessment of submission quality. These results suggest that subjects are not using information about the identity of original innovators when deciding whether to borrow the original innovation or innovate independently. Similar to Experiment 1, preferences about whether to borrow or innovate are relatively stable across conditions and seem to depend on other factors than the identity of the original innovator.

C. Experiment 3: Sensitivity to the Quality of Existing Ideas

The previous experiments explored the extent to which subjects' innovation behavior was influenced by the costs of borrowing or innovating and the perceived quality of the original innovator. Our data suggest that neither costs nor the perceived quality of the source of the existing solution played very much of a role in their decisions to borrow or innovate. But these are not the only relevant factors this decision involves. Rational people should also consider how difficult it will be to make a new discovery that does not infringe upon existing ideas. We refer to this as the scope of the

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[113] Mean (standard deviation) perceived quality of the solution: Previous Participant: 72.28 (16.93); MIT Student: 75.96 (15.28); Computer Generated: 75.92 (16.35). Interestingly, these estimates are lower than the actual quality of the solution (90%), which could explain why subjects chose to innovate at such high rates. All differences are non-significant.

[114] Neither the mean scores of innovators in the three conditions nor of borrowers differed in a statistically significant way. The mean score of the innovators in the computer-generated condition was 94.805, in the previous participant condition 93.512, and in the MIT student condition 92.708. All two-tail t tests between the groups had p values larger than 0.5. The mean score of the borrowers in the computer-generated condition was 90.467, in the previous participant condition 91.897, and in the MIT student condition 89.095. All two-tail t tests between the groups had p values larger than 0.24.

innovation space.[115] When the scope of the innovation space is large, people should be more willing to innovate (all else equal) than when it is small, because it will be easier to find a non-infringing solution.

Two variables affect the scope of the innovation space: the quality of the existing ideas and the strength of the IP rights protecting them.[116] For example, a new discovery may open up an entire field of research that is only barely touched by existing IP rights. The early days of most fields look like this. But as the field matures, it will tend to be harder and harder to produce new ideas that do not overlap with existing ones. In the same way, if the breadth of the existing IP rights increases, such that new creators have to produce ideas with fewer similarities to the existing ideas, innovation will become harder, and borrowing from the existing ideas will be more attractive. Here, in Experiment 3, we test the extent to which subjects are responsive to changes in the innovation space derived from the quality of the underlying ideas.

1. Experiment 3: Design

Experiment 3 used the same Wagon creativity task and experimental software program as the previous experiments. Where those experiments manipulated the costs and sources of the underlying ideas, this experiment manipulated the quality of the underlying ideas. After going through the practice game, subjects were given the same instructions about the nature of the game and the distribution of points. Subjects were told that they would receive an additional 16 points if their submission did not use three or more of the items from the existing submission.

Then subjects were randomly assigned to one of three conditions based on the strength of the underlying submission. Depending on condition, subjects were either shown a submission that was 60%, 80%, or 100% of the best submission strength. Subjects were not told how strong the submission was, but they should have been capable of making informed judgments about it.[117] While the 60% solution afforded many valuable options that subjects could choose that did not exceed the property rule, the 100% solution offered very few, and the 80% solution was in the middle. Subjects then played the game, answered two comprehension questions, and answered a series of follow-up and demographic questions similar to those used in the previous studies.[118]

The 16 point bonus offered to all subjects should fall near subjects' rational indifference point in the 80% condition. In this condition, the offer

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[115] *See supra* note 77.

[116] See our discussion *supra* notes 71-77.

[117] For example, as submission strength increased, so too did the number of items used in the submission.

[118] Experiment 3 did not include the 50-item personality inventory.

of 16 points for innovating produced options that were about equally good for either choice. In the 60% condition, though, because the innovation space was so much greater, subjects should tend to accept the bonus at very high rates, and we should see near universal innovating. On the contrary, in the 100% condition, the available innovation space was very small (although not zero),[119] so almost all subjects should eschew the bonus and borrow.

D. Experiment 3: Results

We recruited 303 subjects via Amazon Mechanical Turk to participate in the study. As with the previous experiments, subjects were paid $0.50 for participating and $0.03 for each point that they scored in the game. We excluded 62 subjects from the final data analysis for missing one of the comprehension questions, not being native English speakers, or missing an attention question. Exclusions did not differ significantly between the three conditions. Of the remaining population of 241 subjects, 143 (59.34%) were male, with mean age of 33.04 (range 19-68).

Our results are partly consistent with our expectations and partly inconsistent with them. As predicted, when confronted with a smaller innovation space, subjects were less likely to innovate and more likely to borrow. Subjects in the 60% condition innovated more than those in the other conditions. Although subjects in the 80% condition innovated more than those in the 100% condition, we cannot say that the result was statistically significant. In general, then, we observe some degree of sensitivity to the scope of innovation space, but it is not as great as we would have predicted.

Table 4: Innovation Rates by Condition[120]

	60% Condition	**80% Condition**	**100% Condition**
Innovation %	80.52% [(a)(b)]	68.92% [(a)(c)]	59.77% [(b)(c)]

(a) 60 vs. 80: chi square test, $p = 0.102$
(b) 60 vs. 100: chi square test, $p = 0.004$
(c) 80 vs. 100: chi square test, $p = 0.226$

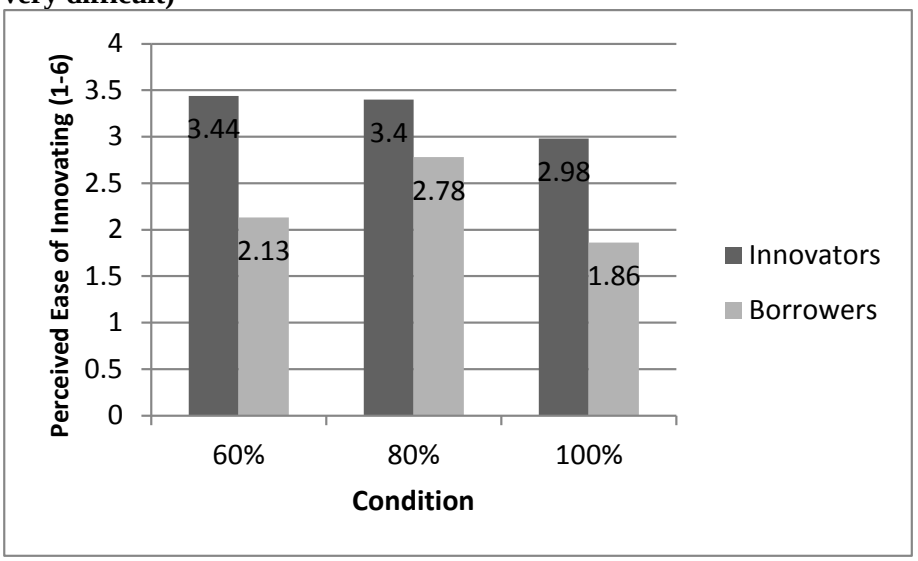
[119] In addition to the 100% solution provided to the subjects, three other 100% solutions to the knapsack problem exist. If a subject chooses to innovate and comes up with one of the other 100% solutions, he will always be better off than by choosing to borrow, as he not only receives the payoff for the 100% solution, but also the 16 points bonus for innovating. But the likelihood that a subject will come up with one of three other 100% solutions is small, given that there are over 3000 possible solutions to the knapsack problem, whose quality ranges from 0 to 100%.

[120] The reported statistical results use Pearson's chi square test for statistical significance. The values do not change much if we employ two-tailed t-tests.

Moreover, as in our previous studies, innovation rates are still unusually distributed. Although innovation rates were higher in the 60% condition, they did not reach the nearly universal level that rational choice theory would have predicted. And on the opposite side of the spectrum, in the 100% condition, more than half of the subjects still chose to innovate even though doing so was incredibly difficult. So although the scope of the innovation space is affecting subjects' decisions, the magnitude of its effect is still relatively small.[121]

Again, when we look at our follow-up and demographic data we can tell a richer story about innovation behavior. The changes in innovation rates across conditions and subjects' within-condition innovation behavior are related to their perceptions of how easy they thought it was to innovate (i.e., find a solution using 2 or fewer previously used items). Within each condition, those subjects who innovated believed that doing so was significantly easier than did those who borrowed (see Figure 5 below).[122]

Figure 5: Mean Perceived Ease of Innovating (6 = very easy; 1 = very difficult)



Logistic regression analysis of a full set of these data indicates that the strongest predictor of innovation was subjects' beliefs about how easy it was to innovate.[123] For every one point increase (on a 6-point scale) in how

[121] Regression analysis of the three conditions with no other controls yields an R^2 value of only 0.029, indicating that differences between the conditions explain very little of the overall variation in subjects' decision making. *See* Appendix C, Regression 1.

[122] All *p*s < 0.05.

[123] *See* Appendix C, Regression 4.

easy subjects thought it was to find a solution using two or fewer items from the other submission, they were 280.1% more likely to innovate.[124] This is important for two reasons. First, it suggests, again, that our subjects were playing the game rationally and consistently with their perceptions of how easy it was to innovate. Second, it indicates that subjects' perceptions of the ease of innovating were much more important than the objective ease of innovating when it comes to their actual behavior. When deciding whether to innovate or borrow, subjective beliefs were much more influential than the actual state of the world.

Because subjects seem to be playing the game consistently with their subjective beliefs about the difficulties of innovating, we do not wish to label their behavior "irrational." But their strategies were not necessarily optimal.[125] Consider the subjects in the 60% condition, where innovating was relatively easy and most subjects innovated. Those who did not innovate, approximately one-fifth of the group, scored much lower than did those who innovated (Innovators mean score = 94.32; Borrowers mean score = 85.40).[126] Although the borrowers may have been playing consistently with their own beliefs, those beliefs may have led them astray.[127]

Comparing these results to those of our previous experiments, it appears as though subjects' innovation decisions are more sensitive to changes in the quality of existing solutions to a problem than they are to the costs of innovating or to information about the source of an existing solution. Whereas Experiment 1 showed almost no differences in innovation behavior despite large differences in cost, and Experiment 2 similarly showed little effect on innovation behavior relating to the provenance (and therefore possible perceived quality) of the existing solution, Experiment 3 produced some significant differences in innovation with changes in the actual quality

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[124] *Id*.

[125] Their behavior is consistent with what is often referred to as "bounded rationality." See Russell Korobkin, *Bounded Rationality, Standard Form Contracts, and Unconscionability*, 70 U. CHI. L. REV. 1203 (2003); HERBERT A. SIMON, MODELS OF BOUNDED RATIONALITY: EMPIRICALLY GROUNDED ECONOMIC REASON (1982); Gerd Gigerenzer & Reinhard Selten, *Rethinking Rationality*, *in* BOUNDED RATIONALITY: THE ADAPTIVE TOOLBOX 1, 4 (Gerd Gigerenzer & Reinhard Selten, eds , 2002) ("models of bounded rationality describe how a judgment or decision is reached (that is, the heuristic processes or proximal mechanisms) rather than merely the outcome of the decision").

[126] One-tailed t-test, $p = 0.059$.

[127] The scores of the two groups in the other two conditions were much closer together. 80% Condition: Innovators = 90.58; Borrowers = 86.22 ($p = 0.12$). 100% Condition: Innovators = 88.38; Borrowers = 85.54 ($p = 0.13$). The success of the innovators in the 100% condition is also interesting. Here, even though innovating should have been a suboptimal strategy given the strength of the provided submission, innovators were still able to score at least as well as borrowers. Perhaps this suggests that some of these innovators were rationally choosing to innovate because, at least for them, it was more promising. Further research is necessary to understand this issue.

of the underlying solution. In none of these cases, however, is innovation behavior fully consistent with rational choice predictions: when innovation is costly or difficult many subjects still choose to innovate, and when innovation is cheap and easy some subjects still choose to borrow. This suggests that there may be strong individual differences or other unobserved variations affecting innovation behavior. Moreover, these innovation decisions often lead to suboptimal outcomes for significant portions of our subject pool.

III. DISCUSSION AND IMPLICATIONS

Regulating sequential innovation is perhaps the most important challenge IP law faces. In one sense, all IP doctrine and theory come down to this fundamental issue about balancing incentives to initial creators with opportunities for subsequent creators. In order to figure out how to do so efficiently, the law needs an accurate understanding about how people make decisions about innovating and borrowing. More research needs to be done in this area, but our findings have interesting implications for IP law and policy. We will break them out into three separate sections. First, we will discuss the implications of our findings for the efficiency of innovation markets. We will then consider how (and how well) IP law affects creators' incentives. Then, we will address issues associated with the production and acquisition of creativity, and the theory of the firm. Finally, we will discuss some limitations to our study design and future research that we plan to undertake.

Before we discuss the implications of our findings for innovation IP law, we should keep two important points in mind. First, when we think about "creativity" we tend to think about the kinds of ideas that represent substantial advancements from existing knowledge: Edison and the light bulb, Picasso and cubism, Perry and "Firework." This kind of pioneering creativity is obviously important; it is the source of Nobel prizes and MacArthur genius grants. Yet despite all of the attention that it receives, it represents a relatively small percentage of human creative endeavor.[128] At least as important are the innumerable tinkerers and tweakers whose only goal is to refine and adapt existing ideas.[129] Quantitatively and perhaps qualitatively, this kind of creativity is responsible for at least as much scientific and artistic progress as the pioneering kind. For every Edison,

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[128] *See* RAUSTIALA & SPRIGMAN, *supra* note 100, at 132-33.

[129] Eric von Hippel has done important research on the social value of user innovation which often takes the form of tweaking existing products for new uses. *See* ERIC VON HIPPEL, DEMOCRATIZING INNOVATION 1 (2005); Joachim Henckel & Eric von Hippel, *Welfare Implications of User Innovation*, *in* ESSAYS IN HONOR OF EDWIN MANSFIELD 45 (Albert N. Link & F.M. Scherer, eds., 2005).

Picasso, and Perry there are dozens, hundreds, or thousands of others who have continued to develop, interpret, and repurpose their ideas.[130]

Second, when we think about innovation we tend to ascribe to it a positive normative valence. But as Kitch pointed out, sometimes innovation is costly and wasteful. If one drug successfully treats a disease, the addition of a second or third drug to treat the same disease may not be that valuable, especially compared to the use of those resources elsewhere.[131] Innovation races and inventing around patents often lead to duplicative expenses without actual improvements in idea quality.[132] Our Wagon game allows for this. Subjects might choose to innovate rather than borrow, but their innovation does not necessarily produce a higher score. IP and innovation scholars need to be clear about when innovation is valuable and when it is costly.

A. The Efficiency of IP Markets

Similar to other areas of the law, the fundamental structure of U.S. IP law is premised on the assumption that the people affected by it—creators, owners, and users—are rational. In this sense, rationality means seeking to maximize one's welfare by comparing the costs and benefits of decisions and acting consistently with that calculus.[133] Rationality does not mean that people don't make mistakes, only that those mistakes will tend to be randomly distributed over time or in a society. If a person overestimates the costs of an action this time, he is likely to underestimate those costs the next time, and may improve his estimates in the long term.[134] Or if a market

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[130] Consider, for example, the large and growing arena of fan fiction. Fans write their own stories using existing (often copyrighted) characters, placing them in new settings or changing other aspects of their identities and relationships. *See* Rebecca Tushnet, *Legal Fictions: Copyright, Fan Fiction, and the New Common Law*, 17 Loy. L.A. ENT. L.J. 651, 655 (1997) ('[f]an fiction,' broadly speaking, is any kind of written creativity that is based on an identifiable segment of popular culture, such as a television show, and is not produced as 'professional' writing."); Anupam Chander & Madhavi Sunder, *Everyone's a Superhero: A Cultural Theory of "Mary Sue" Fan Fiction as Fair Use*, 95 CAL. L. REV.597 (2007).

[131] The existence of multiple drugs to treat the same disease will have some possible social welfare effects by increasing competition and thus reducing monopoly pricing. But competition will occur inevitably once the patents expire.

[132] For a discussion of these issues see Michael Abramowicz, *The Uneasy Case for Patent Races Over Auctions*, 60 STAN. L. REV. 807, 817-18 (2007).

[133] *See* Russell B. Korobkin & Thomas Ulen, *Law and Behavioral Science: Removing the Rationality Assumption from Law and Economics*, 88 CAL. L. REV.1051, 1063 (2000) ("the basic requirement of expected utility theory is that decision makers conduct an explicit or implicit cost-benefit analysis of competing options and select the optimal method of achieving their goals.")

[134] *See* Richard A. Epstein, *Behavioral Economics: Human Errors and Market Corrections*, 73 U. CHI. L. REV. 111, 114-118 (2006); Richard A. Epstein, *The Neoclassical Economics of Consumer Contracts*, 92 MINN. L. REV. 803, 810-814 (2008); Jeffrey J. Rachlinski, *Cognitive Errors, Individual Differences, and Paternalism*, 73 U. CHI. L. REV.

participant always overestimates the costs of an action, another market participant will always underestimate them.[135] In markets where there are both rational and biased actors, marginal buyers and sellers who determine equilibrium prices in the aggregate will often be rational individuals. Their rational behavior can wield sufficient influence to lead to an efficient market, from which biased individuals can also profit.[136] Over time and on balance, learning and imitation strategies lead rational actors engaged in market transactions to converge toward optimal behavior.

In an ideal world, in which people act rationally and there are no transaction costs, innovation markets should function efficiently to direct resources to their highest valuing uses.[137] As we described in Part I, rational follow-on creators will weigh the costs and benefits of innovating and borrowing and select the optimal approach.[138] If the owner of the underlying IP right insists on too high of a price to license it, the rational creator will innovate. Or if the scope of the remaining innovation space is exceedingly narrow, the sequential creator will be willing to pay more to borrow from existing ideas. In this ideal world, the role of the IP system is simply to establish clear rights and allow people to transact. Social welfare is optimized by individuals rationally pursuing their private good.[139]

Our findings in these experiments suggest that markets for innovation may be less efficient than standard economic analysis assumes. Moreover, these inefficiencies may produce significant social costs. Although our data are far from conclusive, they are consistent with a growing body of research noting similar departures from rationality in other aspects of

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207, 219-221 (2006); Alan Schwartz, *How Much Irrationality Does the Market Permit*?, 37 J. LEGAL STUD. 131, 143 note 17 (2008) (hereinafter Schwartz, Irrationality).

[135] *See* RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW 17 (9th ed., 2014) ("The obvious fact that people do not always make rational choices … does not invalidate rational-choice theory. Economics is concerned with explaining and predicting tendencies and aggregates rather than the behavior of each individual; and in a reasonably large sample, random deviations from normal rational behavior will cancel out."); Richard A. Posner, *Rational Choice, Behavioral Economics, and the Law*, 50 STAN. L. REV. 1551, 1556-57; Epstein, *supra* note 134, at 121.

[136] Oren Bar-Gill & Elizabeth Warren, *Making Credit Safer*, 157 U. PA. L. REV. 1, 12-13 (2008). On a similar problem involving information asymmetries between producers and consumers, see Alan Schwartz & Louis L. Wilde, *Intervening in Markets on the Basis of Imperfect Information: A Legal and Economic Analysis*, 127 U. PA. L. REV. 630, 638 (1979); Louis L. Wilde & Alan Schwartz, *Equilibrium Comparison Shopping*, 46 REV. ECON. STUDIES 543 (1979); Elizabeth Hoffman & Matthew Spitzer, *Experimental Law and Economics: An Introduction*, 85 COLUM. L. REV. 991, 1021 (1985).

[137] This is simply an application of the Coase Theorem to innovation markets. See Ronald H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960) (establishing the conditions in which markets will function to efficiently distribution resources through society).

[138] *See supra* notes 71-77.

[139] Eldred, 537 U.S. at 212 n. 18 ("copyright law serves public ends by providing individuals with an incentive to pursue private ones").

innovation, which raise the possibility of inefficiencies inhering in those aspects as well.[140]

The results of Experiment 1 indicate that many of our subjects were making their innovate/borrow decisions suboptimally and that these decisions had significant effects on the total "welfare" produced in the game. In the +1 condition, where the rational choice was borrowing, more than half of our subjects innovated, and in the +72 condition, where the rational choice was innovating, almost a third of our subjects borrowed. Implicitly, this means that the least amount of money that these subjects were willing to accept to innovate was significantly skewed from what rational choice would predict. This seems to be due primarily to the overoptimism of the first group and the underoptimism of the latter about how easy it will be to create a non-infringing solution. In addition, we see that personality differences in openness to innovation also play a significant role in these decisions. The setup of our experimental task even allowed us to provide a rough estimate of the social welfare losses accrued due to these deviations from rational behavior.[141]

To appreciate how these biases might affect a real IP transaction, consider a situation in which a research scientist is trying to develop a gene therapy treatment for a disease. She knows that another inventor owns a patent on a technology that relates to her work and that the inventor is willing to license it for a small fee. Our scientist, however, is exceedingly confident that she can work around the existing patent and avoid paying the fee. As it turns out, however, her confidence is misplaced, and the amount of resources she spends trying to avoid the patent dwarfs what she would have paid to license it. Although the market for the rights should have resulted in their efficient transfer, the scientist's overconfidence produces an inefficient outcome.[142]

Now consider how this situation interacts with how initial innovators are likely to price access to their ideas. As we have demonstrated in previous empirical research, creators tend to overvalue their creations because they overestimate their quality and likelihood of market success.[143] We call this the "creativity effect." If the inventor owning the relevant patent in the above

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[140] *See* Buccafusco & Sprigman, *Creativity Effect*, *supra* note 69, at 42 (finding that creators' optimism about the quality of their works leading to overpricing and market inefficiencies); Brueggeman, *supra* note 6 (finding that property rules lead to inefficient distributions of creative goods compared to liability rules); Andrew W. Torrance & Bill Tomlinson, *Property Rules, Liability Rules, and Innovation – One Experimental View of the Cathedral*, 14 YALE J.L. & TECH. 138 (2012).

[141] *See supra* text accompanying note 96.

[142] Of course, the inverse would be the case for those situations in which borrowing is very expensive and innovating is the optimal choice.

[143] Buccafusco & Sprigman, *Creativity Effect*, *supra* note 69, at 42.

example suffers from a similar phenomenon, it is likely to charge a higher price for borrowing the patent than appropriate, because it is overoptimistic about the patent's quality. This will further drive a wedge between the lowest amount of money that the inventor is willing to accept to license the patent and the highest amount of money that the overoptimistic scientist is willing to pay. If overoptimistic improvers consistently meet up with overoptimistic initial creators, we would expect to see suboptimally low levels of IP transactions relative to rational choice expectations.

The opposite will be true for underoptimistic improvers like those who borrowed in the +72 condition of Experiment 1. These subjects demonstrate a high implicit willingness to pay to borrow. But while this might lead to higher levels of IP transactions, it will not necessarily lead to optimal levels. Recall that these subjects are borrowing when there were strong incentives to innovate. In a real world scenario like the one described above, an insufficiently optimistic scientist would tend to overpay for the patent license when it could be easily invented around. The excessive licensing costs would then get passed along to consumers of any resulting discoveries, thereby increasing product prices and decreasing the number of consumers who can benefit from the discovery.

As we explained above, the assumption of rationality in rational choice theory does not entail perfect behavior. Mistakes are inevitable, and, with enough chances, things could simply balance out. However, there are reasons to be skeptical that learning strategies and market forces are sufficient to overcome individual biases. On a general level, individuals who are subject to behavioral biases are often unable to overcome these biases even with training. Many behavioral biases are systematic and robust against learning.[144] Just telling an inventor that he may be too overoptimistic with regard to the prospects of his own invention will not necessarily reduce his overoptimism. Furthermore, in innovation markets, invented products and processes are often hard to compare. This impedes the ability of overoptimistic inventors to imitate and learn from more rational competitors.[145] Finally, the market may not be able to compensate for all mistakes and biases creators make and suffer from.[146]

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[144] Ernst Fehr & Jean-Robert Tyran, *Individiual Irrationality and Aggregate Outcomes*, 19 J. ECON. PERSPECTIVES 43 (2005); Howard Latin, *"Good" Warnings, Bad Products, and Cognitive Limitations*, 41 UCLA L. REV. 1193, 1253-55 (1994); Rachlinski, *supra* note 134, at 219-22; Amos Tversky & Daniel Kahneman, *Rational Choice and the Framing of Decisions*, 59 J. BUS. S251, S278 (1986).

[145] *See* Oren Bar-Gill, *The Behavioral Economics of Consumer Contracts*, 92 MINN. L. REV. 749, 756 (2008) (noting that learning and imitation strategies work best in markets in which products are standardized).

[146] In particular, market forces cannot eliminate the impact of behavioral biases if all market participants are subject to these biases, or if sellers cannot determine which buyers are subject to biases and which are not. In these and other cases, even if only a small number of

More specifically, we have reason to think that the innovation markets will still not be as efficient as predicted when it comes to cumulative innovation. First, the magnitudes of the biases we observe are very large. More than half of the subjects innovated in the +1 condition, while almost a third borrowed in the +72 condition. In addition, because innovation environments differ, there will often be situations in which either innovating or borrowing is clearly the optimal strategy. In those cases, the existence of large groups of creators who would prefer to do the opposite will lead to market pressures that distort prices away from rational levels.

To the extent that we are correct, this suggests that economic predictions about the efficiency of innovation markets could be incorrect. In real world situations in which borrowing is optimal, we will tend to see excessive investment in innovation because downstream creators overestimate how easy it will be to invent around existing ideas. Conversely, in situations in which innovating is optimal, we will tend to see excessive borrowing for the opposite reason. Accordingly, innovation markets are unlikely to run smoothly in the absence of intervention. IP laws may have more to do than establishing rights and letting the system work its way out.

B. IP Doctrine, Optimism, and Tastes for Innovation

IP law solves market failures by molding people's behavior. By providing incentives for some activities and by making other activities more

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market participants are subject to biases or even if these biases are small in size, they can have significant consequences for competitive equilibria. On this theoretical debate in general, see Latin, *supra* note 144, at 1255-57; Schwartz, *Irrationality*, *supra* note 134, For specific economic models, see John Haltiwanger & Michael Waldman, *Rational Expectations and the Limits of Rationality: An Analysis of Heterogeneity*, 75 AM. ECON. REV. 326 (1985); John Haltiwanger & Michael Waldman, *Limited Rationality and Strategic Complements: The Implications for Macroeconomics*, 104 Q.J. ECON. 463 (1989); Uri M. Possen & Mikko Puhakka, *Some Aggregate Effects of Heterogeneity in Information Processing*, 49 BULL. ECON. RES. 231 (1997) (all concerning market participants with different information processing capacities); George A. Akerlof & Janet L. Yellen, *A Near-Rational Model of the Business Cycle, With Wage and Price Inertia*, 100 Q.J. ECON. 823 (1985) (concerning market participants with different reaction rates and applying the envelope theorem to aggregated market behavior); Thomas Russell & Richard Thaler, *The Relevance of Quasi Rationality in Competitive Markets*, 75 AM. ECON. REV. 1071 (1985); Thomas Russell & Richard Thaler, *The Relevance of Quasi Rationality in Competitive Markets: Reply*, 77 AM. ECON. REV. 499 (1987) (concerning market participants with different utility functions). For related experimental studies, see Colin F. Camerer, *Do Biases in Probability Judgment Matter in Markets? Experimental Evidence*, 77 AM. ECON. REV. 981 (1987); Ernst Fehr & Jean-Robert Tyran, *Individual Irrationality and Aggregate Outcomes*, 19 (4) J. ECON. PERSP. 43 (2005); Ernst Fehr & Jean-Robert Tyran, *Limited Rationality and Strategic Interaction: The Impact of the Strategic Environment on Nominal Inertia*, 76 ECONOMETRICA 353 (2008); Colin F. Camerer & Ernst Fehr, *When Does "Economic Man" Dominate Social Behavior?*, 311 SCIENCE 47 (2006).

costly, IP doctrines attempt to affect how people act. But if it is going to accomplish its goal of optimizing creative production, IP law must accurately assess how people respond to the positive and negative incentives that it creates. This assessment should not only focus on the incentives IP law creates to innovate. It should also take into account how IP law affects incentives to license existing innovations.

As we explained at the beginning of the Article, copyright and patent laws must balance the incentives of initial creators with those of subsequent creators. They mostly do this through sequential innovation doctrines like the derivative works right and the doctrine of equivalents. These doctrines affect the scope of rights that are given to initial creators and the scope of the innovation space that is preserved for subsequent creators. By affecting the objective characteristics of the scope of innovation spaces, IP doctrines attempt to alter the economic values associated with different courses of conduct and, thus, the conduct that people choose to engage in.

Our research suggests that people's decisions about whether to engage in innovating or borrowing are not motivated solely by objective factors about innovation environments. Rather, subjective factors including degrees of optimism and individual personality differences play important roles in people's choices. Ultimately, this seriously complicates the law's ability to channel creators' conduct. If there are substantial individual differences between people in terms of their inclinations towards borrowing or innovating, the magnitudes of the incentives that are appropriate for one group of people are likely to be excessive (or insufficient) for another group of people.[147] Instead of seeing creators respond to IP's incentives, we can expect to see rigidity.

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[147] If our findings are driven by individual differences between those attracted to pioneering and those more likely to be tweakers, IP systems may need to rethink some aspects about the ways in which innovation incentives are offered. For example, if many people—especially many people who choose to partake in creative fields—are pioneers rather than tweakers, some innovation incentives may be set too high. In Experiment 1, more than half of the subjects innovated in the +1 bonus condition even though doing so seems economically irrational. But if these people experience substantial intrinsic benefits from innovating (or if they feel bad about copying), then once the opportunity to undertake creative work is presented to them, they may not need much additional incentive to produce creative works at all. If this is true, then perhaps our creativity policy should aim more toward providing the opportunity for pioneers to do creative work – for example, subsidies for science and arts education, or grants and other income support for creators – and worry less about incentives that grant property rights ex post.

Some scholars suggest that people will readily create in reliance on their intrinsic motivation, without regard to extrinsic motivations, such as IP-related incentives. *E.g.*, Yochai Benkler, *Coase's Penguin, or Linux and* the Nature of the Firm, 112 YALE L.J. 369, 426–34 (2002); Rebecca Tushnet, *Economies of Desire: Fair Use and Marketplace Assumptions*, 51 WM. & MARY L. REV. 513, 513 (2009) (exploring "the ways in which the desire to create can be excessive, beyond rationality, and free from the need for economic

This insensitivity to incentives may be less of a problem if there will be opportunities for sorting, such that people with strong preferences either way will find appropriate creative opportunities consistent with their preferences. One possibility is that tweakers will choose opportunities within a given field for borrowing and tweaking, and pioneers will do the opposite. Another possibility is that individuals will select fields based on their preferences. Because different innovation environments have different characteristics – mature technologies with little remaining innovation space favor tweaking, while new technologies with a lot of innovation space unexplored favor pioneering –individuals with strong preferences for either tweaking or pioneering will simply select the sort of innovation environment that suits them.

This may be possible, but whether it is depends on both the structure of innovation environments and IP doctrine. First, we are skeptical that creators are able to easily switch between activities whenever the situation shifts from favoring innovating to favoring borrowing. Investments in skills and resources will prevent many of these changes.[148] If an individual is a tweaker and loves to create artwork, copyright law creates considerable hurdles for him. He cannot avoid them by "self-selecting" into inventing technical improvements simply because patent law is more favorable. Also, many innovation contexts alternate between favoring innovating or borrowing at different times.[149] Some contexts even require innovating and borrowing within the same creative act.[150]

Just as importantly, IP laws themselves affect the extent to which switching between innovating and borrowing is feasible. In particular, while patent law establishes a relatively level playing field between initial creators and downstream creators, copyright law strongly favors initial creators in a

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incentive," and suggesting as a result that copyright law should not "treat[] creative activity as a product of economic incentives"); *see also* YOCHAI BENKLER, THE WEALTH OF NETWORKS: HOW SOCIAL PRODUCTION TRANSFORMS MARKETS AND FREEDOM 92–99 (2006) (analyzing different models for motivation, including "intrinsic motivation"); Diane Leenheer Zimmerman, *Copyrights as Incentives: Did We Just Imagine That?*, 12 THEORETICAL INQUIRIES L. 29, 43 (2011); Eric E. Johnson, *Intellectual Property and the Incentive Fallacy*, 39 FLA. ST. U. L. REV. 623, 625 (2012).

[148] Gregory N. Mandel, *Left-Brain versus Right-Brain: Competing Conceptions of Creativity in Intellectual Property Law*, 44 DAVIS L. REV. 283 (2010) (discussing differences in creative abilities between those engaged in patent and copyright subject matter); Fromer, *supra* note 73.

[149] Given the tremendous variety of different innovation environments subject to the basic rules of patent (pharmaceuticals vs. machines vs. business methods) and copyright (motion pictures vs. poems vs. shampoo bottle labels) it is hard to imagine that the law is getting the channeling right if it does not move people much one way or the other from their baseline preferences for pioneering or tweaking.

[150] For example, producing a movie might include writing a script from scratch but licensing and tweaking lots of pre-existing music.

way that curtails downstream creators' ability to borrow and tweak. As we described above,[151] patent law is generally more solicitous of borrowers than copyright law is. Patent law allows inventors who make novel and non-obvious contributions to existing inventions to obtain their own patents without obtaining a license, while copyright law's derivative works rule generally prohibits borrowers from engaging in sequential creativity without first obtaining a license.

If a guitar designer wants to design and craft a guitar in the shape of Prince's former unpronounceable (but copyrighted) symbol, he cannot do so unless he obtains a license beforehand, and he will be subject to a copyright infringement lawsuit if he makes such a guitar.[152] This is because copyright law, as interpreted currently by most courts, gives control of most tweaking innovations to the original innovator. This is the result in cases like *Pickett v. Prince*,[153] in which Judge Posner ruled infringing a guitar that defendant designed based on the unpronounceable symbol that Prince briefly took as his "name." Judge Posner ruled, moreover, that the defendant owned no part of his derivative work – even those parts which were not taken from Prince's pre-exising work. Had the same activity occurred under the patent regime, however, the designer might have been able to obtain a patent that he could use to negotiate with Prince. In contrast to patent law, which creates rights in improvements and assigns them to the improver, copyright creates no such improver's rights. All ownership of the right to make derivatives is concentrated in the pioneer.[154] This means that minor innovations are relatively more expensive in copyright fields than they are in patent fields.

By making minor innovations more expensive, copyright law likely produces at least two effects on sequential innovation that patent law does not. First, among more-or-less rational creators, copyright law encourages them to engage in innovating rather than borrowing. Because creators are unable to obtain their own rights in their derivate creations, they will have less incentive to borrow from existing works. As the costs of borrowing rise, rational people will switch to innovating. Thus, instead of creating adaptions of existing superheroes, for example, people will create new ones.

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[151] *See supra* notes 36-39.

[152] *See* Pickett v. Prince, 207 F.3d 402 (7th Cir. 2000).

[153] *Id*.

[154] Judge Posner's approach in *Pickett v. Prince* has become the usual rule in copyright. It is also based on a rather shallow doctrinal mistake. Section 103(a) of the Copyright Act provides that "protection for a work employing preexisting material in which copyright subsists does not extend to any part of the work in which such material has been used unlawfully." That text straightforwardly implies that copyright protection can extend to parts of a derivative work that are original to the improver – even if the parts that aren't are used without permission.

Second, some creators will be entirely priced out of the market for sequential innovation. Our experiments suggest that some creators have strong individual preferences for borrowing. They may receive intrinsic value from tweaking existing ideas that exceeds whatever the market value of the innovation may produce.[155] For example, someone may enjoy manipulating sound recordings but have no interest in producing new ones herself. Because copyright law casts this behavior as infringement (and thus subject to substantial statutory damages) and because the market value of the new work will often be small, the would-be tweaker will likely forego the exercise entirely.[156] If she were able to obtain a derivate work copyright in the way that patent law allows blocking patents, she might have sufficient incentive to engage in the activity.[157]

While patent law provides downstream creators with options for both innovating and borrowing, copyright law largely forecloses opportunities for borrowing, at least without a prior licensing arrangement. In so doing, copyright law further distorts creators' behavior in ways that are likely to produce inefficiencies. Although copyright law may encourage more innovating by discouraging borrowing, this is not necessarily valuable innovation. In many cases, it will be duplicative and wasteful. As we have noted, the cumulative value of tweaking may actually be much greater than that of borrowing, but because the value of any individual tweak is small, tweaking will be especially sensitive to the additional transaction costs that copyright law's pre-licensing requirement produces.Whether this variation in the treatment of sequential innovation between patent and copyright is warranted is a question for IP theory and further empirical research. As we noted at the outset, the answer depends on one's assumptions about the costs and direction of investment in research and the desirability of few or many solutions to a given problem. On one hand, copyright law's push towards innovating may produce greater social welfare if we believe that the kinds of issues that artists face are best approached from a variety of different perspectives. Perhaps, by encouraging artists to innovate, copyright law is

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[155] If tweakers derive considerable intrinsic satisfaction from their activities we might hope that this would result in higher willingness to pay to borrow. If that were the case, then there might be opportunities for licensing these sorts of sequential creativity. We doubt, however, that the intrinsic pleasure that tweakers feel is regularly translated into economic value in the sense that they are willing to invest consider sums in producing it. Moreover, the transaction costs of licensing these sorts of deals are large relative to the economic value of the individual works that get produced.

[156] At best, she might switch to manipulating public domain works.

[157] Our assumption here is that although creators may not be very sensitive to incentives to switch from borrowing to innovating, they may need some incentive to engage in creativity in the first place. In the case of copyright law, this need not be the offer of a positive financial return but merely the removal of the negative incentive associated with copyright infringement.

pushing them to view problems with fresh eyes and new insight.[158] On the other hand, we might think that when artistic creativity is involved, people do not value too much novelty, instead preferring reinterpretations of familiar themes.[159] This is in contrast to technological creativity where people value maximal novelty.[160] If this is the case, then copyright law is hindering exactly the kind of creative expression that people want most.

We are not in a position to justify or refute one of these normative assertions. We raise them to illustrate the potential practical importance of our findings and their relevance to IP policy. If copyright law's emphasis on innovating over borrowing is socially costly, there is a readily available alternative that is derived from patent law. The law could reject Judge Posner's interpretation and allow borrowers to obtain "blocking copyrights" in their new contributions.[161] This would level the playing field between initial creators and downstream creators and balance out the incentives that downstream creators face for innovating and borrowing.[162]

C. The Theory of the Firm

Our findings could also have implications for the theory of the firm as applied to innovative industries. The fundamental question involved in the theory of the firm involves whether companies should vertically integrate production or purchase goods on the market. This is often described as the "make or buy" decision. In traditional economic analysis of the boundaries of the firm, the answer to the question typically revolves around managing transaction and agency costs. Thus, scholars want to know if it is cheaper to make certain aspects of a good or to buy them from others. They also want to know how difficult it is to control the behavior of those outside the firm and to incentivize those within it.

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[158] For example, it has been suggested that the inability of the filmmakers of "Selma," the biopic about Martin Luther King, Jr., to use his copyrighted speeches encouraged them to think creatively about the meaning of King's work rather than just its words. *See* Jonathan Band, *How Copyright Forced A Filmmaker To Rewrite Martin Luther King's Historic Words*, TECHDIRT (Dec. 30, 2014), *available at* https://www.techdirt.com/articles/20141229/13390429545/how-copyright-forced-filmmaker-to-rewrite-martin-luther-king.shtml ("Proponents of long copyright term might point to these reviews as proof of the copyright system working properly. Denied the ability to quote King directly, DuVernay was forced to create her own expression—paraphrases of King's speeches—and her own interpretation of King's life.").

[159] *See* Fromer, *supra* note 73.

[160] *Id*.

[161] *See* Lemley, *Economics of Improvement*, *supra* note 7.

[162] We are not committed to this as the optimal strategy. Creating a blocking copyrights regime would increase transaction costs associated with licensing derivative works. In theory, at least, this could cause some of the public goods problems that Kitch was concerned with. *See* Kitch, *supra* note 44, at 266.

Over the last few years, a rich body of literature has analyzed how the theory of the firm can help us understand how intellectual property allocates resources within and outside firm boundaries, and how firms, given these allocations, make their investment, hiring and contracting decisions.[163] This literature is primarily interested in how strategic behavior and IP licensing transaction costs influence firm size and its decision whether to invest in internal R&D or to buy inventions on the market (the same "make or buy" decision but not in the context of ideas). Again, this analysis has focused on transaction and agency costs.[164]

The experiments reported in this Article add additional areas for consideration. Our findings suggest that a theory of the firm in innovative industries should not only worry about strategic behavior of innovators and their potential holding up of employers or contracting partners. It should also be concerned that behavioral biases may affect creators' decisions about innovating or borrowing. The innovate/borrow decisions that we study in this experiment bear a strong resemblance to the make/buy decisions that firms engage in. If firms (or firm members) are subject to the kinds of distortions that we detect here, their decisions will likely result in suboptimal distributions of innovating and borrowing.

Furthermore, in the context of firm boundaries, Ronald Coase rejected the notion that decisions about vertical integration were affected by producers' preferences about making versus buying. Instead, he assumed they based their decisions entirely on costs and benefits. Our experiments suggest, however, that creators may have preferences or "tastes" for innovating versus borrowing. If this is true, then the creative decisions that they make will likely be influenced by internal, subjective preferences in addition to external, objective measures of costs and benefits. This suggests that, in the context of creative industries, the theory of the firm boundaries requires more context and a more thorough appreciation of behavioral realities.

D. Addressing the Limitations of This Research

The laboratory experiments reported here allow us to test fundamental assumptions about people's behavior in novel ways. Random assignment of subjects to different conditions allows us to investigate causal

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[163] *See*, e.g., Dan L. Burk & Brett H. McDonnell, *The Goldilocks Hypothesis: Balancing Intellectual Property Rights at the Boundary of the Firm*, 2006 U. ILL. L. REV. 275; Oren Bar-Gill & Gideon Parchomovsky, *Law and the Boundaries of Technology-intensive Firms*, 151 U. PENN. L. REV. 1649 (2009); Jonathan Barnett, *Intellectual Property as a Law of Organization*, 84 S. CAL. L. REV. 785 (2011).

[164] *See* Anthony Casey, *Mind Control: Firms and the Production of Ideas*, 35 SEATTLE L. REV.1061 (2012) (discussing vertical integration and agency costs for creativity intensive firms).

relationships between factors that are not easily measured in other kinds of empirical studies.[165] As always, though, these advantages come with certain costs. Aspects of our experimental design produce unavoidable limitations in the strength and generalizability of our findings. We have discussed many of these at length in a previous paper and will only briefly mention them here.[166]

A first set of limitations relates to our subject population. We recruited subjects from Amazon Mechanical Turk rather than using real creators and innovators. We did this primarily for purposes of ease and cost reduction. Running these experiments with similar numbers of real life creators would have been enormously more expensive. Nonetheless, these samples could differ in important ways, including in terms of intrinsic motivation, skill, and demographic characteristics. Moreover, unlike our sample of individually acting subjects, many creators work as part of firms.[167] Perhaps aspects of firm relations alter the individual effects that we see here. While we look forward to running similar experiments with more realistic samples in the future, we also want to note the extent to which creativity and innovation are increasingly mass phenomena.[168]

A second set of limitations involves the creativity task that we employed. Although the Wagon game involved aspects of creativity associated with algorithmic and heuristic thinking, it obviously differs in many ways from filming a movie or designing a smartphone. Perhaps our results would have been different if we had used a more open-ended creativity task or if the game had involved slower cognition. It is certainly possible, although it is difficult for us to predict how these changes would likely affect our results. And again, we are currently designing an experiment to replicate these results using a linguistic creativity task.

In order to answer these and other questions more thoroughly, more research is needed. We have a number of ideas for how to further develop our findings about tweakers and pioneers. One possibility is to implement a within-subjects design in which subjects engage in the game a few times while subject to different bonus conditions to see if stable sets of responses

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[165] ROBERT M. LAWLESS, JENNIFER K. ROBENNOLT & THOMAS S. ULEN, EMPIRICAL METHODS IN LAW 101 (2010) ("one of the advantages of the experimental design is in its ability to isolate causal relationships").

[166] *See* Buccafusco et al., *supra* note 69, at 1973-75.

[167] Similarly, creative production frequently occurs in teams, *see, e.g.*, Anthony J. Casey & Andres Sawicki, *Copyright in Teams*, 80 U. CHI. L. REV. 1683 (2013), which might also change the effects or salience of IP thresholds.

[168] Consider the rise of Web 2.0. See Edward Lee, *Warming Up to User-Generated Content*, 2008 U. ILL. L. REV. 1459. *See also* VON HIPPEL, *supra* note 129 at 1 ("When I say that innovation is being democratized, I mean that users of products and services—both firms and individual consumers—are increasingly able to innovate for themselves."); Stefan Bechtold, *Physicians As User Innovators*, *in* INTELLECTUAL PROPERTY AT THE EDGE: THE CONTESTED CONTOURS OF IP 343 (Rochelle Cooper Dreyfuss & Jane C. Ginsburg, eds. 2014).

emerge. Another is to replicate our findings with different experimental creativity tasks. We could also push harder on the incentives to innovate than we currently do. Perhaps we could consider penalizing innovating rather than encouraging it. Would subjects be willing to innovate if innovation was not incentivized at all or if it were penalized? All of these questions await further research.

CONCLUSION

Perhaps more than any other area of the law, IP is grounded in the idea that legal doctrines can affect people's behavior in socially beneficial ways. In order to succeed, however, the law needs an accurate account of human motivation. The three experiments reported in this Article shed new light on the central issue of IP law—how best to regulate sequential innovation. More research like this is essential if IP law is going to give up its reliance on untested assumptions and adopt a behaviorally realistic view of human motivation.

APPENDICES

Appendix A: Experiment 1 - Bonus

Logistic regression of innovation behavior. When the coefficient is greater than 1.0 this indicates a positive relationship between that variable and innovating. When it is less than 1.0 there is a negative relationship. Coefficients equal to 1.0 indicate no directional relationship. Numbers in parentheses indicate standard error.

Dependent Variable – Innovation/Borrow Dummy (1 = Innovate; 0 = Borrow)
$p < 0.01$ - ***
$p < 0.05$ - **
$p < 0.10$ - *

Variable	Reg. 1	Reg. 2	Reg. 3	Reg. 4	Reg. 5
Bonus Condition	1.002 (0.004)				
Ease of Solving		0.589*** (0.151)		0.594*** (0.156)	0.566*** (0.163)
Ease of Innovating		3.726*** (0.15)		3.866*** (0.156)	3.704*** (0.155)
Risk Seeking		0.972 (0.076)			
Openness			1.329** (0.119)	1.231 (0.136)	1.156 (0.138)
Extroversion			0.858 (0.108)	0.751** (0.127)	0.853 (0.110)
Conscientiousness			0.878 (0.141)	0.853 (0.160)	
Agreeableness			1.130 (0.137)	1.262 (0.156)	
Neuroticism			0.852 (0.122)	0.771* (0.141)	
Age			1.018* (0.011)		1.014 (0.012)
Gender			0.993 (0.224)		0.992 (0.254)
Constant	1.993*** (0.16)	0.412 (0.564)	0.909 (1.32)	0.554 (1.477)	0.517 (1.110)
Did not Understand Instructions					0.604** (0.110)
Observations	432	432	432	432	432
R^2	0.00067	0.237	0.028	0.254	0.253

Appendix B: Experiment 2 – Sources

Logistic regression of innovation behavior. The default condition is *Previous Mturk Player*. When the coefficient is greater than 1.0 this indicates a positive relationship between that variable and innovating. When it is less than 1.0 there is a negative relationship. Coefficients equal to 1.0 indicate no directional relationship. Numbers in parentheses indicate standard error.

Dependent Variable – Innovation/Borrow Dummy (1 = Innovate; 0 = Borrow)
p < 0.01 - ***
p < 0.05 - **
p < 0.10 - *

Variable	Reg. 1	Reg. 2	Reg. 3	Reg. 4
MITStudent	1.542 (0.355)	1.643 (0.347)	1.389 (0.400)	1.349 (0.411)
ComputerGenerated	0.922 (0.340)	0.938 (0.347)	0.834 (0.376)	0.837 (0.390)
Age		1.025 (0.017)		1.047** (0.020)
Gender		1.646 (0.314)		1.636 (0.351)
Risk Seeking		0.963 (0.094)		
Perceived Quality of Solution			0.976** (0.011)	0.973** (0.012)
Ease of Solving			0.481*** (0.202)	0.486*** (0.206)
Ease of Innovating			2.447*** (0.188)	2.651*** (0.197)
Did not Understand Instructions			0.524** (0.273)S	0.471*** (0.283)
Constant	1.483 (0.240)	0.415 (0.742)	24.856*** (1.208)	3.810 (1.425)
Observations	212	212	212	212
R^2	0.011	0.037	0.189	0.225

Appendix C: Experiment 3 – Quality

Logistic regression of innovation behavior. The default condition is *60% Strength*. When the coefficient is greater than 1.0 this indicates a positive relationship between that variable and innovating. When it is less than 1.0 there is a negative relationship. Coefficients equal to 1.0 indicate no directional relationship. Numbers in parentheses indicate standard error.

Dependent Variable – Innovation/Borrow Dummy (1 = Innovate; 0 = Borrow)
$p < 0.01$ - ***
$p < 0.05$ - **
$p < 0.10$ - *

Variable	Reg. 1	Reg. 2	Reg. 3	Reg. 4
80% Condition	0.574 (0.376)	0.608 (0.379)	0.484* (0.412)	0.516 (0.416)
100% Condition	0.396*** (0.356)	0.399** (0.360)	0.581 (0.398)	0.600 (0.399)
Age		0.999 (0.014)		
Gender		0.643 (0.304)		0.735 (0.330)
Risk Preference		1.015 (0.093)		
Ease of Solving			0.528*** (0.210)	0.534*** (0.212)
Ease of Innovating			2.826*** (0.182)	2.801*** (0.182)
Constant	3.937*** (0.280)	4.842** (0.747)	1.793 (0.632)	2.064 (0.651)
Observations	241	241	241	241
R^2	0.029	0.04	0.192	0.195