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PATENTLY RISKY: FRAMING, INNOVATION, AND ENTREPRENEURIAL PREFERENCES

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I. INTRODUCTION

An emerging common wisdom holds that courts have made it “too hard” to obtain patent protection in critical industries. The origin of this criticism dates back at least as far as the United States Supreme Court’s 2012 landmark opinion in *Mayo Collaborative Services v. Prometheus Laboratories*, *Inc.*[1] which (the argument goes) triggered a chain reaction of judicial opinions rendering patent rights progressively more

1. 566 U.S. 66, 92 (2012). In *Mayo*, the Court invalidated a patent claim directed at determining the proper dosage of a thiopurine drug used to treat patients with autoimmune disease. Writing for a unanimous Court, Justice Breyer held that the claim failed to satisfy the requirement of patentable subject matter because it was directed to a “law of nature.” *Id.* In 2014, the Supreme Court continued its expansion of the doctrine and invalidated a claim in the software field for failing the *Mayo* test for patentable subject matter. Alice Corp. Pty. Ltd. v. CLS Bank Int’l, 573 U.S. 208, 210 (2014). In *Alice*, the Supreme Court held that the *Mayo* test also prohibited patenting abstract ideas.

difficult to secure.[2] Two years later, the Supreme Court decided *Alice Corp. v. CLS Bank*,[3] another opinion widely viewed as restricting patent rights.[4] And, barely three years after *Mayo*, the Federal Circuit cited it in invalidating a patent for a groundbreaking diagnostic test to detect fetal genetic conditions such as Down Syndrome early in pregnancy.[5] Before the test at issue was available, clinical diagnostic methods involved invasive techniques that materially endangered the health of the fetus.[6] But in 1996, doctors at Sequenom, Inc., a biotechnology company, discovered that maternal blood contains trace amounts of fetal DNA.[7] Having made this discovery, the same team developed a noninvasive blood test that could screen for fetal genetic conditions without endangering the fetus.[8] Sequenom's invention garnered it significant acclaim and prestigious awards for medical innovation.[9] The Federal Circuit was somewhat less impressed, and it invalidated the patent for failure to assert claims that were "significantly more" than a mere natural law.[10]

Critics were quick to pounce.[11] Invention is already risky and costly enough, they argued, and this opinion made patent protection not only harder but also unpredictable, undermining the incentives to

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2. *See, e.g.*, Cleveland Clinic Found. v. True Health Diagnostics, 859 F.3d 1352, 1363 (Fed. Cir. 2017), *cert. denied*, 138 S. Ct. 2621 (2018) (finding a testing process created by the Cleveland Clinic to determine the risk for having atherosclerotic cardiovascular disease invalid because it was directed to a patent-ineligible law of nature); Athena Diagnostics, Inc. v. Mayo Collaborative Servs., 915 F.3d 743, 753 (Fed. Cir. 2019), *cert. denied*, 140 S. Ct. 855 (2020) (finding a diagnostic method claim patent ineligible as a natural law).

3. 573 U.S. 208 (2014).

4. *Id.* at 219 (finding claims directed to a computerized system and method for exchanging financial obligations are ineligible subject matter for patenting and consequently invalid).

5. Ariosa Diagnostics, Inc. v. Sequenom, Inc., 788 F.3d 1371, 1375–77 (Fed. Cir. 2015), *reh'g en banc denied*, 809 F.3d 1282 (Fed. Cir. 2015), *cert. denied*, 136 S. Ct. 2511 (2016).

6. *Id.* at 1373, 1381.

7. *Id.* at 1373.

8. *Id.*

9. *Id.* at 1381 (referring to the invention as "groundbreaking," stating that "The Royal Society lauded this discovery as 'a paradigm shift,'" and noting that "the inventors' article describing this invention has been cited well over a thousand times").

10. *Id.* at 1377 (quoting Mayo Collaborative Servs. v. Prometheus Lab'ys, Inc., 566 U.S. 66, 79 (2012)) (internal quotation marks omitted). *See also* David J. Kappos, *This U.S. Court Decision Just Quashed Innovation in Health Care*, FORTUNE (Oct. 21, 2015, 4:48 PM), https://fortune.com/2015/10/21/sequenom-ariosa-diagnostics-patent/ [https://perma.cc/DHJ7-8T35] ("[T]he Federal Circuit's decision in June that declared a wide swath of healthcare innovation unpatentable threatens to impose just this sort of stagnation."). Despite approximately twenty amici briefs from academics, industry, and interest groups who argued that patent protection is necessary for such inventions, the Supreme Court denied certiorari. *Ariosa Diagnostics*, 136 S. Ct. at 2511.

11. *See, e.g.*, David O. Taylor, *Patent Eligibility and Investment*, 41 CARDOZO L. REV. 2018, 2022 (2019); Halie Wimberly, *The Changing Landscape of Patent Subject Matter Eligibility and Its Impact on Biotechnological Innovation*, 54 HOUS. L. REV. 995, 995 (2017) ("This roadblock to intellectual property protection for biotechnological inventions, due both to the recent restrictions and to the uncertain legal standard, may slow growth of the industry that relies heavily on investment.").

develop and finance critical new inventions.[12] As a result, they feared, risk-averse inventors and investors would stay away in droves, unjustly and inefficiently depriving society of many ground-breaking inventions such as Sequenom's. As Judge Kimberly Moore of the Court of Appeals for the Federal Circuit explained it in a recent dissent:

> The math is simple, you need not be an economist to get it: Without patent protection to recoup the enormous R&D cost, investment in diagnostic medicine will decline. To put it simply, this is bad. It is bad for the health of the American people and the health of the American economy.[13]

The criticism recounted above seems intuitive, appealing, and powerful. But is it right? In this article, we interrogate it by deploying experimental methods to measure people's attitudes toward risk when investing in innovative activities. Although our inquiry produces a variety of insights, one in particular stands out: We uncover novel evidence that *when confronted with an investment decision that is "innovation-related," people appear to become far more tolerant of risks than they are in other, economically equivalent settings.* This result appears to be significant and robust, and it holds up regardless of whether one controls for subjects' age, gender, ethnicity, or several metrics of baseline risk aversion. Our results also persist when we vary the quantitative and qualitative risks involved, so long as the investment is tied to innovation. The effect appears to weaken substantially, however, when a risky option is framed simply as an investment opportunity, shorn of any invention-related dimension. Our interpretation of these findings is that the pursuit of *invention* — in concert with *investing* — introduces a critical interaction that operates to dampen people's manifest aversion to risk. In fact, we can even impute a quantitative size of this preference-dampening effect, by

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12. *See The State of Patent Eligibility in America, Part II: Hearing Before the Subcomm. on Intell. Prop. of the S. Comm. on the Judiciary*, 116th Cong. 6–7 (2019) (statement of Hans Sauer, Deputy Gen. Couns. & Vice President for Intell. Prop., Biotechnology Innovation Org.) ("Absent the ability to protect their discoveries with valid patents . . . companies would lack the necessary incentive to make the risky, expensive, and time-consuming investments in research and development often required to bring new technologies to market."); *The State of Patent Eligibility in America, Part III: Hearing Before the Subcomm. on Intell. Prop. of the S. Comm. on the Judiciary*, 116th Cong. 1 (2019) (statement of Robert Deberardine, Chief Intell. Prop. Couns., Johnson & Johnson) ("It is only because of the United States patent system, and the predictability that it has historically provided, that we have been able to make the investments, conduct the research, and take the risks required to develop these treatments. . . . Unfortunately, the patent system in the United States today is anything but predictable.").

13. Athena Diagnostics, Inc. v. Mayo Collaborative Servs., 915 F.3d 743 (Fed. Cir. 2019), *reh'g en banc denied*, 927 F.3d 1333, 1358 (Fed. Cir. 2019) (Moore, J., dissenting).

calibrating our results to a well-known set of risk tolerance measurement techniques in the economics literature.[14] Here, for the median subject in our study, we estimate that the innovation-related frame induces a reduction of manifest risk aversion of just under one-half of a standard deviation relative to our overall subject population.[15]

To the extent that our results are generalizable, they have obvious implications for the "Goldilocksian" conundrum of patent protection — balancing the need to incentivize investors and inventors against the economic distortions from granting limited property rights to successful innovators. If inventors, entrepreneurs, and investors are comparatively more tolerant of risk in inventive settings, then patent policy may be able to incentivize value-enhancing innovation without throwing in a "premium" to compensate investors for their aversion to risk. Moreover, our results have broad implications outside of intellectual property, and in particular to the fast-developing areas of commercial and corporate law that must similarly wrestle with the question of how richly to incentivize financial investors in innovative industries.

Several caveats to our analysis deserve specific mention before proceeding. First, as with all experimental findings, ours are subject to questions about the generalizability of our results in light of the subject pool. All of our experiments make use of either university students or workers on Amazon's Mechanical Turk platform ("M-Turk").[16] Consequently, one might fairly question the representativeness of our subject pool relative to real-world inventors and investors, who actually participate in day-to-day innovation markets. The use of M-Turkers is sometimes singled out for criticism in this regard within the experimental literature, since it represents a population that is less capable of experimental control than conventional lab subjects.[17] We confront these concerns along multiple fronts. Foremost, we make sure to compensate our subjects with real monetary payoffs, so as to motivate and induce them to internalize the core financial tradeoffs we

14. We calibrate manifested risk aversion using a common benchmarking first established by Charles Holt and Susan Laury. *See infra* Part I; Charles A. Holt & Susan K. Laury, *Risk Aversion and Incentive Effects*, 92 AM. ECON. REV. 1644, 1651–53 (2002).

15. In addition, because our results hold even in the presence of presenting subjects with the possibility of negative payoffs, our results contrast with (though do not directly contradict) the predictions of Nobel Prize winning work by Daniel Kahneman and Amos Tversky, who found that preferences in the presence of negative payoffs (relative to a reference point) behave fundamentally differently from those with strictly positive payoffs. Amos Tversky & Daniel Kahneman, *The Framing of Decisions and the Psychology of Choice*, 211 SCIENCE 453, 457–58 (1981).

16. *See* AMAZON MECH. TURK, www.mturk.com [https://perma.cc/YA2H-XR3P].

17. *See generally* Matthew J. C. Crump, John V. McDonnell & Todd M. Gureckis, *Evaluating Amazon's Mechanical Turk as a Tool for Experimental Behavioral Research*, 8 PLOS ONE e57410 (Mar. 13, 2013), https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0057410 [https://perma.cc/3CKK-ENGT] (reviewing the literature).

wish to study. Additionally, our dual-population study design allows us to draw comparisons between the university and M-Turk populations. Although we confirm the existence of differences (both demographic and behavioral) between these two populations,[18] the phenomenon of interest here (i.e., how innovation framing interacts with risk tolerances) remains remarkably consistent between the groups.[19] Although we cannot guarantee that these results would carry over to all real-world actors, their persistence across multiple distinct subject pools is at the very least encouraging.

Second, although we believe our results deliver an important rejoinder to recent criticisms about courts' burgeoning stinginess towards patent holders, they do so in a particular and focused way: by showing that accommodations for risk preferences are perhaps unnecessary (or at least less necessary than one might think) in innovation-related contexts. A related but distinct criticism of the judicial opinions noted above is that they have simply made it costlier — even for a risk-neutral actor — to innovate or finance innovation because, for example, copying is insufficiently deterred. Our results have little to say about this dimension of the debate, other than to suggest that we may be able to confront the cost problem on its own terms, without also having to make significant additional allowances for risk aversion.

The remainder of this Article consists of four parts. Part I discusses the motivation and background for our study, with particular emphasis on the oft-asserted argument that, within innovative industries, legal policy should accommodate risk aversion much like in other domains. Part II provides an overview of the experimental protocol, tying it to the relevant literature. Part III presents our core results, both for our baseline experiment and for a set of robustness experiments meant to stress test our core results to different environments. Part IV turns to implications, situating our findings within a variety of central legal puzzles regarding innovation. A series of appendices contain background technical derivations and provide additional statistical results.

18. Most notably, in addition to their demographic differences, M-Turkers manifest greater risk aversion, regardless of frame, than students on the Internet and in the lab. *See infra* Section VA.4

19. Although there are many papers exploring whether results on M-Turk are different from those in the lab, *see supra* note 110, we have not identified any that consider the sort of framing that we utilize. Our results appear to confirm that — despite their various observable differences from conventional subjects — M-Turkers can be used successfully to test the types of framing manipulations studied in this Article.

II. BACKGROUND

Before diving into our experimental enterprise, we first lay the foundation by providing a little background and context for our analysis. This Part describes the contours of some of the core behavioral theories that undergird much of intellectual property law and policy, focusing principally on patents. It further explores the assumptions that other scholars have made about the risks associated with intellectual property, including risks surrounding copying and risks surrounding creation. It then situates these theories against the literature on early-stage startup investing in technology firms, where — despite the asserted risks — there has long been significant appetite to invest. Finally, we provide the reader with a brief orientation on the experimental framing in psychology and behavioral economics to better motivate and elucidate our experimental design.

A. Intellectual Property

The field of intellectual property (IP) is broadly comprised of patents, copyrights, trademarks, and trade secrets. Patent law is the most relevant for this article, though our results have something to say about copyrights as well. Patent rights provide the ability to exclude others from the marketplace, and in so doing grant patent owners a limited monopoly right.[20] Such rights are ostensibly awarded by the government to reward and incentivize invention.[21] Copyrights — which are justified on a similar economic theory as patents — protect original works of authorship, such as books and music.[22]

There are numerous junctures in the IP literature where incentives and risk preferences of the relevant actors are thought to play an important role for law and policy. We consider several of them below.

1. Incentives for Inventing and Creating

A longstanding literature in economics, as well as in sociology and psychology, attempts to explain why individuals and firms generate new creative and innovative works.[23] The classic insight from economic theory is that providing ex ante incentives (such as the limited exclusive rights embodied by patents) are necessary to

20. *See* MARTIN J. ADELMAN, RANDALL R. RADER & GORDON P. KLANCNIK, PATENT LAW IN A NUTSHELL 12 (1st ed. 2008).

21. *See id.* at 4–5 (describing how patents create an incentive to invent).

22. *See* PETER S. MENELL, MARK A. LEMLEY & ROBERT P. MERGES, INTELLECTUAL PROPERTY IN THE NEW TECHNOLOGICAL AGE: 2020 VOL. II: COPYRIGHTS, TRADEMARKS AND STATE IP PROTECTIONS 508 (2020).

23. *See, e.g.*, Jie He & Xuan Tian, *Institutions and Innovation: A Review of Recent Literature*, 12 ANN. REV. FIN. ECON 377 (2020).

encourage socially valuable generation of new works. This economic account, in turn, subdivides into two parts. First, absent legal protection, successful inventors would face the prospect of copying.[24] Once an inventor has sunk the time and effort needed to produce the innovation, others may endeavor to copy it, competing against the original inventor and reducing her profits. In this way, the monetizable value of a costly innovation theoretically can be driven down to almost nothing. And, anticipating such copying, the inventor simply chooses not to innovate in the first instance. By preventing copying, then, IP rights catalyze innovative effort.

Second, the innovation process itself is generally quite unpredictable, and thus — the argument goes — patent rights might additionally be used to confront the fact that inventors might otherwise gravitate to less risky pursuits. The late Nobel laureate Kenneth Arrow, for example, argued that risk-aversion may lead to under-investment in inventive activity.[25] According to this theory, the ostensibly lucrative monopoly-like rights provided by the patent system can supply an additional "premium" to compensate would-be innovators for taking on this risk, motivating them to innovate in ways that are socially desirable. This basic economic theory is no stranger to United States Supreme Court jurisprudence. In *Kewanee Oil Co. v. Bicron Corp.*, a well-known case that discussed the purposes of intellectual property law, the Supreme Court famously remarked: "[t]he patent laws . . . [offer] a right of exclusion for a limited period as an incentive to inventors to risk the often-enormous costs in terms of time, research, and development."[26] A central focus of this Article is this second aspect of the economic theory.

Outside of financial incentives, the IP literature also suggests other motivators of innovation, including reputational effects, career rewards, and a variety of intrinsic motivations.[27] For instance, some individuals derive entertainment value from solving puzzles — an activity that can also lead (when appropriately directed) to innovation even as it provides intrinsic satisfaction and motivation to the inventor.[28] Similarly, employees within a firm may be motivated by opportunities for promotion rather than direct pecuniary benefits from

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24. *See* Mark A. Lemley, *Property, Intellectual Property, and Free Riding*, 83 TEX. L. REV. 1031, 1043 (2005).

25. 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, 616 (1962).

26. Kewanee Oil Co. v. Bicron Corp., 416 U.S. 470, 480 (1974).

27. *See, e.g.*, Saul Lach & Mark Schankerman, *Incentives and Invention in Universities*, 39 RAND J. ECON. 403, 422 (2008).

28. Alice Lam, *What Motivates Academic Scientists to Engage in Research Commercialization: 'Gold', 'Ribbon' or 'Puzzle'?* 40 RSCH. POL'Y 1354, 1365 (2011); *see also* JESSICA SILBEY, THE EUREKA MYTH: CREATORS, INNOVATORS, AND EVERYDAY INTELLECTUAL PROPERTY 14 (2014).

patenting.[29] Our analysis is tangentially related to these motivations as well, at least insofar as non-monetary incentives are similarly affected by risk aversion.

2. Risk Preferences of Individuals and Firms with Respect to Creating

Because risk plays a central role in shaping innovation markets, and because inventors are thought to require compensation for taking on such risk, the task of calibrating how much compensation is required looms large for legal policy. As would-be innovators' aversion to risk grows, so too would the size of the patent premium needed to motivate them. Unfortunately, there is scant empirical or experimental evidence on the risk preferences of individuals and firms within the innovation ecosystem. As we discuss below, to the extent the IP literature takes on the issue, much of it appears to assume that creators, inventors, and investors in innovation are risk-averse in a manner similar to anyone else (although a minority of scholars sometimes conjecture the opposite — that creators and inventors are risk-seeking). Below we review and synthesize some of the major contributions in this area.

Joseph Stiglitz, yet another Nobel laureate, articulates the canonical view that "[p]eople and firms are risk averse, and if they have to bear risk, they have to be compensated for doing so."[30] Under this view, potential creators and others in the innovation system are afflicted with risk aversion just like anyone else. Without the financial premiums promised by the patent and copyright systems, the argument goes, risk-averse creators will engage in sub-optimal levels of creative activity. Steven Horowitz makes a similar claim about copyright, arguing that copyright holders are "risk averse, valuing clear entitlements more than equivalent murky ones."[31]

Analogizing to the American mineral system for public lands, in 1977 Edmund Kitch propounded the "prospect theory" of patents, which conceives of patent-related R&D as somewhat akin to gold prospecting, and asserting that patent rights are useful in channeling and coordinating development activities in new technologies.[32] By

29. Matthew S. Clancy & GianCarlo Moschini, *Incentives for Innovation: Patents, Prizes, and Research Contracts*, 35 APPLIED ECON. PERSP. & POL'Y, 206, 217–18 (2013) ("[I]f scientists are relatively risk-neutral or are talented enough that the probability of successful outcome is high, the optimal contract is tightly tied to performance. . . . [A] scientist may choose . . . to do research in a field because it is populated with scientists who can certify their work.").

30. Joseph A. Stiglitz, *Economic Foundations of Intellectual Property Rights*, 57 DUKE L.J. 1693, 1723–24 (2008).

31. Steven J. Horowitz, *Copyright's Asymmetric Uncertainty*, 79 U. CHI. L. REV. 331, 334 (2012).

32. Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265, 266 (1977). Kitch's prospect theory is analytically distinct from Kahnemann &

awarding exclusivity shortly after invention, Kitch's prospect theory asserts that the patent system provides the first inventor with an incentive to develop the broad field of invention.[33] Other scholars note that prospect theory implicitly presupposes a risk-averse inventor who needs strong property rights to be incentivized to develop the field.[34]

It is important to note that not all IP commentators are convinced that creators are relatively risk-averse on average, and some in fact assert the opposite. F.M. Scherer, for example, advanced a "lottery theory" of patents, analogizing them to lottery tickets, with most patents being essentially worthless and a small minority of them having substantial value.[35] Building upon Joseph Schumpeter's theory that investors overestimate their chances of success when presented with a potentially great reward,[36] Scherer posited that potential inventors are idiosyncratically incentivized to create new inventions by the remote chance of garnering a large payoff from a patent.[37] Gideon Parchomovsky and R. Polk Wagner situate (and ultimately criticize) this argument in broader organizational contexts, noting that "the lottery theory critically depends on the assumption that inventors, like lottery ticket buyers, are risk-seeking — indeed, so risk-seeking that they are willing to engage in an activity with a negative expected value."[38] Nevertheless, Parchomovsky and Wagner argue, it is *firms*, and not individuals, that pursue most patents, thereby diffusing much of the lottery-theory effect, since "the decisions of corporate managers appear both rational and even risk-averse."[39]

In short, while most voices in the IP chorus appear to have coalesced around the proposition that primary actors in patent settings are risk-averse, it is not difficult to isolate dissonant voices, asserting contrary positions across the spectrum. Perpetuating and amplifying

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Tversky's prospect theory, published two years later, regarding the predictable results of a lottery. *See* Daniel Kahnemann & Amos Tversky, *Prospect Theory: An Analysis of Decision Under Risk*, 47 ECONOMETRICA 263, 284–86 (1979).

33. Kitch, *supra* note 32, at 266.

34. *See, e.g.*, Shubha Ghosh, *Patents and the Regulatory State: Rethinking the Patent Bargain Metaphor after* Eldred, 19 BERKELEY TECH. L.J. 1315, 1329 (2004) ("Given the support for risk-seeking behavior, inventors . . . may actually prefer a strong form of patent law that richly rewards successful inventors rather than a form that seeks to protect unsuccessful inventors who survive through imitation.").

35. *See* F. M. Scherer, *The Innovation Lottery*, *in* EXPANDING THE BOUNDARIES OF INTELLECTUAL PROPERTY: INNOVATION POLICY FOR THE KNOWLEDGE SOCIETY 3 (Rochelle Cooper Dreyfuss et al. eds., 2001); *see also* Dennis D. Crouch, *The Patent Lottery: Exploiting Behavioral Economics for the Common Good*, 16 GEO. MASON L. REV. 141, 142 (2008) ("The majority of issued patents are relatively worthless, as the holder never asserts, licenses, or even leverages the asset. . . . [O]nly a few are highly valuable.").

36. *See* JOSEPH A. SCHUMPETER, CAPITALISM, SOCIALISM, AND DEMOCRACY 73–74 (1942).

37. Scherer, *supra* note 35, at 15–16.

38. Gideon Parchomovsky & R. Polk Wagner, *Patent Portfolios*, 154 U. PA. L. REV. 1, 25 (2005).

39. *Id.* at 5 n.4, 58.

this heterogeneity is the fact that there is little reliable data about how or whether risk aversion manifests within intellectual property settings, and most of what does exist seems frustratingly inconclusive.[40] Perhaps the most well-known study on this score was authored by Thomas Åstebro, who examined a sample of approximately one thousand Canadian inventions that had been evaluated for commercialization potential by a non-profit organization, the Canadian Innovation Centre (CIC).[41] Åstebro surveyed the inventors many years after the CIC evaluation to learn whether they had commercialized after receiving the CIC evaluation, and if so, what the return on investment was.[42] He reported that independent inventors tended to develop and commercialize even inventions that were projected to have *negative* expected returns.[43] In other words, these individuals continued to invest time and money in their inventions in a manner that would have been better spent elsewhere. Why might this be so? Åstebro concludes that "[r]isk-seeking is one of several plausible reasons why so many inventors proceed to develop their inventions while only a small fraction can reasonably expect to earn positive returns on their efforts. Another plausible explanation is that inventors are unrealistic optimists in that they overestimate their abilities to succeed."[44]

Risk preferences also play an important role in understanding the incentives of those who license IP from others. For example, these parties may similarly make their licensing choices in a manner that reflects the risk of liability for infringement. Robert Merges points to "risk aversion" as the reason a potential patent infringer may pay a higher rate or fee for a license than that which would be justified by a traditional economic analysis.[45] Jeanne Fromer makes a similar argument, not about the royalty rate, but about entering into licenses in the first instance. According to Fromer, competitors take patent licenses because they are risk-averse about potential liability.[46]

Although patent law is the central focus of this article, our arguments extend beyond it. Several scholars and courts, for example, consider the patent and copyright law as being closely intertwined.[47]

40. *See* Andres Sawicki, *Risky IP*, 48 LOY. U. CHI. L.J. 81, 120 (2016) ("Existing empirical work provides some support for this [risk tolerance] hypothesis, although it is inconclusive.").

41. *See* Thomas Åstebro, *The Return to Independent Invention: Evidence of Unrealistic Optimism, Risk Seeking or Skewness Loving?*, 113 ECON. J. 226, 227 (2003).

42. *Id.* at 228.

43. *Id.* at 227.

44. *Id.* at 236.

45. Robert P. Merges, *Commercial Success and Patent Standards: Economic Perspectives on Innovation*, 76 CALIF. L. REV. 803, 867 n.260 (1988).

46. *See* Jeanne C. Fromer, *Claiming Intellectual Property*, 76 U. CHI. L. REV. 719, 751 (2009).

47. *See, e.g.*, Global-Tech Appliances, Inc. v. SEB S.A., 563 U.S. 754, 763 (2011) (considering case law from copyright law to interpret Section 271(b) of the Patent Act

This is in part because both areas of law draw their authority from the same clause in the U.S. Constitution.[48] But even on a more functionalist level, risk aversion appears to play a similar motivating role in the copyright literature. James Gibson, for example, writes that "the decision-makers in the real world of copyright practice are typically risk-averse" and that new copyrightable works require "high upfront investment" and only a "prospect" at profits, reflecting the risk of creation failure.[49] But Gibson also ties the risk-aversion to liability for infringement, saying that decision makers "approach legal issues very conservatively, particularly issues like copyright liability, which have the potential to delay or even destroy the entire project."[50] Fromer also posits that fear of copyright liability causes particular problems because authors are risk-averse. She opines that "risk-averse authors might frequently avoid modifying works in ways that ought to be construed as fair uses or secure an unnecessary license authorizing this modification."[51]

On the other hand, Andres Sawicki nicely explains the state of the research into risk tolerances relating to copyright (and intellectual property more broadly). While noting the empirical evidence is often inconclusive and scant, Sawicki hypothesizes that creators have a greater tolerance for risk than the general population.[52] The reasoning is that creative individuals prefer riskier environments because such environments open up more avenues for creativity than less risky ones.[53] Sawicki further speculates that the risk preferences of creators might affect which form of incentive — IP rights, prizes, grants, and tax credits — would be societally optimal.[54] But in the end, all of this is admittedly conjecture: As Sawicki himself emphasizes, the empirical evidence has not been uniform.[55]

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regarding inducing infringement); Sony Corp. of Am. v. Universal City Studios, 464 U.S. 417 (1984) (quoting United States v. Paramount Pictures, 334 U.S. 131, 158 (1948)) (noting that copyright law, like patent law, makes reward to the owner a secondary consideration); J.H. Reichman, *Charting the Collapse of the Patent-Copyright Dichotomy: Premises for a Restructured International Intellectual Property System*, 13 CARDOZO ARTS & ENT. L.J. 475, 508–12 (1984).

48. U.S. CONST. art. I, § 8, cl. 8 ("The Congress shall have Power . . . To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries.").

49. James Gibson, *Risk Aversion and Rights Accretion in Intellectual Property Law*, 116 YALE L.J. 882, 891 (2007).

50. *Id.*

51. Jeanne C. Fromer, *Expressive Incentives in Intellectual Property*, 98 VA. L. REV. 1745, 1820 (2012).

52. *See* Sawicki, *supra* note 40, at 81.

53. *Id.*

54. *Id.* at 88.

55. *Id.* at 85. One article is tangential to our experiment — Hans Hvide and Georgios Panos used stock market investment participation by Norwegian investors as a proxy for risk tolerance, and then showed that individuals with higher manifest risk tolerance are more likely

Backing up a layer, what do we know about the risk tolerances of the firms organizing and underwriting IP? Here, available data is similarly scant and somewhat open to interpretation, but a few observations warrant consideration. As is well known, the venture capital (VC) investment model is one that dominates innovation markets, with portfolio-company entrepreneurs and VC investors contracting over investments designed to propel the startup onto the right trajectory for a lucrative exit event, such as initial public offering or acquisition.[56] It is also well known that this trajectory is fraught with risk: a familiar statistic in the tech industry is that nine out of ten VC-backed startups fail.[57] Moreover, neither employees nor VC investors are easily able to diversify away their economic risks: Human capital investments are generally undiversifiable by definition, and venture capital funds must still concentrate their investments on a handful of illiquid equity positions.[58]

On first blush, an industry with a significant amount of undiversifiable risk would appear to be an unattractive target for risk-averse entrepreneurs and investors. Or at the very least, one might expect financial market participants to demand substantial risk premia

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to become entrepreneurs. Hans K. Hvide & Georgios A. Panos, *Risk Tolerance and Entrepreneurship*, 111 J. FIN. ECON. 200, 200 (2014). Their identification strategy hinges on consistency of preferences over time and across contexts. *See id.* at 203 ("An implicit assumption . . . is that the risk preference parameter *r* is stable over time and across decision problems. This assumption is debatable."). Our study, in contrast, demonstrates that risk preferences may not be consistent over time or across contexts. Also, we do not directly test entrepreneurship itself, but rather willingness to invest in risky entrepreneurial projects more heavily in one's stock market portfolio choices.

56. Elizabeth Pollman, *Startup Governance*, 168 U. PA. L. REV. 155, 164, 167 (2019); *see also* Brian Kingsley Krumm, *Fostering Innovation and Entrepreneurship: Shark Tank Shouldn't Be the Model*, 70 ARK. L. REV. 553, 561–69 (2017) (describing the history and model of venture capitalist investment).

57. This statistic is quite pervasive throughout the tech industry. *See, e.g.*, Erin Griffith, *Why Startups Fail, According to Their Founders*, FORTUNE (Sept. 25, 2014, 3:00 PM), https://fortune.com/2014/09/25/why-startups-fail-according-to-their-founders/ [https://perma.cc/XZM9-LTTJ]; Neil Patel, *90% of Startups Fail: Here's What You Need to Know About the 10%*, FORBES (Jan. 16, 2015, 10:00 AM), https://www.forbes.com/sites/neilpatel/2015/01/16/90-of-startups-will-fail-heres-what-you-need-to-know-about-the-10/ [https://perma.cc/WP72-5YAU]. However, studies have suggested that while venture capitalist startups tend to have high failure rates, those rates likely do not reach ninety percent. *See, e.g.*, Yael V. Hochberg, Alexander Ljungqvist & Yang Lu, *Whom You Know Matters: Venture Capital Networks and Investment Performance*, 62 J. FIN. 251, 263–64 (2007) (finding that companies who received their first institutional funding round between 1980 and 1999 failed about one-third of the time); Deborah Gage, *The Venture Capitalist Secret: 3 Out of 4 Start-Ups Fail*, WALL ST. J. (Sept. 20, 2012, 12:01 AM), https://www.wsj.com/articles/SB10000872396390443720204578004980476429190 [https://perma.cc/Q4R6-GA42] (finding that 75% of companies receiving venture funding failed from 2004 to 2010).

58. For example, Professor Gompers and Professor Lerner observed that VC funds typically invest in at most two dozen firms over their lifetime. Paul Gompers & Josh Lerner, *An Analysis of Compensation in the U.S. Venture Capital Partnership*, 51 J. FIN. ECON. 3, 6 (1999).

to tie up their capital in such illiquid purgatories. And yet, the venture capital industry has been vibrant for over three decades and continues to thrive, particularly in the innovation industries.[59] It is difficult to explain the explosiveness of this sector in the presence of significant individual risk aversion among its principal participants. And indeed, while VC investors tend to earn attractive returns (a possible marker of market risk aversion), several commentators have noted that the return premiums for VC investors appear comparatively modest when compared to equivalently risky investments, particularly in the last decade.[60] This phenomenon appears to hold true even though many of the same actors also routinely exhibit more conventional (risk-averse) tendencies in their other investment activities.[61]

The confluence of a vibrant VC market and generally risk-averse investors is easier to understand if risk tolerances interacted meaningfully with the domain of innovation. For example, if investors were more tolerant of risks in an innovation-related setting, then they would not demand compensation for risk-bearing to the same degree as in an analogous setting outside innovation industries. As such, it would make the longevity of the VC-backed industries much more understandable, as well as the seemingly inconsistent behavior of individual investors across segments — willing to gamble in innovation industries but shunning risk elsewhere.[62]

59. The private capital database Pitchbook, for example, documents that the total number of VC deals in innovative industries within the United States has more than tripled during the past few years, from 9,090 deals in 2010 to its peak of 29,202 deals in 2018, with the number remaining relatively constant afterwards. Moreover, total capital invested has been on a constant rise, reaching its peak in 2018 with $734.97 billion in capital raised. In 2019 there were $565.04 billion raised, a threefold increase from 2010 with $192.94 billion. *See* PITCHBOOK, www.pitchbook.com [https://perma.cc/4MAR-QPHA].

60. *See, e.g.*, Raphael Amit, Lawrence Glosten & Eitan Mueller, *Entrepreneurial Ability, Venture Investments, and Risk Sharing*, 36 MGMT. SCI. 1232, 1243 (1990) (developing a theoretical model that shows risk-averse entrepreneurs with differential ability will want to have VC investors who are risk-neutral); *cf.* Michael Ewens, Charles Jones & Matthew Rhodes-Kropf, *The Price of Diversifiable Risk in Venture Capital and Private Equity*, 26 REV. FIN. STUD. 1853, 1856–57 (2013) (reviewing the literature that shows that the large returns demanded by VC funds are not only compensating for risk, but also contain pure excess returns driven by agency cost considerations).

61. Ben Walther, *The Peril and Promise of Preferred Stock*, 39 DEL. J. CORP. L. 161, 204 ("Holders of preferred stock are also naturally risk-averse, since they participate in losses but not in gains; they can be expected to be unhappy with the board if it takes risks."); *see also* Brendan Coffey, *Venture Capitalists Become Risk Averse*, FORTUNE (Oct. 20, 2011, 5:48 PM), https://fortune.com/2011/10/20/venture-capitalists-become-risk-averse/ [https://perma.cc/Q42E-ERBG]; *cf.* Steven N. Kaplan & Per Strömberg, *Characteristics, Contracts, and Actions: Evidence from Venture Capitalist Analyses*, 59 J. FIN. 2177, 2208 (2004) (assessing the effect of internal and external risks on venture capitalist decision-making).

62. *Cf.* Ewens et al., *supra* note 60, at 1883 (describing the "idiosyncratic risk" resulting from "[u]navoidable principal-agent problems . . . combined with the need for investment oversight").

3. Prior Related Experiments on Intellectual Property.

Having reviewed some of the conceptual literature related to innovation markets and risk aversion, here we touch briefly on the growing amount of experimental work in the IP field. There is some prior work here complementary to our enterprise, but none of it appears to be right on point.[63] Perhaps the closest exploration to our own was conducted by Christopher Buccafusco and Christopher Sprigman, who ran a series of experiments designed to test for the existence and size of the "endowment effect" in intellectual property rights.[64] The endowment effect is a well-known (and oft-debated) phenomenon in behavioral psychology, asserting that people tend to value rights (or initial "endowments") more when they already own them, as opposed to when they would have to pay to acquire such rights.[65] For example, a person would tend to demand more to sell a property or other legal right that she already owns than she would be willing to pay for the identical right out of a stock of cash (or other liquid asset). Exactly *why* people's valuations depend on initial endowments is not entirely clear. Gregory Klass and Kathryn Zeiler explain endowment effects as a corollary to "loss aversion" — the idea that losses cause more pain than gains cause pleasure.[66] The existence of endowment effects is somewhat controversial with a few economists,[67] but many

63. Foremost are several prior experimental papers on IP law, many of them by Christopher Buccafusco, Christopher Sprigman, and various coauthors. *See infra* notes 68, 70, 71, 73. These experiments aim to figure out how people respond creatively to various types of incentives, and how they value and trade the IP once it is created.

64. Christopher Buccafusco & Christopher Sprigman, *Valuing Intellectual Property: An Experiment*, 96 CORNELL L. REV. 1, 4 (2010) [hereinafter *Valuing Intellectual Property*] ("[N]o study has explored the existence of the endowment effect for property that, like IP, (1) was actually *created by* the owners and (2) is *nonrival* . . . . [W]e present an experiment that demonstrates a substantial valuation asymmetry. . . . The observed differences . . . indicate that IP licensing markets may be substantially less efficient than previously believed."); Christopher Buccafusco & Christopher Sprigman, *The Creativity Effect*, 78 U. CHI. L. REV. 31, 31 (2011) [hereinafter *The Creativity Effect*] ("[W]e report on . . . a planned series of experiments designed to determine whether transactions in intellectual property (IP) are subject to the valuation anomaly commonly referred to as the 'endowment effect' — the empirical finding that owners of goods tend to value them substantially more than do purchasers.").

65. Russell Korobkin, *The Endowment Effect and Legal Analysis*, 97 NW. U. L. REV. 1227, 1228 (2003) (discussing the endowment effect).

66. Gregory Klass & Kathryn Zeiler, *Against Endowment Theory: Experimental Economics and Legal Scholarship*, 61 UCLA L. REV. 2, 4 (2013). But other psychological explanations might be possible. Thus, one might gain some sentimental attachment to objects, particularly intimate objects such as wedding rings, clothing, and jewelry, from owning them. Margaret Jane Radin, *Property and Personhood*, 32 STAN. L. REV 957, 959 (1982).

67. *See, e.g.*, Klass & Zeiler, *supra* note 66, at 6; Charles R. Plott & Kathryn Zeiler, *The Willingness to Pay—Willingness to Accept Gap, the "Endowment Effect," Subject Misconceptions, and Experimental Procedures for Eliciting Valuations*, 95 AM. ECON. REV. 530, 531 (2005) (suggesting that experimental subjects' misconceptions are responsible for the endowment effect); Elizabeth Hoffman & Matthew Spitzer, *Willingness-To-Pay vs.*

experiments, including those of Buccafusco and Sprigman, find that they are real and extend to IP markets.[68] Specifically, Buccafusco and Sprigman find that the endowment effect is large for the rights to a prize for a winning poem or painting.[69] However, these insights — while interesting and important in their own right — are somewhat tangential to our inquiry here. First, they test for bids and offers for a prize in a copyright context, not the decision to invest in an invention. Second, their endowment effect frame is fundamentally different from (and independent of) our risk tolerance frame.[70]

There are a number of other important experimental recent works on IP. For example, Buccafusco, Burns, Fromer, and Sprigman test the different incentives provided by copyright and patent on creativity.[71] They have subjects play a game, randomly assigning the scoring rubrics. Buccafusco et al. argue that the different scoring rubrics are proxies for the creativity thresholds in patent and copyright, with patent having a higher bar to score any points, and copyright with a low bar. Unlike our study, their experiment does not address risk preferences of inventors or investors. Several prior works have focused on sequential innovation — the problem of needing to get permission to use prior, protected works in creating new works. The first was an extremely

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Willingness-To-Access: Legal and Economic Implications, 71 WASH. U. L. Q. 59, 59–60 (1993); Jennifer Arlen, Matthew L. Spitzer & Eric L. Talley, *Endowment Effects Within Corporate Agency Relationships*, 31 J. LEGAL STUD. 1, 5 (2002); Jason F. Shogren, Seung Y. Shin, Dermot J. Hayes & James B. Kliebenstein, *Resolving Differences in Willingness to Pay and Willingness to Accept*, 84 AMER. ECON. REV. 255, 256–56 (1994).

68. *See Valuing Intellectual Property*, *supra* note 64, at 3–4 (creating an experimental market for poems modeled after a market for licensing IP and finding a substantial valuation asymmetry between authors of poems and potential purchasers of them); *The Creativity Effect*, *supra* note 64, at 39 (showing that painters value their paintings more than four times higher than potential buyers of the paintings did and almost twice as high as did legal owners of the paintings).

69. *The Creativity Effect*, *supra* note 64, at 42.

70. *See infra* Section II.B. In addition, they do not test for the differences between laboratory experiments and M-Turk. There is at least one prior work using M-Turk for an IP experiment. *See generally* Christopher Buccafusco, Paul J. Heald & Wen Bu, *Testing Tarnishment in Trademark and Copyright Law: The Effect of Pornographic Versions of Protected Marks and Works*, 94 WASH. U. L. REV. 341, 341 (2016) ("This Article presents two novel experimental tests of the tarnishment hypothesis . . . . Our results find little evidence supporting the tarnishment hypothesis."). However, we have found no prior work testing for the *difference* between a brick-and-mortar laboratory and M-Turk in any IP experiment.

71. Christopher Buccafusco, Zachary C. Burns, Jeanne C. Fromer & Christopher J. Sprigman, *Experimental Tests of Intellectual Property Laws' Creativity Thresholds*, 92 TEX. L. REV. 1921, 1946 (2014). These legal rules can be quite idiosyncratic. For a superb experimental test of the fairness of the German "Bestseller Paragraph" provision in copyright, and its effect on the market, see Christoph Engel & Michael Kurschilgen, *Fairness Ex Ante and Ex Post: Experimentally Testing Ex Post Judicial Intervention into Blockbuster Deals*, 8 J. EMPIRICAL LEGAL STUD. 682, 699 (2011).

complicated, multiple stage game.[72] Some subsequent experiments have been less complex and suggest that IP rights in a first invention hinder sequential innovation.[73] Others suggest that a *lack* of rights in a first invention, as against sequential invention, discourages the initial invention.[74] Sequential innovation is an interesting yet distinct question from the research questions we tackle in this article.

In sum, although there are several interesting scholarly contributions at the intersection of IP and experimental methods, it appears that none of them directly addresses the issues we attempt to take on in this paper.

B. Framing Effects

The core focus of our study pertains to whether risk tolerances appear to interact responsively to contexts "framed" by innovative activity. Consequently, our arguments intersect in meaningful ways with the "framing literatures" that permeate much of psychology, political science, and economics. Within these literatures, as it turns out, the term "frame" can be used in several different ways. Thus, in order to identify and situate our contribution, we briefly review below several competing conceptions of the term, identifying where our analysis fits in. Readers who are already knowledgeable about the taxonomy of "framing effects" in economics, psychology, political science, and sociology literatures may go directly to Section 4 in this subsection, which identifies the particular type we utilize in our experiments.

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72. *See* Andrew W. Torrance & Bill Tomlinson, *Patents and the Regress of Useful Arts*, 10 COLUM. SCI. & TECH. L. REV. 130, 142 (2009) ("This Article presents empirical data generated using PatentSim, — a simulation game designed specifically to test hypotheses about patent systems, commons systems, and technological innovation.").

73. *See, e.g.*, Stefan Bechtold, Christopher Buccafusco & Christopher Jon Sprigman, *Innovation Heuristics: Experiments on Sequential Creativity in Intellectual Property*, 91 IND. L.J. 1251, 1251 (2016) ("We find that subjects are only mildly responsive to external incentives. Rather, choices between innovation and borrowing correlated much more powerfully with their internal, subjective beliefs about the difficulty of innovating."); Julia Brüggemann, Paolo Crosetto, Lukas Meub & Kilian Bizer, *Intellectual Property Rights Hinder Sequential Innovation — Experimental Evidence*, 45 RSCH. POL'Y 2054, 2054 (2016) ("Our results suggest that granting intellectual property rights hinders innovations, especially for sectors characterized by a strong sequentiality in innovation processes."). Note, however, that Bechtold et. al. obtains results partially *inconsistent* with inventor rationality. Bechtold, *supra*, at 1286.

74. *See, e.g.*, Kevin J. Boudreau & Karim R. Lakhani, *"Open" Disclosures of Innovations, Incentives, and Follow-on Reuse: Theory on Processes of Cumulative Innovation and a Field Experiment in Computational Biology*, 44 RSCH. POL'Y 4, 4 (2015) ("We find intermediate disclosure has the advantage of efficiently steering development towards improving existing solution approaches, but also the effect of limiting experimentation and narrowing technological search.").

1. Categorization Schemes

Framing categorization schemes in the political science and psychology literatures are reasonably well established. For example, James Druckman contrasts *equivalence* framing — "the use of different, but logically equivalent, words or phrases (e.g., 5% unemployment or 95% employment, 97% fat-free or 3% fat) causes individuals to alter their preferences" — with *emphasis* framing effects, which "caus[e] individuals to focus on certain aspects or characterizations of an issue or problem instead of others."[75] Priyodorshi Banerjee and Sujoy Chakravarty, on the other hand, contrast *label* framing, invoked "if subjects are confronted with alternative wordings, but objectively equivalent material incentives and unchanged reference points (with regard to how the endowment is initially allocated)," with *value* framing, where "subjects are confronted with alternative wordings and objectively equivalent material incentives but changed reference points."[76] Irwin Levin, Sandra Schneider, and Gary Gaeth contrast *risky choice* framing (similar to value framing) with *attribute* framing, where "people are more likely to evaluate a gamble favorably when it is described positively in terms of winning rather than when it is described negatively in terms of losing," and *goal* framing, which describes "the goal of an action or behavior."[77] None of these categorizations is directly analogous to our inquiry here.

2. Light Computation

In other literatures, framing tends to place subjects in a situation that requires light computation to understand the choices they confront. These framing studies include the "reference point" studies for which Kahneman and Tversky are most famous.[78] This category also includes circumstances where frames induce asymmetric errors in understanding games.[79] There are additionally experiments that use compound

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75. James N. Druckman, *The Implications of Framing Effects for Citizen Competence*, 23 POL. BEHAV. 225, 228, 230 (2001).

76. Priyodorshi Banerjee & Sujoy Chakravarty, The Effect of Minimal Group Framing in a Dictator Game Experiment 5 (June 1, 2012) (unpublished manuscript) (available at https://papers.ssrn.com/abstract_id=2071006 [https://perma.cc/D3TD-AZZE]).

77. Irwin P. Levin, Sandra L. Schneider & Gary J. Gaeth, *All Frames Not Created Equal: A Typology and Critical Analysis of Framing Effects*, 76 ORGANIZATIONAL BEHAV. & HUM. DECISION PROCESSES 149, 150, 159–60 (1998).

78. *See* Tversky& Kahneman., *supra* note 15, at 456.

79. *See* Toke Reinholt Fosgaard, Lars Gårn Hansen & Erik Wengström, *Framing and Misperception in Public Good Experiments*, 119 SCANDINAVIAN J. ECON. 435, 440 (2016). Fosgaard et al. ran a public goods game in two different frames. After the game was over, the authors asked the subjects which set of strategies would have maximized their own payoffs,

lotteries.[80] For example, Mohammed Abdellaoui, Peter Klibanoff, and Laetitia Placido measured compound risk and found that subjects valued compound risks differently than simple risks and that the risk attitudes displayed "more [risk] aversion as the reduced probability of the winning event increases."[81] Also worthy of note here is a fascinating recent paper by Richard Brooks, Alexander Stremitzer, and Stephan Tontrup, which studies the *effort* participants exerted when they entered into a contract and completed economic tests for compensation.[82] The authors determined that thresholds and framing affect effort, noting particularly that loss framing with "poorly selected thresholds may reduce effort."[83] These versions of light computation frames have features that are shared with the type of frame we study here.

3. Emphasis and Priming

There are also frames that tend to emphasize some aspect of a given choice, casting one (or more) option in a negative or positive light. An excellent example comes from Dennis Chong and James Druckman, discussing a study by Paul Sniderman and Sean Theriault:

> What is particularly vexing in public opinion research is a phenomenon known as "framing effects." These occur when (often small) changes in the presentation of an issue or an event produce (sometimes large) changes of opinion. For example, when asked whether they would favor or oppose allowing a hate group to hold a political rally, 85% of respondents answered in favor if the question was prefaced with the suggestion, "Given the importance of free speech," whereas only

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and which set of strategies would have maximized the payoff to other group members. When a subject was unable to answer these questions correctly, the authors coded that as an error. Fosgaard et al. found that one of the frames induced far more errors than did the other frame, even though the underlying tasks and choices were identical. *Id.* at 437, 449.

80. A simple lottery has the general form $pA + (1 - p)$, where p is a probability between 0 and 1, and A and B are outcomes. A two-element compound lottery has the general form $r[pA + (1 - p)B] + (1 - r)[qC + (1 - q)D]$, where p, q, and r are all probabilities, and A, B, C, and D are outcomes.

81. Mohammed Abdellaoui, Peter Klibanoff & Laetitia Placido, *Experiments on Compound Risk in Relation to Simple Risk and to Ambiguity*, 61 MGMT. SCI. 1306, 1306 (2015).

82. Richard R. W. Brooks, Alexander Stremitzer & Stephan Tontrup, *Stretch It but Don't Break It: The Hidden Cost of Contract Framing*, 46 J. LEGAL STUD. 399, 402 (2017).

83. *Id.* at 399.

> 45% were in favor when the question was prefaced with the phrase, "Given the risk of violence."[84]

In this sort of frame, there is no real difficulty or mental computation required in understanding the basic choice of allowing a hate group to hold a rally or not. The frame, instead, prompts the subject to concentrate on either a positive aspect (the value of free speech) or a negative aspect (the risk of violence) inherent in the choice. Emphasis frames seem very close to *priming* in psychology — an approach that gives subjects some information that triggers a particular emotional reaction, or which focuses attention on some aspect of the experiment.[85] Thus, a recent article "primes" experimental subjects (all of whom were financial professionals) with either a boom or a bust scenario.[86] Those who were primed with a bust scenario became more risk-averse.[87] But one could just as easily say that the subjects were in a bust frame, where the frame is an emphasis frame.[88] Priming, rather than framing, tends to be used in experiments involving financial decision-making and risk

84. Dennis Chong & James N. Druckman, *Framing Theory*, 10 ANN. REV. POL. SCI. 103, 104 (2007) (citing Paul M. Sniderman & Sean M. Theriault, *The Structure of Political Argument and the Logic of Issue Framing*, *in* STUDIES IN PUBLIC OPINION: ATTITUDES, NONATTITUDES, MEASUREMENT ERROR, AND CHANGE 132, 151–52 (Willem E. Saris & Paul M. Sniderman eds., 2018)).

85. *See* John A. Bargh & Tanya L. Chartrand, *The Mind in the Middle: A Practical Guide to Priming and Automaticity Research*, *in* HANDBOOK OF RESEARCH METHODS IN SOCIAL AND PERSONALITY PSYCHOLOGY 253, 255 (Harry T. Reis & Charles M. Judd eds., 2000) (providing a guide to various priming methods used across psychological fields); Els C. M. Van Schie & Joop Van Der Pligt, *Influencing Risk Preference in Decision Making: The Effects of Framing and Salience*, 63 ORGANIZATIONAL BEHAV. & HUM. DECISION PROCESSES 264, 265 (1995) (discussing the relevance of salience, which may be produced by priming).

86. Alain Cohn, Jan Engelmann, Ernst Fehr & Michel André Maréchal, *Evidence for Countercyclical Risk Aversion: An Experiment with Financial Professionals*, 105 AM. ECON. REV. 860, 861–62 (2015). For a similar boom/bust priming experiment with M-Turk subjects, see Jae Hyoung Kim & Elizabeth Hoffman, Contrast Effects in Investment and Financing Decisions 7–9 (Oct. 19, 2018) (unpublished manuscript) (available at https://papers.ssrn.com/abstract_id=3256087 [https://perma.cc/2Y8U-HW5J]) (finding that contrast effects altered investment decisions, but not financing decisions, and hypothesizing that the fact that subjects took significantly more time making financing decisions than investment decisions suggests that financing decisions required more careful thought and triggered "slow" thinking, as described by Daniel Kahneman, *see generally* DANIEL KAHNEMAN, THINKING FAST AND SLOW (2011)).

87. Cohn et al., *supra* note 86, at 861–62.

88. Similarly, Ellingsen et al. found that situational labels significantly affect behavior. They framed a prisoner's dilemma as a "community game" or a "stock market game," and found that subjects were more cooperative when framed as a "community game." Tore Ellingsen, Magnus Johannesson, Johanna Mollerstrom & Sara Munkhammar, *Social Framing Effects: Preferences or Beliefs?*, 76 GAMES & ECON. BEHAV. 117, 124 (2012). Further, Tyran and Feld found that expectations of cooperation amongst others lead to an increase in cooperation with non-deterrent sanction laws. Jean-Robert Tyran & Lars P. Feld, *Achieving Compliance when Legal Sanctions Are Non-Deterrent*, 108 SCANDINAVIAN J. ECON. 135, 153 (2006).

acceptance.[89] Again, this approach does not seem to square with the frame in our paper.

4. Imagine Yourself in a Context

Finally, "Imagine Yourself in a Context" frames can be found in experiments that either tell subjects that they are in a particular setting, or ask the subjects to imagine themselves in a particular setting when making choices. These experiments often involve risky choices, particularly those experiments looking for the source of differences between men's and women's attitudes towards risk.[90] In these frames, the subjects are prompted to imagine themselves in a casino, or imagine themselves buying insurance, or imagine themselves making an investment. In some of these papers, the context, interacted with gender, produces a change in risk aversion.[91] For example, Renate

89. *See, e.g.*, Hans-Peter Erb, Antoine Bioy & Denis J. Hilton, *Choice Preferences Without Inferences: Subconscious Priming of Risk Attitudes*, 15 J. BEHAV. DECISION MAKING 251, 253 (2002); Katja Meier-Pesti & Elfriede Penz, *Sex or Gender? Expanding the Sex-Based View by Introducing Masculinity and Femininity as Predictors of Financial Risk Taking*, 29. J. ECON. PSYCH. 180, 188–89 (2008). For a highly imaginative connection of priming and memory, see Petko Kusev, Paul van Schaik & Silvio Aldrovandi, *Preferences Induced by Accessibility: Evidence from Priming*, 5 J. NEUROSCIENCE PSYCHOL. & ECON. 250 (2012).

90. *See, e.g.*, Catherine C. Eckel & Philip J. Grossman, *Forecasting Risk Attitudes: An Experimental Study Using Actual and Forecast Gamble Choices*, 68 J. ECON. BEHAV. & ORG. 1, 1 (2008) ("We find that women are significantly more risk averse than men . . . and predictions of both women and men tend to confirm this difference."); Renate Schubert, Martin Brown, Matthias Gysler & Hans Wolfgang Brachinger, *Financial Decision-Making: Are Women Really More Risk-Averse?*, 89 AM. ECON. REV. 381, 382–83 (1999) (describing experiments designed to test how men and women react differently when confronted with risky financial decisions); Helga Fehr-Duda, Manuele de Gennaro & Renate Schubert, *Gender, Financial Risk, and Probability Weights*, 60 THEORY & DECISION 283, 286 (2006); Sebastian Lotz, Is Women's Behavior More Context-Dependent than Men's? Gender Differences in Reluctant Altruism 1 (December 19, 2014) (unpublished manuscript) (available at http://ssrn.com/abstract=2540050 [https://perma.cc/G9RE-GHM9]); Gary Charness & Uri Gneezy, *Strong Evidence for Gender Differences in Risk Taking*, 83 J. ECON. BEHAV. & ORG. 50, 55 (2012).

91. The study conducted by Schubert et al. found that "female subjects do not generally make less risky financial choices than male subjects." Schubert et al., *supra* note 90, at 384. However, the female subjects had different reactions to risk than male subjects in abstract gambling situations. *Id*. Additionally, Lotz found "considerable gender differences between women and men that depended on the context of the game." Lotz, *supra* note 90, at 4. When the game demanded more giving, women displayed more generosity, while the "men's behavior is not context-dependent." *Id.* at 1. Croson et al. observed differences in risk and social and competitive preferences and noted that emotions, overconfidence and framing could be the cause behind sex differences. Rachel Croson & Uri Gneezy, *Gender Differences in Preferences*, 47 J. ECON. LITERATURE 448, 452–54 (2009). Additionally, Charness and Gneezy directly found that women are less likely to invest. Charness et al., *supra* note 90, at 57. When Eckel and Grossman conducted research in gambling games with three framings, they found that women were more risk-averse even with an investment frame with no losses. Eckel et al., *supra* note 90, at 1. In contrast, Nelson reviewed thirty-five empirical works that studied sex-based risk aversion and determined that in many cases, the difference between men and women lacked statistical significance. Julie A. Nelson, *Are Women Really More*

Schubert and coauthors gave subjects a choice between a lottery and a certain amount of money.[92] First, subjects were given a plain, unadorned choice, with no context. Then, later in the experiment, subjects were offered the same choice, but within an "investment" context. In the unadorned choice, women exhibited more risk aversion than did men. But when the choice was embedded in an investment context, women and men revealed the same levels of risk aversion.[93] Although such a result is quite striking, the exact mechanism is unclear. It could be that subjects have different utility functions in different contexts, or perceive probabilities differently in different contexts (e.g., casino vs. insurance) or it could be that the frames prime different emotions that in turn change behavior.[94] This context is, in essence, the nature of the frame we employ below.

III. Description of Experiment

Having reviewed the general literature on intellectual property, risk tolerance and framing effects, we are now in a position to explain the details of our experimental design.

1. Experimental 2x2 Design

As noted in the Introduction, the central question we explore in this article is whether people manifest different risk tolerances when an otherwise risky choice is framed in terms of an innovation-related investment. Thus, a key feature of our experiment is to confront subjects with a choice between (1) a safe option and (2) a risky option; and then to manipulate that choice to be framed in (i) an innovation-framed context or (ii) a non-framed context. Our baseline experiments, then — as well as our robustness tests — navigate variants of the basic design illustrated in Table 1:

Risk-Averse Than Men? A Re-Analysis of the Literature Using Expanded Methods, 29 J. ECON. SURVS. 566, 580 (2015).

92. Schubert et al., *supra* note 90, at 383–84.

93. *Id.* at 384.

94. Emotions such as fear can alter risk decisions; Lee and Andrade studied the effect fear plays on risk taking. Chan J. Lee & Eduardo B. Andrade, *Fear, Excitement, and Financial Risk-Taking*, 29 COGNITION & EMOTION 178, 178 (2014). They induced fear by having subjects watch two horror movie clips and observed that fear-induced subjects were more risk-averse when the risk was framed as a stock market game. *Id.* However, they found that risk taking *increased* when framed as an "exciting casino game." *Id.*

Table 1: 2x2 Setup for Experimental Design

	(1) Safe Option	**(2) Risky Option**
(I) Innovation-Related Frame	I	II
(ii) No Frame	III	IV

Consider first the choice presented to subjects in the innovation-related frame (cells I and II in the top row of Table 1, which we refer to in what follows as our "Invest in Invention" treatment group). Subjects in this frame were given the following prompt:

> Before filling out a brief questionnaire, you will be given $8 either to *Keep* or to *Invest* in creating a hypothetical invention . . . . If you choose to *Keep*, your earnings will be $8. If you choose to *Invest* there is a 1/3 chance that the creative and commercialization process will be successful and return $30, and a 2/3 chance that it will be unsuccessful in the market and return $3. A role of a die will determine your earnings, either $30 or $3.

Now consider the choice presented to subjects in the non-innovation frame (cells III and IV in the bottom row of Table 1, or the "Simple Lottery" control group). Subjects in this frame were given the following prompt:

> Before filling out a brief questionnaire, you will be asked to make a choice between *Option A* and *Option B*. You will have only a single opportunity to choose. After you have made your choice, if you chose *Option A*, your earnings will be $8. If you chose *Option B*, there is a 1/3 chance that your earnings will be $30, and a 2/3 chance that your earnings will be $3. A role of a die will determine your earnings, either $30 or $3.

Note that the Simple Lottery frame and the Invest in Invention frame describe economically identical risk-reward choices. The key difference is the way the choices are framed.[95]

95. The attentive reader will notice that the Invest in Invention frame initially endows the subject with cash and asks whether she wants to invest it in the risky option, while the Simple Lottery setup does not endow the subject with anything and asks her to choose between safe and risky options. Consequently, one might be concerned that this phrasing inadvertently introduces a type of "endowment effect" in the innovation frame. We address this issue below.

In passing, it is worth observing that the first setup above is closest to the "Imagine Yourself in a Context" version of framing discussed above, albeit incentivized with real economic stakes. In the Invest in Invention frame, we inform subjects that they have the opportunity to invest in a "hypothetical invention." The payoffs correspond to whether or not the invention succeeds and is a success in the market. Beyond the (accurate) financial rewards, clearly none of this is *literally* true. Rather, by being prompted that this is a hypothetical invention, the subjects are being asked to imagine that it is true, and act accordingly (incentivized by monetary rewards). We used the adjective "hypothetical" to describe the invention to reduce the chance that subjects felt that the invention was exciting or prosocial. We believe that labeling it as a hypothetical invention should moderate the effect of the word "invention" on subjects, likely rendering conservative estimates of the true effects of "invention."[96] Significantly, the two choices are stated in absolutely identical terms. And, just as in the other papers that use this frame, we assume that the subjects are imagining in precisely the way that we ask of them.

Notice also that the experiment uses a simple, binary choice between a safe option and a risky option. We chose this design deliberately, for two reasons. First, anticipating that we would be running our experiment on M-Turk, and knowing that M-Turk subjects often present a different profile from brick-and-mortar subjects in the lab,[97] we wanted to keep the choice simple and intuitive.[98] Second, we

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See infra Section V.A.2. But to cut to the chase, it does not appear that this concern has much of an impact on our results. First, there are *a priori* reasons to doubt the endowment effect plays much of a role in this context, since it is known to dissipate when the initial "endowment" consists of cash or liquid assets (as does ours). But even if our innovation frame introduced an endowment effect, we would predict it would cut in the direction of making our subjects in that frame *overly reluctant* to part with their safe endowment for the risky choice. (As we show, the strong tendency of our subjects is to do the opposite.) But in any event, we also explore a variation on our experiment where the treatment retains the endowment feature but strips out all investment and innovation framing. There, our measured effect largely disappears. *See infra* Section V.A.1.

96. Our frame is also tangentially related to a light computation frame, similar to the reference point frame used by Kahneman and Tversky. *See* Tversky et al., *supra* note 15, at 456.

97. *See* Gabriele Paolacci & Jesse Chandler, *Inside the Turk: Understanding Mechanical Turk as a Participant Pool*, 23 CURRENT DIRECTIONS PSYCH. SCI. 184, 185 (2014) (finding that M-Turkers averaged 30 years of age, tending to be younger than the general population). Lab subjects in our experiment average just over 20 years of age.

98. *See* Chetan Dave, Catherine Eckel, Cathleen Johnson & Christian Rojas, *Eliciting Risk Preferences: When Is Simple Better?*, 41 J. RISK & UNCERTAINTY 219, 219 (2010) ("We analyze how and when a simpler, but coarser, elicitation method may be preferred to the more complex, but finer, one. . . . [T]he simpler task may be preferred for subjects who exhibit low numeracy, as it generates less noisy behavior but similar predictive accuracy."). An alternative would have been to use something like the choice used by Gneezy and Potters. Uri Gneezy & Jan Potters, *An Experiment on Risk Taking and Evaluation Periods*, 112 Q.J. ECON. 631, 634 (1997). Each subject was given 200 units (convertible to cash at the end of the

used the simple, binary choice because it captures some of the features of the external world in ways that more complex and nuanced choices do not. When someone is asking herself, "Should I invest this money or keep it?", she is far more likely to approach this question as binary, at least as a first step. And there are many situations, possibly as a result of mental accounting,[99] where binary choices seem pervasive. None of this is to say that a more complex, continuous-choice approach is not also relevant to understanding behavior. If one were trying to model someone who is deciding on a large number of investments as a portfolio, a different approach would be needed.[100]

2. Demographic Variables and Baseline Risk Aversion

In addition to making the choices described above, each subject additionally answered a series of demographic questions (related to age, gender, education, and the like) as well as a well-known risk aversion scale[101] that delivers a quantitative reflection of risk aversion for each subject.

The risk aversion diagnostic we employ is often known in the economics literature as the Holt-Laury (or HL) measure. The HL measure for risk aversion asks a subject to make a choice — Option A (a low variance gamble) or Option B (a high variance gamble) — across

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experiment), and then offered the choice to allocate X, where $0 \leq X \leq 200$, to the following gamble: a 2/3 chance of losing the amount of her "bet," X; and a 1/3 chance of winning 2.5 times X. *Id.* If the subject allocated less than 200 to the gamble, she received $200 - X$ with certainty, plus the outcome of the gamble. *Id.* For highly numerate subjects, such an approach might provide more fine-grained information on attitudes towards risk. However, this choice is somewhat complicated, and with our M-Turk subjects, we feared generating a great deal of noise.

99. *See* Richard H. Thaler, *Mental Accounting Matters*, 12 J. BEHAV. DECISION MAKING 183, 183 (1999) ("Mental accounting is the set of cognitive operations used by individuals and households to organize, evaluate, and keep track of financial activities."); *see also* Thomas Langer & Martin Weber, *Prospect Theory, Mental Accounting, and Differences in Aggregated and Segregated Evaluation of Lottery Portfolios*, 47 MGMT. SCI. 716, 717 (2001) (reviewing literature suggesting that isolated evaluation frames may affect manifest preferences).

100. Jae Hyoung Kim and Elizabeth Hoffman examine the effect that prior good or bad news has on portfolio choices. Kim et al., *supra* note 86.

101. *See* Holt et al., *supra* note 14. We could have used the simpler Eckel and Grossman risk aversion test. Eckel et al., *supra* note 90, at 2. However, as Eckel and Grossman said themselves of Holt and Laury, "This mechanism imposes a finer grid on the subjects' decisions, and thus produces a more refined estimate of the relevant utility function parameters. However, this comes at a cost of increased complexity, which may lead to errors." *Id*. Others add: "The prevalent use of the Holt-Laury measure has allowed researchers to compare risk attitudes across a wide array of contexts and environments. In turn, this has facilitated a less fragmented approach to the study of risk preferences that minimizes methodological differences and aims to characterize a more general phenomenon." Gary Charness, Uri Gneezy & Alex Imas, *Experimental Methods: Eliciting Risk Preference*, 87 J. ECON. BEHAV. & ORG. 43, 46 (2013). Since we wanted to estimate a risk aversion parameter, we made the decision to use Holt and Laury, despite the increased complexity.

a grid of decisions that have progressively different risk characteristics corresponding to each succeeding row of Table 2. Typically, subjects' preferred option will switch from Option A to Option B at some row in the table, and then stay there for the remaining rows. It is important to note that asking subjects to choose between Option A and Option B from each row is the only instruction given to subjects. They do not even see the "Low Variation" and "High Variation" descriptors and we suggest no order for their answers.[102]

Table 2: Holt-Laury Risk Aversion Index

	Option A (Low Variation)	**Option B (High Variation)**
Row 1	10% chance of $2.00 and 90% chance of $1.60	10% chance of $3.85 and 90% chance of $0.10
Row 2	20% chance of $2.00 and 80% chance of $1.60	20% chance of $3.85 and 80% chance of $0.10
Row 3	30% chance of $2.00 and 70% chance of $1.60	30% chance of $3.85 and 70% chance of $0.10
Row 4	40% chance of $2.00 and 60% chance of $1.60	40% chance of $3.85 and 60% chance of $0.10
Row 5	50% chance of $2.00 and 50% chance of $1.60	50% chance of $3.85 and 50% chance of $0.10
Row 6	60% chance of $2.00 and 40% chance of $1.60	60% chance of $3.85 and 40% chance of $0.10

102. Subjects do not get any further instructions. But, for readers unfamiliar with HL, Table 2 is perhaps best understood by starting at the bottom row (Row 10). Neither Option A nor Option B has any risk whatsoever. Option A gives the subject $2.00 with certainty, while Option B gives the subject $3.85 with certainty. Any subject who prefers more money to less — a fundamental assumption about subjects in economics experiments — should choose Option B. Now consider the options provided in Row 9. By choosing Option A the subject has a 90% chance of getting $2.00 and only a 10% chance of getting $1.60, with an expected value of $1.96 = (0.90×($2.00)+0.10×($1.60)). Option B, on the other hand, gives the subject a 90% chance at $3.85, which is (still) much more than $2.00. However, Option B also introduces a 10% chance of getting a relatively unattractive downside of $0.10. Here, Option B has an expected value of $3.475, which is still much more than $1.96, but it now involves some downside risk. Is it rational to choose Option A in this circumstance? It could be, for someone who was very fearful of the 10% chance of $0.10 and was willing to trade almost half of Option B's expected value to escape that risk. We call such a person highly risk-averse. As one proceeds up the chart, from Row 10 (where everyone should choose Option B), to Row 1, each subject will eventually switch from Option B to Option A. Once the subject has switched from Option B to Option A, she should not (as a matter of theory) switch back. The unique row on the chart where the subject switches gives us a scaled measure of how risk-averse or risk-seeking that subject is. To be more precise, from the switching point one can compute upper and lower bounds of the subject's tolerance for risk, defined by the rows above and below the point of switching. The implications of these bounds is explored more fully below and in the Appendix. The key principle is that one can use these estimates of risk aversion as controls for the underlying general risk tolerances of each subject in our experiment. For more detailed discussion, see *infra* Appendix A.

Row 7	70% chance of $2.00 and 30% chance of $1.60	70% chance of $3.85 and 30% chance of $0.10
Row 8	80% chance of $2.00 and 20% chance of $1.60	80% chance of $3.85 and 20% chance of $0.10
Row 9	90% chance of $2.00 and 10% chance of $1.60	90% chance of $3.85 and 10% chance of $0.10
Row 10	100% chance of $2.00 and 0% chance of $1.60	100% chance of $3.85 and 0% chance of $0.10

3. Subject Pool, Recruitment and Compensation

Our data come from multiple waves of subjects, recruited across different platforms. We first conducted a series of the above experiments in the lab at Iowa State University, using students as subjects. The responses of these subjects were collected on a paper form, and the roll of a die determined the payoff for those subjects who chose the risky option. In this wave (and all the others), subjects were randomly assigned to either the Invest in Invention frame treatment group or the Simple Lottery frame control group, and the order of presentation of the certain and the risky options was randomly presented as either the first or the second option.

We then migrated our experiments to the M-Turk platform, using a Qualtrics format to collect the data and roll a simulated, electronic die. M-Turk subjects were paid in experimental dollars that converted to one-fourth of the lab payoffs.

Finally, we replicated the experiments using a Qualtrics survey emailed to college students and conducted entirely online. Subjects chose to be paid by Amazon gift card, PayPal, or a check. The payoffs were expressed in experimental dollars that converted to one-half of the lab payoffs.[103]

In addition to our baseline condition, we stress tested our results with a variety of robustness checks. Of particular note, we confronted

103. We paid the M-Turk subjects about the same as they could earn in other M-Turk tasks. In contrast, we paid the subjects in the brick-and-mortar lab more because they had to spend much more time, including getting to and from the lab, to do the experiment. Also, they could not take the experiment at their convenience. Thus, the brick-and-mortar lab subjects had a much higher cost of participating in the experiment than did the M-Turk subjects. We paid the Qualtrics at Iowa State subjects an intermediate amount, representing a notion that although they could take the experiment at their convenience, they had many demands on their time, most prominently homework. Thus, we were attempting to compete with the opportunity costs of their time. We do not believe that the different levels of payment in the different contexts changed the results. *See* John Gibson & David Johnson, The Economic Relevancy of Risk Preferences Elicited Online and with Low Stakes 1 (June 8, 2018) (unpublished manuscript) (available at https://mpra.ub.uni-muenchen.de/87231/1/MPRA_paper_87231.pdf [https://perma.cc/4QFY-7AVF]) (finding that preferences are preserved online and with small stakes when compared to other published experimental results).

a select subset of our subjects (drawn from the M-Turk and online experiments) with a slightly varied vignette in which downside risk also presented the possibility of *negative* payoffs. For the negative-payoff conditions, *Option A* or *Keep* provided earnings of [$8],[104] just as in the baseline. But for *Option B* or *Invest in Invention*, we informed subjects that "there is a 1/3 chance that your earnings will be [$42], and a 2/3 chance that your earnings will be [-$3] . . . . These earnings or losses will be added to or subtracted from your [$5] participation fee."

In two additional robustness checks, we reran versions of the baseline experiments with slightly modified frames, both of which reverted to the baseline "can't lose money" setup. In the "Invest Only" version, the risky choice was framed without language referring to a "hypothetical invention." In the "Endow Only" version, the risky choice was framed in a manner that addresses possibilities of endowment effects in our baseline experiments. (Both robustness tests are described in greater detail in the next Part of this article.)

In all, we report on experiments with 1,159 subjects, drawn from laboratory, M-Turk and Qualtrics online student populations. For each group, subjects were then randomly assigned to treatment and control arms as listed in Table 3.

Table 3: Distribution of Subjects by Population and Version

	Laboratory	**Mechanical Turk**	**Qualtrics Online**
Baseline Treatment Group – Can't Lose $	51	101	59
Baseline Control Group – Can't Lose $	49	92	60
Baseline Treatment Group – Can Lose $	0	102	78
Baseline Control Group – Can Lose $	0	100	80
Robustness Treatment Group – Invest Only	0	94	0
Robustness Control Group – Invest Only	0	90	0

104. As described above, in the Qualtrics online surveys shown to M-Turker and Iowa State students, we converted the dollars to experimental dollars. In those experiments, we used a mythical monetary symbol ₳ to refer to the payouts to avoid confusing subjects. (We provided subjects with information that would allow them to make appropriate monetary conversions.)

Robustness Treatment Group – Endow Only	0	102	0
Robustness Control Group – Endow Only	0	100	0
Subtotals	100	781	277

We also collected a variety of demographic control variables for each subject, as specified in Table 4.[105]

Table 4: List of variables and descriptions

Collected Variables	**Description**
Age	Subject's age
Gender	Dummy = 1 if subject is male
Hand	Dummy = 1 if subject is left-handed
Ethnicity	Dummy = 1 if subject is non-white
Gambled	Dummy = 1 if subject has gambled for fun before

Figure 1 describes the breakdown of these various demographic variables (as well as the proportional representation of M-Turkers in our subject pool).

105. We collected gender because there is a literature on whether men's and women's risk preferences differ, and whether the preferences differ by frame. *See supra* notes 90–91. We collected the other data on the same theory — that maybe these characteristics would independently affect risk preferences, as well as preferences towards investing.

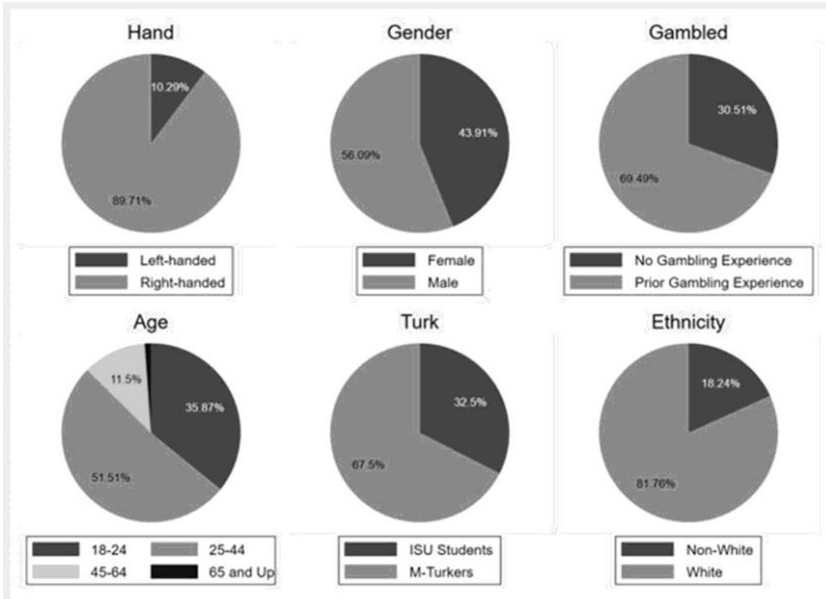

Figure 1: Breakdown of subjects by several demographic variables

Finally, as noted above, we elicited from each subject a Holt-Laury "score" ("HL score") by presenting them a version of Table 2, and recording the first row at which the subject switched away from preferring the low-variability Option A, and into the high-variability Option B. The distribution of switching points (as a proportion of the entire population of subjects) is depicted in Figure 2. Overall, the median switching point was at Row 7, with a mean of 6.43 and a standard deviation of 2.23. Note from the figure that just under 6% of our subjects appear to manifest significant risk tolerance, opting for Option B out of the gate, in the first row of Table 2. In addition, note that 3.86% of our subjects favor Option A across all rows — a behavior that seems abnormal once Row 10 is reached (since there is no risk in Row 10 and Option B dominates). For the sake of transparency, we retain these subjects for our results reported below, but we have confirmed that their exclusion does not materially change our results.[106]

106. For computing means and medians, we treat the modest number of "Always A" subjects as an 11 in our distribution scale. Excluding them entirely does not affect medians, and changes the mean and standard deviation only modestly.

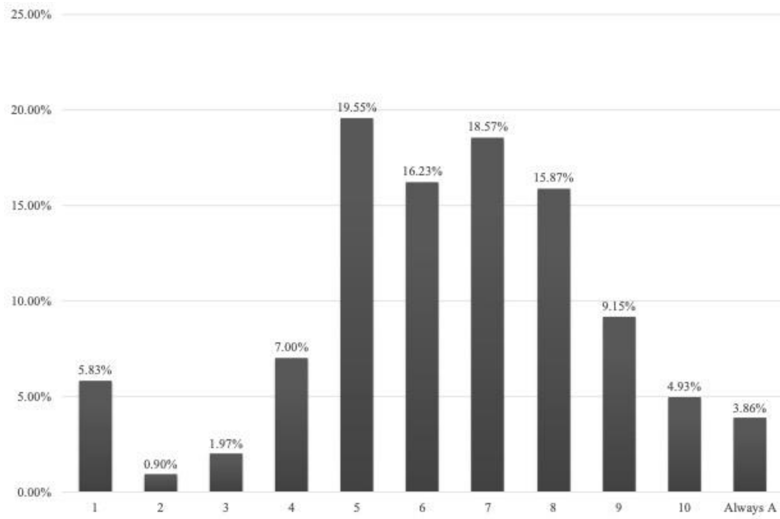

Figure 2: H-L Scores (first row where subject opted for Option B over Option A)

IV. RESULTS

Our primary results are shown in Figure 3, which illustrates the rate at which subjects opted for the "safe" choice depending on the frame presented to them. The left panel (3A) depicts the results of our largest, "baseline" experiment ("Invest in Invention Frame (Can't Lose Money)"), which tracks the exact wording of the hypotheticals as presented at the beginning of Part II. The right panel (3B) represents the results from the version of the experiment where it was possible to lose money with the risky choice ("Invest in Invention Frame (Can Lose Money)"). As is clear from the Figure, subjects in the experiment where losing money was possible (3B) opted for safety more frequently than when they could not lose money (3A). This effect alone should not be surprising (since frame 3B both introduces negative payoffs and increases the variance of the gamble represented by the risky option). More provocative, however, is the effect of the randomized framing treatment on *both* groups. In the "Can't Lose Money" subjects, framing the risky choice as an investment in innovation caused them to move from slightly preferring the risky option (56% to 44%) to *strongly* preferring the risky option (66% to 33%). The same inclination held in the right panel, and indeed the framing even caused subjects to "flip" from disfavoring the risky option (47% to 53%) to favoring it (56% to 44%).

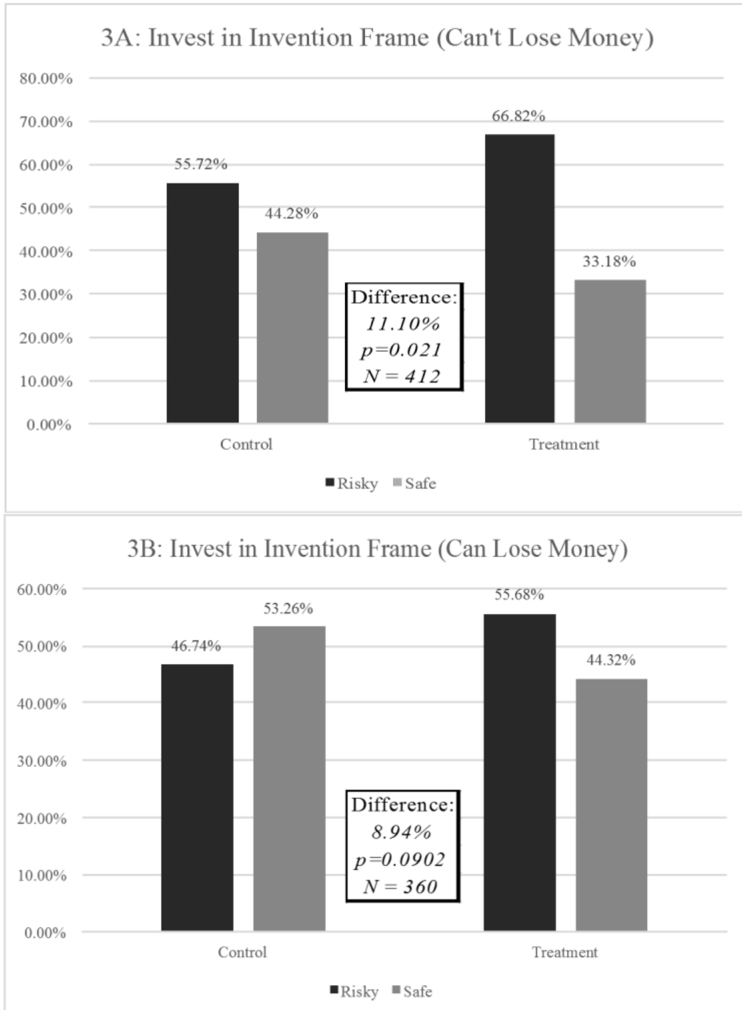

Figure 3: Percentage of subjects choosing each option by frame

The striking effect depicted above of the invention frame on manifest risk tolerance is statistically significant at conventional levels. The left panel (Panel 3A) depicts our baseline manipulation, where the risky choice did not entail the possibility of losing money. Here, the Invest in Invention frame caused the treatment group to opt for the risky choice at a nearly 2-to-1 ratio, even though they were more evenly split in the control group setting. The difference in risk-taking proclivity between the treatment and control groups was 11.1%, which was statistically significant at conventional levels.

Even when we situate our subjects in a setting where they can lose money (Panel 3B), the effect of the frame persists (in only slightly weaker form). Here, control-group subjects actually tended to prefer the safe option — an observation that is not surprising given the possibility of losing money and the wider variability of the risky choice. But introducing the frame flipped this proclivity, causing more subjects now to favor the risky choice. The difference between treatment and control groups here was smaller — just under 9% — and its statistical significance was slightly reduced. But the effect still appears to be discernible.

Table 6: Baseline Experiments — Losing Money Not Possible OLS Estimation

	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6
INVENTION FRAME	-0.111* (-2.32)	0.134*** (-3.00)	- 0.134*** (-3.00)	- 0.121*** (-2.73)	-0.134* (-2.34)	-0.134** (-2.34)
GAMBLED			0.021 (0.44)	-0.014 (-0.28)	-0.037 (-0.75)	-0.035 (-0.71)
AGE				0.009*** (3.62)	0.002 (0.53)	0.001 (0.29)
MALE				-0.018 (-0.41)	-0.048 (-1.06)	-0.001 (-0.02)
HAND				-0.017 (-0.30)	-0.017 (-0.30)	-0.017 (-0.29)
ETHNICITY				0.064 (1.15)	0.05 (0.90)	0.045 (0.82)
TURK					0.220* (2.33)	0.297*** (2.65)
MALE X TURK						-0.11 (-1.21)
CONSTANT	0.443*** (12.61)	0.580*** (3.74)	0.563*** (3.53)	0.328+ (1.95)	0.441*** (2.79)	0.437*** (2.77)
R-SQD	0.013	0.183	0.183	0.212	0.23	0.233
P	0.020	0.000	0.000	0.000	0.000	0.000
N	412	412	412	412	412	412
HL SWITCH FE	No	Yes	Yes	Yes	Yes	Yes

T-Statistics In Parentheses:
+ = Significant At 5% (One Tailed Test); 10% (Two Tailed Test)
** = Significant At 2.5% (One Tailed Test); 5% (Two Tailed Test)*
*** = Significant At 1% (One Tailed Test); 2% (Two Tailed Test)*
**** = Significant At 0.5% (One Tailed Test); 1% (Two Tailed Test)*

Tables 6 and 7 drill a little deeper into our results, reporting on ordinary least squares estimates of both (a) our baseline specification where subjects could never lose money from opting for the risky choice (Table 6); and (b) the specification that includes the robustness test where negative payoffs are possible (Table 7). In addition to our control/treatment assignment (which was random, and should be sufficient alone)[107] these Tables also control for a variety of demographic variables (such as age, gender, left-handedness, ethnicity) and some behavioral answers to a variety of questions related to risk aversion (such as whether the subject has gambled, and a fixed effect for the HL "row" where the subject switches from low variability to high variability choice).[108] Our Tables also control for whether the subject was part of our M-Turk population.

The key coefficient of interest for each model in the Tables is the first line, which reports the probability difference between the treatment and control groups in choosing the "safe" over the "risky" option. (Thus, a negative coefficient indicates that the subjects are more likely to choose the risky option.) The different columns of the Tables reflect alternative specifications of our estimated model, where we include additional statistical controls (such as demographic variables and HL scores). As we can see across Table 6, the innovation frame induces between 11% and 13.4% lower probability of opting for the safe option, regardless of other variables we control for (including baseline measured risk aversion). Moreover, it does not appear that introducing the prospect of losing money materially undermines the estimated effect (though it does slightly reduce it). Note from the subsequent Table 7 that the estimated coefficient of interest now ranges between 9% and 11.5%, but it remains statistically significant by conventional measures.

107. Since we randomized assignment of treatment and control, it is not strictly necessary to control for other variables. We do so anyway, however, to underscore the effect, and because we have information on risk preferences.

108. *See supra* Table 1. Our regression specifications use a fixed effect to capture the HL score rather than using the score as a standard control variable. This choice is deliberate, since our HL score can only capture an ordering, and thus the numerical values of it do not reflect evenly-spaced intensities of risk preferences. A fixed-effect approach allows for each HL "bin" to have an independently estimated effect.

Table 7: Baseline Experiments — Can Lose Money OLS Estimation

	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6
INVENTION FRAME	-0.089+ (-1.70)	-0.103* (-1.98)	-0.102+ (-1.95)	-0.105* (-1.98)	-0.112* (-2.08)	-0.114* (-2.12)
GAMBLED			-0.04 (-0.74)	-0.038 (-0.65)	-0.031 (-0.54)	-0.035 (-0.60)
AGE				0.001 (0.31)	0.003 (0.89)	0.003 (0.73)
GENDER				-0.034 (-0.60)	-0.02 (-0.35)	0.021 (0.25)
HAND				-0.011 (-0.09)	-0.016 (-0.14)	-0.014 (-0.12)
ETHNICITY				-0.006 (-0.08)	0.009 (0.12)	0.006 (0.08)
TURK					-0.076 (-0.91)	-0.021 (-0.19)
MALE X TURK						-0.079 (-0.70)
CONSTANT	0.533*** (14.44)	0.710*** (4.90)	0.743*** (4.84)	0.733*** (4.18)	0.705*** (3.96)	0.700*** (3.93)
R-SQD	0.008	0.073	0.074	0.076	0.078	0.079
P	0.090	0.003	0.003	0.019	0.024	0.029
N	360	360	360	360	360	360
HL SWITCH FE	No	Yes	Yes	Yes	Yes	Yes

T-Statistics In Parentheses
+ = Significant At 5% (One Tailed Test); 10% (Two Tailed Test)
** = Significant At 2.5% (One Tailed Test); 5% (Two Tailed Test)*
*** = Significant At 1% (One Tailed Test); 2% (Two Tailed Test)*
**** = Significant At 0.5% (One Tailed Test); 1% (Two Tailed Test)*

The growth in the estimated coefficient of interest that emerges in Models 2–6 once we control for underlying risk aversion (captured by HL score) might seem odd initially, but it is an artifact of the heterogeneity of the underlying risk tolerances of our subject pool, which adds noise to our estimates. As illustrated above in Figure 2, some of our subjects start out as extremely risk-seeking (low HL scores) or extremely risk-averse (high HL scores). When one controls for their baseline risk aversion (which we elicited independently), the remaining estimated effect is better able to capture the effect of the frame. In fact, in Appendix B, we present alternative specifications that show the same effects in a set of slightly more nuanced "discrete choice" frameworks.[109] From those models, our estimates (when projected onto a subject at median HL risk aversion score) imply between a 16% to 18% swing in the subjects' proclivity to take risk — a change that is consistent with a one-category shift in the HL scale pictured in Figure 2, or just under one-half of a standard deviation in HL score. But in any event, regardless of representativeness of either sample, the estimated effect appears to be consistent and economically significant across them.

Overall, the above analysis suggests that our manipulation appears to have generated a material contextual shift to subjects' risk tolerances, consistent with our hypothesis. Averaged across all subjects, the manipulation induces a larger propensity to pursue the risky choice by approximately ten percentage points. When one controls for variation related to the subjects' underlying risk aversion, these estimates get even larger, and it appears to be relatively consistent across specifications, and strongly statistically significant under any conventional measures. The only control variable that appears stronger than the manipulation is whether the subject was an M-Turk subject. Which group is the "better" one for purposes of external validity is, of course, debatable. Some studies have found U.S.-based M-Turkers who participate in experiments to be more representative of the U.S. population than conventional student samples, and that M-Turkers pay as much attention to experimental tasks as undergraduates in a lab.[110]

V. Discussion and Implications

Our findings have important implications, both for what they add to the experimental analysis of law and for a variety of practical legal policy debates around innovative activities. This Part explores several of those broader implications, as well as potential caveats. First, we offer an interpretation of how our results fit into the experimental literature more broadly, focusing on robustness of our experimental effect and its limitations. We next discuss how our findings intersect with a variety of ongoing policy debates within intellectual property and corporate law about how (and whether) law should accommodate risk preferences. Finally, we discuss the broader potential consequences of our results.

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109. In Tables B1 and B2 in Appendix B, we illustrate the robustness of our ordinary least squares results in Probit and Logit specifications. *See infra* Appendix B.

110. Gabriele Paolacci, Jesse Chandler & Panagiotis G. Ipeirotis, *Running Experiments on Amazon Mechanical Turk*, 5 JUDGMENT & DECISION MAKING 411, 415 (2010).

A. Limitations and Robustness

Although the previous section has already explored one principal area of robustness of our results (i.e., whether they carry over to contexts where subjects could lose money), there are a variety of other avenues that merit brief exploration, all having to do with the outer limits or boundaries of the framing effect we identify. This subsection briefly explores several of them.

1. Invest in Invention Frame

The Invest in Invention frame highlighted in the previous section triggers what appears to be a noteworthy shock to manifest risk tolerance. But that result, in turn, raises the interesting and obvious question about which element of our frame is the culprit: Is it the "invest" portion, the "invention" portion, or perhaps a little of both? Because our baseline experiment employed the prompt "invest in a hypothetical invention,"[111] it does not allow us (yet) to pick apart the contributions of each attribute. To test one aspect of this quandary — whether the crucial frame is "invest" or "invest in invention" — we ran an additional set of experiments to concentrate on a single element (in this case the "invest" part). We reran the experiment with a new sample (n = 184), but this time we provided our treatment subjects with a different set of instructions, telling them only that the risky choice coincided with an opportunity to "invest" in a risky choice; no possibility of an invention coming out of the investment was mentioned. Our new treatment vignette thus read as follows:

> Before filling out a brief questionnaire, you will be given [$8] either to *Keep* or to *Invest*. You will have only a single opportunity to choose. If you choose to *Invest* there is a 1/3 chance that your earnings will be [$30], and a 2/3 chance that your earnings will be [$3]. A roll of a die will determine your earnings, either [$30] or [$3]. If you choose to *Keep* you will keep the [$8].

We then compared the results for this modified treatment group to a control group who had been given the Simple Lottery instructions, described in Section II.A. These results are given in Figure 4. Unlike in the prior analyses, here the "Invest" framing generally has no statistically significant effect across the different models. Although the

111. We needed to use the word "hypothetical" to avoid misleading some subjects into believing that there was a real invention involved in the experiment.

effect goes in the same direction as in the baseline experiments, it is significantly smaller in magnitude. Moreover, as shown in Appendix B, the insignificant result remains (and even gets a little weaker) after controlling for other characteristics (such as elicited risk aversion). At a minimum, we view these results as suggesting that the removal of the "innovation" component of the frame is critical, and it substantially nullifies the risk-aversion dampening effect discussed above. If anything, in fact, this robustness test suggests that the effect of an innovation frame is even stronger than we advertise.

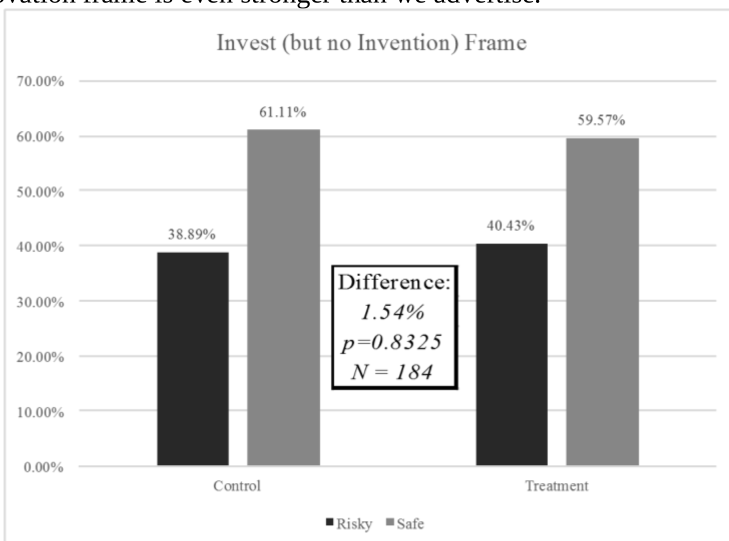

Figure 4: Robustness Test with Invest (but no Invention) Frame

In Appendix B, we show that the direction of our estimated results and the significance were qualitatively identical for a variety of regression specifications.[112] Given these additional experiments, we can rule out, with some confidence, the possibility that the prospect of "investing" alone is a sufficient factor for generating our main results. At the same time, it remains possible that the "investing" frame may be necessary for our results, interacting with the innovation frame to produce a meaningful *combined* effect. While we conjecture that an interaction effect is plausible (and even likely), we leave that exploration for later work.[113]

112. *See infra* Appendix B.

113. We found it challenging — using a sufficiently similar vignette as our baseline experiment — to design a satisfactory robustness test that dropped the "invest" frame to focus only on the "invention" component.

2. Endowment Effects

Second, as noted above, our baseline treatment condition for the risky investment used the word "keep" to characterize the safe option, while the control group (the Simple Lottery frame) was offered the prospect of earning money in both safe and risky options. One might thus worry that this wording introduced a type of "endowment effect" unrelated to our principal manipulation that ultimately drives our results.[114]

We are relatively confident this concern is unfounded, based on both *a priori* reasoning and on an additional robustness check. As to the former, we observe that the endowment effects literature long ago identified that the effect usually vanishes when the "endowment" takes the form of a monetary sum (or a liquid claim on a monetary sum).[115] But even if the endowment effect were present in our baseline experiment, its typical directionality would cause us to *understate* the overall size of our findings: Indeed, if subjects in the Invest in Invention frame thought they were entitled to the $8 before deciding whether to invest, then they should have been *less* willing to give up the $8, causing them to appear to be *more* risk-averse in the Invest in Invention frame when compared to the control. However, we find diametrically opposite behavior. Accounting for an endowment effect (if one even exists in this context) would only make our detected effect larger.

Nevertheless, in response to several questions along these lines from other researchers, we explored the issue a bit further, and re-ran a version of our experiment that focused only on the word "keep." We recruited a new set of 202 subjects (all M-Turkers), and gave the treatment group alternatively worded instructions that read as follows:

> Before filling out a brief questionnaire, you will be given [$8] and asked to make a choice between Option A and Option B. You will have only a single opportunity to choose. If you chose Option A, you will Keep the [$8]. If you chose Option B, there is a 1/3 chance that your earnings will be [$30], and a 2/3 chance that your earnings will be [$3]. A role of a die will determine your earnings, either [$30] or [$3].

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114. Note that some economists and legal scholars doubt the robustness of the empirical evidence supporting the endowment effect. *See generally* Klass et al., *supra* note 66. Other researchers believe that subjects can debias to overcome any endowment effect. *See generally* Jennifer Arlen & Stephan Tontrup, *Does the Endowment Effect Justify Legal Intervention? The Debiasing Effect of Institutions*, 44 J. LEGAL STUD. 143 (2015). For the purpose of this discussion, we will assume that the endowment effect — the tendency of people to value what they own more highly *because* they own the assets — is real.

115. *See generally* Klass et al., *supra* note 66; Arlen et al., *supra* note 114.

Notice that this variation strips out the Invest in Invention frame and retains only the "Keep" terminology, so as to isolate any endowment effects. If the endowment effect is at play (in the opposite direction as its usual manifestation), we should detect it here.

We then ran the same diagnostics with this additional robustness check.[116] The basic results are pictured in Figure 5. As is shown by the Figure, subjects in this condition now tend to choose the risky option at relatively close rates between treatment and control, with no statistically significant difference between them.[117] We consider these results to add additional experimental support to the *a priori* reasoning that our results are unlikely to be an artifact of the endowment effect, channeled by telling subjects (in the baseline experiment) that they could "keep" $8.

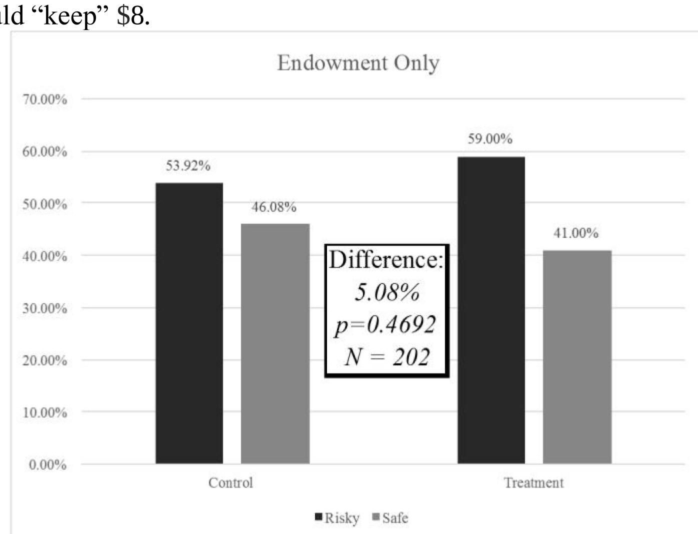

Figure 5: Robustness Test with Endowment Only Frame

3. No False Preferences

Neoclassical welfare economics tends to assume that preferences are fixed and stable across contexts. Behavioral economics and psychology, in contrast, tend to resist that foundational assumption (at least categorically). This study is an example of the latter group. It is important to note that we (like many other exercises in behavioral

116. Our control group in this robustness check used the Simple Lottery frame. *See supra* Section II.A.

117. For regression results, see *infra* Appendix D. Per our prior discussion, note that even the directionality of the (statistically insignificant) difference between treatment and control groups moves in the opposite direction as one would expect if an endowment effect were present.

economics and psychology) cannot definitively determine that only one set of revealed preferences — e.g., the ones in the Simple Lottery frame, or in the Invest in Invention frame — is the "true" set of preferences for purposes of welfare analysis. In fact, *both* sets of preferences may be true, just for different settings and contexts. And, given that each set of preferences is true within its setting, the results are quite usable for *policy purposes*. Consider the Invest in Invention frame, where the experiments explicitly employ the word "invention." As illustrated above, subjects became discernibly more willing to take on the gamble under such a frame. This response could be because subjects enjoyed feeling that they were part of an exciting enterprise, leading to new, useful knowledge, and thereby producing higher utility from the choice.[118] There could also be an effect from knowing that inventions are prosocial, leading to spillover knowledge that helps society. Both rationales might motivate subjects to prefer the gamble in the Invest in Invention frame, but not in the stripped-down Simple Lottery frame. And that enhanced risk tolerance, in turn, motivates a discussion of a variety of important implications for legal and public policy (addressed below).

4. M-Turkers and Risk

Finally, our results suggest a potentially important methodological validation check for using on-line platforms (such as M-Turk) for experimental data collection. As noted above, experimental researchers have expressed some doubts about the validity (external and internal) of using M-Turk subjects — even as many take advantage of the data source. And we can confirm that M-Turkers do act "differently" from in-lab subjects. For example, subjects from M-Turk were consistently more risk-averse than our other subjects. This was true even after controlling for age, sex, and ethnicity. But in our case, it did not matter appreciably for our key manipulation: M-Turk subjects changed behavior in the same way that the other subjects changed in response to the Invest in Invention frame; all subject groups (M-Turkers and not) manifested less risk aversion under our treatment condition. We also investigated whether there were interaction effects between gender and M-Turk, but the results were insignificant, and did not change the effect or significance of the Invest in Invention frame. Thus, it appears that M-Turk can be used to test the effect of frames like the one we used. However, because there are underlying differences between M-Turk and laboratory populations, it makes sense to sample from both populations (at least initially) to confirm that the laboratory and the

118. We note that our subjects were not tasked with actually inventing anything. Rather, they were asked if they wanted to *invest* in an invention.

platform perform similarly enough to allow researchers to use both of them to run experiments and trust the results.[119]

B. Broader Implications

Beyond contributing to the stock of knowledge in the experimental study of law, our results also have implications for a variety of legal and policy debates. We flag several of them below.

1. Implications for Intellectual Property

As noted in the Introduction, our findings suggest that at least some of the concerns about recent judicial rulings limiting patentable subject matter[120] may be overblown. A socially desirable patent policy is based, in part, upon assessing the risk tolerances of investors in inventive activity.[121] Our findings suggest that in innovative environments, entrepreneurs and investors may be comparatively more tolerant of risk than previously recognized. Accordingly, we may not need to be as concerned about providing compensation to investors and inventors so as to ameliorate their risk aversion. In fact, given that patent policy may already reflect a premium for such previously assumed risk aversion, the recent judicial decisions restricting patent may actually be more socially beneficial (or at least less socially harmful) than scholars and commentators have feared. Of course, our findings do not touch upon concerns about copying, a separate rationale for the patent incentive.

One may reasonably ask: How is the entire IP ecosystem (and not just individual actors) implicated by our experiments? To begin to answer this question, consider a simple example. Assume that there are an inventor and an investor. *Both* must participate in order to produce a positive chance of making a successful invention. The investor provides some initial money, $\$A$, to the inventor, and then, contingent on the success of the invention in the marketplace, takes a portion of the revenues. Similarly, the inventor will need to expend effort valued at $\$B$ to invent. We will assume that failure implies a $0, no salvage, outcome. Suppose that there is a probability, p, of success, which means

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119. This will be the subject of a short paper on methodology that we hope to produce in the future.

120. *See generally* Alice Corp. v. CLS Bank Int'l, 573 U.S. 208 (2014); Athena Diagnostics v. Mayo Collaborative Servs., 915 F.3d. 743 (Fed. Cir. 2019); Cleveland Clinic Found. v. True Health Diagnostics LLC, 859 F.3d 1352 (Fed. Cir. 2017); Roche Molecular Sys., Inc. v. CEPHEID, 905 F.3d 1363 (Fed. Cir. 2018); Genetic Techs. Ltd. v. Merial LLC, 818 F.3d 1369 (Fed. Cir. 2016); Ariosa Diagnostics, Inc. v. Sequenom, Inc., 788 F.3d 1371 (Fed. Cir. 2015); *In re* BRCA1- and BRCA2-Based Hereditary Cancer Test Patent Litig., 774 F.3d 755 (Fed. Cir. 2014); PerkinElmer, Inc. v. Intema Ltd., 496 Fed. App'x 65 (Fed. Cir. 2012).

121. *See supra* Section II.A.2.

both technological and market success. It follows that in order to induce the parties to participate *even if they are risk-neutral*, we would need to provide each party with sufficient rewards to compensate them for their foregone investment of capital and effort.

Because this is a joint activity, both parties must anticipate receiving sufficient compensation to make the invention a real possibility. Thus, even for risk-neutral parties, a successful invention must produce at least $\frac{\$(A+B)}{p}$ so as to induce both investment and inventive activity.[122] How is the return to the invention allocated? Corporate and commercial rules and practices control how the monetizable value is split up, affecting the likelihood that *both* the investor and inventor receive sufficient compensation.

But what if the investor and/or inventor are risk-averse? In that case, and holding the inventor's characteristics fixed for the moment, adjusting for risk aversion would require increasing the investor's reward by an additional risk premium ($\$\alpha$). The size of the risk premium, moreover, increases with the investor's risk aversion. A similar argument applies to the inventor, who would require her own risk premium ($\$\beta$). Consequently, for risk-averse parties a successful invention would have to offer an even larger bounty, of:

$$\frac{\$(A+B)}{p} + \frac{\$(\alpha+\beta)}{p}$$

Our results suggest that the baseline level of risk aversion, as defined in the Simple Lottery condition, appears to decrease (for whatever reason) in the Invest in Invention frame. Consequently, the total added risk premium needed to induce investment and activity, $\frac{\$(\alpha+\beta)}{p}$, may not be as large as one might otherwise believe in such contexts. This insight, in turn, implies that it may be possible to loosen some of the patent doctrines that help to produce the returns that help to provide the money.

This basic policy result — that we can relax some of the institutional commitments that help to channel risk premiums into required returns — has important potential implications for various patent (and copyright) doctrines that attempt (at least implicitly) to calibrate return to creative effort. These include the doctrine of equivalents, the availability of injunctive relief, patent duration, damages, and obviousness. Viewed through the lens of our results, each

122. The traditional "garage inventor" example combines $\$A/p$ and $\$B/p$ into one person, and thus makes it very hard to determine what is going on. The garage inventor essentially invests in her own inventive activity. The text, and our experiments, separate out these functions.

of these doctrines could potentially be modulated to fine tune the patent system, and a careful reconsideration of these doctrines may be warranted, in light of our evidence that risk aversion may retreat in these settings. To wit, consider the following.

Doctrine of Equivalents. The doctrine of equivalents permits a finding of infringement even in circumstances in which an accused product or process is outside the literal scope of the claimed invention.[123] The product or process can infringe if it is insubstantially different from the claimed invention, or if it "performs substantially the same function in substantially the same way to reach the same result."[124] The doctrine addresses patent scope, and has ebbed and flowed in its breadth over time. Reducing the scope of the doctrine of equivalents makes it more difficult for a patentee to prove infringement and thus is functionally similar to reducing the return premium on a patent.

Injunctions. In its 2005 *eBay v. MercExchange* decision, the Supreme Court made it harder for successful patentees to be awarded an injunction as a remedy.[125] Previously, the Court of Appeals for the Federal Circuit had a practice of granting an injunction to almost all successful litigating patent holders.[126] That is no longer the case.[127] The less likely a patent owner is to receive injunctive relief, the lower the return on investment. The effects of *eBay* have been most pronounced on non-practicing entities (NPEs, sometimes pejoratively called "patent

123. David L. Schwartz, *Explaining the Demise of the Doctrine of Equivalents*, 26 BERKELEY TECH. L.J. 1157, 1158 (2011); John R. Allison & Mark A. Lemley, *The (Unnoticed) Demise of the Doctrine of Equivalents*, 59 STAN. L. REV. 955, 956 (2007).

124. Graver Tank & Mfg. Co. v. Linde Air Prod. Co., 339 U.S. 605, 608, 610 (1950) (noting two tests for infringement under the doctrine of equivalents: (1) the function-way-result test (whether the accused product performs "substantially the same function in substantially the same way to obtain the same result,"); and (2) the insubstantial differences test (whether the accused product or process is substantially different from what is patented) (quoting Sanitary Refrigerator Co. v. Winters, 280 U.S. 30, 42 (1929)); *see also* Warner-Jenkinson Co. v. Hilton Davis Chem. Co., 520 U.S. 17, 24–25 (1997).

125. eBay Inc. v. MercExchange, LLC, 547 U.S. 388, 395 (2006).

126. *See* MercExchange, LLC v. eBay, Inc., 401 F.3d 1323, 1338 (Fed. Cir. 2005) ("[T]he general rule is that a permanent injunction will issue once infringement and validity have been adjudged.").

127. Injunctive relief in patent cases continues to be a source of controversy. *See* Ryan T. Holte & Christopher B. Seaman, *Patent Injunctions on Appeal: An Empirical Study of the Federal Circuit's Application of* eBay, 92 WASH. L. REV. 145 (2017) (providing an empirical study showing, *inter alia*, that injunctive patent relief is not routine in the District Courts); Carl Shapiro, *Injunctions, Hold-Up, and Patent Royalties*, 12 AM. L. & ECON. REV. 280 (2010) (arguing against the availability of patent injunctions with a formal economic model); Erik Hovenkamp & Thomas F. Cotter, *Anticompetitive Patent Injunctions*, 100 MINN. L. REV. 871 (2016) (arguing against patent injunctions for firms that own a patent but neither practice the patent nor license it on reasonable terms, even if the patent owner produces goods in the same market as those who practice the patent).

trolls").[128] But even practicing entities run a risk that an injunction will not be granted.[129] Reducing the likelihood that injunctive relief will issue to plaintiffs, even plaintiffs who are practicing the patent and manufacturing products, reduces the premium that the successful inventor can extract, since it is now harder to hold out in negotiating with high-valuing licensees.

Duration. Many scholars have argued for using the duration of patent protection (i.e., the patent term) as a lever to encourage innovation.[130] In general, under current law, patents in the U.S. expire twenty years from their filing. That term is in accord with various international treaties.[131] Putting aside international comity concerns,[132] patent terms could be adjusted upwards or downwards to fine tune the premium associated with successful innovations.

Damages Measures. The Federal Circuit has made it harder and harder for plaintiffs to prove reasonable royalty damages in patent cases. For instance, the Federal Circuit has required that royalties be based upon the "smallest saleable unit," the smallest unit that embodies the claims of the patent, which may be different from the product sold in the marketplace.[133] Copyright is different, with a form of liquidated

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128. Christopher B. Seaman, *Permanent Injunctions in Patent Litigation After* eBay: *An Empirical Study*, 101 IOWA L. REV. 1949, 1949 (2016); *see also* Matthew Spitzer, *Patent Trolls, Nuisance Suits, and the Federal Trade Commission*, 20 N.C. J.L. & TECH. 75 (2018).

129. *See* Holte et al., *supra* note 127; Seaman, *supra* note 128.

130. *See generally* M. Rafiquzzaman, *The Optimal Patent Term Under Uncertainty*, 5 INT'L J. INDUS. ORG. 233 (1987) (arguing that different types of uncertainty produce different effects on the optimal patent term); Mark A. Lemley, *An Empirical Study of the Twenty-Year Patent Term*, 22 AIPLA Q.J. 369, 370–71 (1994) (concluding that a 20-year term from date of application usually gives patentees more protection than did the old term of 17 years from date of patent issuance). The term of copyright protection has also been a subject of intense debate. *See, e.g.*, Paul M. Schwartz & William Michael Treanor, Eldlred *and* Lochner*: Copyright Term Extension and Intellectual Property as Constitutional Property*, 112 YALE L.J. 2331 (2003); Dennis S. Karjala, *Judicial Review of Copyright Term Extension Legislation*, 36 LOY. L.A. L. REV. 199 (2002); Rufus Pollock, *Forever Minus a Day? Some Theory and Empirics of Optimal Copyright*, 6 REV. ECON. RSCH. ON COPYRIGHT ISSUES 35 (2009); William M. Landes & Richard A. Posner, *An Economic Analysis of Copyright Law*, 18 J. LEGAL STUD. 325 (1989).

131. For a discussion of the TRIPS agreement as it relates to patent duration, see generally David S. Abrams, *Did TRIPS Spur Innovation? An Analysis of Patent Duration and Incentives to Innovation*, 157 U. PA. L. REV. 1613 (2008).

132. *See generally* Koren W. Wong-Ervin, Bruce H. Kobayashi, Douglas H. Ginsburg & Joshua D. Wright, *Extra-Jurisdictional Remedies Involving Patent Licensing*, COMPETITION POL'Y INT'L (Dec. 14, 2016) (explaining the importance of international comity concerns when considering intellectual property rights).

133. VirnetX, Inc. v. Cisco Sys., Inc., 767 F.3d 1308, 1326 (Fed. Cir. 2014) ("[W]hen claims are drawn to an individual component of a multi-component product, it is the exception, not the rule, that damages may be based upon the value of the multi-component product."); Uniloc USA, Inc. v. Microsoft Corp., 632 F.3d 1292, 1320 (Fed. Cir. 2011) ("This case provides a good example of the danger of admitting consideration of the entire market value of the accused [product] where the patented component does not create the basis for customer demand."); Lucent Techs., Inc. v. Gateway, Inc., 580 F.3d 1301, 1335 (Fed. Cir. 2009); John M. Golden, *Reasonable Certainty in Contract and Patent Damages*, 30 HARV.

damages available in many situations.[134] These statutory damages may overcompensate copyright holders. The ability to get adequate damages dramatically affects the return from the invention.

Enhanced Damages. In *Halo Electronics, Inc. v. Pulse Electronics, Inc.*, the Supreme Court in 2016 made it slightly easier to obtain enhanced damages for willful patent infringement.[135] The Supreme Court ruled that the previous two-part test for finding willfulness was unduly rigid.[136] Furthermore, the Supreme Court lowered the burden of proof required for a patent owner to prove willful infringement, finding that willfulness needed to be shown by a preponderance of the evidence.[137] The lower the standard of proof and greater the likelihood of higher damages for a patent holder, the greater the effective premium from invention.

Obviousness. Finally, the doctrine of obviousness ensures that patents are only granted for sufficient leaps over the prior art.[138] A given invention is either obvious or non-obvious, a binary determination.[139] Concerns about "close call" inventions falling just below the bar add risk and may affect *ex ante* incentives.[140] The line between obvious inventions and non-obvious ones can be altered to adjust the patent incentive. Increasing the standard for nonobviousness

J.L. & TECH. 257, 261 (2017) ("[T]he Federal Circuit issued a series of decisions tightening the evidentiary standards for establishing the value of reasonable royalty damages."); Jonas Anderson, *Congress as a Catalyst of Patent Reform at the Federal Circuit*, 63 AM. U. L. REV. 961, 1000–02 (2014) (discussing a "flurry of noteworthy damages decisions from the Federal Circuit").

134. Statutory damages of between $750 and $30,000 per work are available if the author has registered the work before the infringement began or within three months of publication. 17 U.S.C. §§ 412, 504.

135. Halo Elecs., Inc. v. Pulse Elecs., Inc., 136 S. Ct. 1923, 1926 (2016).

136. *Id.* at 1932; *see also* Lisa Larrimore Ouellette, *Who Reads Patents?*, 35 NATURE BIOTECHNOLOGY 421, 421 (2017) (claiming that "few researchers are deterred from reading patents by concerns about enhanced legal liability"); *see generally* Brandon M. Reed, *Who Determines What Is Egregious: Judge or Jury: Enhanced Damages After* Halo v. Pulse, 34 GA. ST. U. L. REV. 389 (2018) (discussing whether a judge or a jury decides whether willful, egregious misconduct justifies enhanced damages).

137. *Halo Elecs.*, 136 S. Ct. at 1934 ("'[P]atent infringement litigation has always been governed by a preponderance of the evidence standard. . . . Enhanced damages are no exception.") (quoting Octane Fitness, LLC v. ICON Health & Fitness, Inc., 572 U.S. 545, 557 (2014)).

138. *See, e.g.*, Ryan T. Holte & Ted Sichelman, *Cycles of Obviousness*, 105 IOWA L. REV. 107 (2019); Daralyn J. Durie & Mark A. Lemley, *A Realist Approach to the Obviousness of Inventions* (Stanford Pub. L. Working Paper, No. 1133169, 2011); Ezra Friedman & Abraham Wickelgren, *Optimal Standards of Proof in Patent Litigation: Infringement and Non-Obviousness* (Northwestern Law & Econ. Rsch. Paper No. 19-07, U. of Texas Law, Law & Econ. Rsch. Paper No. 591, 2019).

139. *But see* Laura G. Pedraza-Fariña & Ryan Whalen, *A Network Theory of Patentability*, 87 U. CHI. L. REV. 63, 109 (2019) (arguing that network analysis of obviousness determinations overcomes the "binary" nature of current doctrine).

140. *Id.* at 69 (noting the high risk of "hindsight bias" in the factfinder in "reconstructing" whether the invention is obvious).

would make it more difficult to obtain patent protection, reducing the return from the inventive concept.

Any of the aforementioned doctrines (or some combination of them) represents a potential legal policy tool for altering the size of the patent incentive. Of course, we are reluctant to conclude on the basis of a set of experiments that any or all of these areas should be changed to provide less protection compared to where patent doctrine is now. That is, we cannot conclude with confidence that the length of IP protection should be shortened, the doctrine of equivalents should be made narrower, injunctive relief should be limited, or that damages for infringement should be capped or reduced. Nevertheless, such conclusions might follow if we were already convinced that current patent policy calibrations were close to correct, on average, but erroneously assumed the parties' risk preferences were much like anyone else's. And we simply cannot be confident about that. The past two decades have seen a general assault on patent from both the courts and much of the academy.[141] It has gotten to the point where some General Counsels in tech companies speak of "efficient infringement," which essentially means that it is cheaper to infringe than to take a license because it is so hard for patentees to obtain relief through the courts.[142] If this critique is right — that the assault on patent has gone

141. The discussion in Part I of this Article describes the basic issues. *See* Jonathan M. Barnett, *Has the Academy Led Patent Law Astray?*, 32 BERKELEY TECH. L.J. 1313, 1324 (2017) ("Academic theories concerning the adverse effects of a strong patent system would be of little practical interest were it not for the fact that policymaking entities have taken actions under patent or antitrust law, or issued influential statements, that explicitly or implicitly rely on, or are consistent with, those theories."); *see also* Michele Boldrin & David K. Levine, *The Case Against Patents*, 27 J. ECON. PERSP. 3 (2013); Carl Shapiro, *Injunctions, Hold-Up, and Patent Royalties*, 12 AM. L. & ECON. REV. 280 (2010) (arguing against the availability of patent injunctions with a formal economic model); Carl Shapiro, *Patent Remedies*, 106 AM. ECON. REV. 198 (2016). Nowhere has this assault been more powerful than in the area of Standard Essential Patents. *See, e.g.*, Mark A. Lemley & Carl Shapiro, *Patent Hold Up and Royalty Stacking*, 85 TEX. L. REV. 1992 (2007); Colleen V. Chien & Mark A. Lemley, *Patent Holdup, the ITC, and the Public Interest*, 98 CORNELL L. REV. 1 (2012); Carl Shapiro & Mark A. Lemley, *The Role of Antitrust in Preventing Patent Holdup* (Stan. L. & Econ. Olin Working Paper No. 554, 2020), https://ssrn.com/abstract=3666211 [https://perma.cc/K4LT-RY49].For a skeptical view of patent holdup, see Alexander Galetovic, Stephen Haber & Ross Levine, *An Empirical Examination of Patent Holdup*, 11 J. COMPETITION L. & ECON. 549 (2015). Patent assertion entities (also known as "trolls") have generated a lot of criticism as well. *See generally* Spitzer, *supra* note 128.

142. Conversation with General Counsel, Fortune 500 technology company (May 2014); conversation with Associate General Counsel, small technology company (May 2015); *see also* Joe Nocera, *The Patent Troll Smokescreen*, N.Y. TIMES (Oct. 3, 2015), https://nyti.ms/1KvDFOg [https://perma.cc/B3HF-X2JE] ("[A] new phrase has emerged in Silicon Valley: 'efficient infringing.' That's the relatively new practice of using a technology that infringes on someone's patent, while ignoring the patent holder entirely. And when the patent holder discovers the infringement and seeks recompense, the infringer responds by challenging the patent's validity." If a lawsuit ensues, the infringer, which is often a big tech company, has its patent lawyers ready. "Because the courts have largely robbed small inventors of their ability to seek an injunction — that is, an order requiring that the infringing

too far — then patent law probably needs to be stronger. What do our results mean? They mean that Congress does not need to go as far as it otherwise would when strengthening patent.

2. Implications for Contract Law, Corporate Law, and Other Areas

Another area where our results may have some import is in areas of corporate and contract law that pertain to the financing and governance of tech startups. As we noted in Part I, investors in innovative startups require sufficient returns to compensate them for their risk of investment and the risk of failure. But how much of a premium do they *really* require to take on such risk? How much control should they be given over the decision as to whether a startup should opt for a "safe exit" (often through an acquisition) or to continue the risky path of development for a hoped-for future payday? How is a corporate board supposed to resolve such disputes when it is required to maximize value for *all* shareholders?

As it happens, much of contemporary corporate law is currently in a state of flux over how to handle fiduciary duties when it comes to this very dispute between inventors/entrepreneurs and venture-capital ("VC") investors of late-stage startups.[143] As is typical in such relationships, founders (and core employees) typically receive common stock.[144] In contrast, VC investors tend to receive preferred stock, giving them priority in any liquidation.[145] In addition, the venture capitalists' preferred shares typically enjoy a conversion option that provides an even greater return should the startup enjoy phenomenal success.[146] A considerable governance difficulty generally emerges when the company has done well enough to stay afloat, but not much more. In such circumstances there is a conflict of interest. The outside VC investors — usually preferred shareholders whose liquidation preferences are on the line — perceive considerable downside risk from continuing, and they have a strong preference to accept any purchase offer that gets close to their liquidation right. On the other hand,

product be removed from the market — the worst that can happen is that the infringer will have to pay some money. For a rich company like, say, Apple, that's no big deal.").

143. *See, e.g.*, Sarath Sanga & Eric Talley, Don't Go Chasing Waterfalls: Fiduciary Duties in Venture Capital Backed Startups (October 31, 2020) (unpublished manuscript) (available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3666211 [https://perma.cc/8JVJ-VDPB]).

144. Jesse M. Fried & Mira Ganor, *Agency Costs of Venture Capitalist Control in Startups*, 81 N.Y.U. L. REV. 967, 981 (2006) ("The common is held by the founders, employees, angel investors, and, in certain cases, strategic partners and third-party service providers.").

145. *Id.* at 981–82 ("The preferred is held by VCs, who invest in startups almost exclusively through this type of security. In fact, most venture-backed startups issue a new series of preferred stock for each round of financing.").

146. *Id.* at 982 ("Like most preferred stock, VCs' preferred shares carry a liquidation preference and are convertible into common.").

common shareholders perceive principally upside risk, and they strongly prefer to stay in the game, hoping for luck to turn in their favor.[147]

From a value-maximizing perspective, of course, an efficient allocation of fiduciary duties would grant solicitude between common and preferred shareholders in a way that maximizes their joint payoff, taking account of their risk preferences. If — as our results suggest — VC investors in innovative industries exhibit reduced aversion, then it might well justify putting a heavier thumb on the scale favoring the party that wishes to avoid exit—usually the founders. And this appears to be exactly what courts have recently begun to do. Consider, for example, Delaware Vice Chancellor Laster's 2017 opinion in *Hsu v. ODN Holding Corp.*[148] This case was substantially similar to the situation described above, pitting preferred shareholders, who wished to exit, against common shareholders, who resisted. Hoping to secure an exit, the preferred shareholders used their control of the board to facilitate payment of a contractual redemption right, thereby starving the firm of capital and effectively forcing an exit.[149] After the common shareholders sued, the VC investors moved to dismiss.[150] In denying that motion, the Vice Chancellor explicitly prioritized the interests of the common shareholders in the calculus of fiduciary obligations: "[I]t generally 'will be the duty of the board, where discretionary judgment is to be exercised, to prefer the interests of common stock — as the good faith judgment of the board sees them to be — to the interests created by the special rights, preferences, etc., of preferred stock.'"[151]

Based on our experimental findings, Vice Chancellor Laster's opinion may make considerable sense. Rather than according outside investors special treatment (and a premium) associated with their preference rights, he essentially held that the interests of preferred stockholders should instead be treated as no more than contractual, with no implied duty of the board to take account of their idiosyncratic preferences (including risk aversion).[152] The growing body of opinions such as this effectively allocate how the available surplus from successful inventions is split between investors and inventors,

147. *See* Sarath Sanga & Eric Talley, Don't Go Chasing Waterfalls: Fiduciary Duties in Venture Capital Backed Startups 3–4 (Oct. 31, 2020) (unpublished manuscript) (available at https://ssrn.com/abstract=3721814 [https://perma.cc/G75B-TPNJ]).

148. Frederick Hsu Living Tr. v. ODN Holding Corp., No. 12108, 2017 WL 1437308 (Del. Ch. Apr. 14, 2017).

149. *Id.* at *5.

150. *Id.* at *10.

151. *Id.* at *22 (quoting Equity-Linked Invs., L.P. v. Adams, 705 A.2d 1040, 1042 (Del. Ch. 1997)).

152. *Id.* at *19 ("The fact that some holders of shares might be market participants who are eager to sell and would prefer a higher near-term market price likewise does not alter the presumptively long-term fiduciary focus.").

particularly in the tech start-up field, shifting that allocation slightly away from investors and towards inventors.

C. Social Welfare

On a broader level, to the extent our results hold with actual investors in technology, they are potentially important for society as well. When a large number of gambles are repeated, each having significant positive expected value, and they are not overly correlated with each other, the aggregation of such gambles will almost certainly produce more wealth for society. Framing the risky choice as an investment in an invention induced more subjects to choose expected gambles with positive expected value. This may be good not only for the individuals; in the case of inventions, where many of the benefits are external to the particular invention, it is also good for society.

We should be clear about two important limitations of this argument, even within the scope of our study. First, over a third of our subjects continued to opt for the certain (i.e., riskless) choice even in the Invest in Invention frame.[153] From a social welfare standpoint, it is plausibly desirable that *all* subjects would opt to invest in the invention. We offered subjects a strongly attractive actuarial gamble — with an expected value of 12 compared to a certain option of only 8. Thus, some of our subjects left significant expected value "on the table." Put another way, from a social welfare point of view, our subjects could have done better. Hence, even though the results of our experiments provide *some* comfort, one still might be concerned about too much residual risk aversion. Second, as noted above, for any experimental approach external validity can (and should) be a concern. We ran our experiments on a general population of students as well as M-Turkers. We did not run our experiments on either inventors or on those who typically invest in inventions (such as professional venture capitalists). Real-world inventors and investors in inventions might have different attitudes towards risk than do the general population.[154] Part of our plans for the future include running our experiment on these populations. Until then, one should be conservative when making policy prescriptions based on our experimental results.

* * * * *

153. More precisely, 38.9% (189 out of 486 subjects) took the certain choice in our experiments, combining the loss and no-loss versions. Considering only the no-loss experiments, 35.8% (111 out of 310 subjects) took the certain choice.

154. We also did not have subjects actually try to invent anything, preferring to keep the experimental design simple. In the future, we may incorporate a creative task as part of the experiment.

To sum up, our experiments suggested that people appear to behave in decidedly less risk-averse ways when placed in a frame that entails having them invest in an invention, rather than a Simple Lottery frame. This result might lead us to worry less about the "risk" problem of inducing individuals to invest in inventions, concentrating, instead, on the copying problem. Particular doctrines in patent and corporate law could be modified, based on our results. Thus, there may be a public policy payoff to our results. Again, we should caution against relying too strongly on these implications at this stage. More work needs to be done. Still, we find the *direction* of the implications to be both intriguing and worthy of policymakers' attention.

VI. CONCLUSION

A central challenge to formulating sound legal policy is calibrating institutions to provide appropriate incentives around activities of interest. Such design calculus is inherently difficult, and it is often complicated by the perceived need to account for how risk preferences affect actors' behavior. In certain domains that are known to be risk-intensive (such as in innovation industries), this added complexity can be daunting. The experiments detailed in this Article deliver several new results, the most robust of which is directly pertinent to this policy-design question. When people confront a risky choice that is framed in the context of investing in an invention, an interesting phenomenon emerges: subjects become significantly less risk-averse in their decision-making, taking on risky projects that they would eschew if framed differently. Our experimental results appear to be robust to a variety of demographic variables (e.g., gender, age, subject population), as well as certain situational ones (e.g., the prospect of losing money on the risky gamble). However, they appear to depend critically on the contextual nature of the frame: removing the "invention" component of the framing, for example, causes the effect to dissipate.

To the extent our results are generalizable, they have material implications for legal policy. They suggest that — at least in pertinent domains — accounting for risk aversion may be slightly less critical than in other risky contexts. Consequently, policy makers in such domains may be able to narrow their sights (at least a little) to concentrate on the other elements of legal and regulatory design that are of first-order importance.

We view these findings as contributing to a still small but growing body of experimental work on intellectual property and its role in economics, psychology and law. Many of the most interesting questions, having to do with the responsiveness of investment to the strength of patent protection and how scientists respond to incentives to invent, remain largely unexplored terrain. And embarking on that quest is a risk we should all be willing to take.

Appendix A: Theoretical Framework and Identification

As a theoretical matter, we represent subject choices within a generalized expected utility (GEU) choice-theoretic framework.[155] In our framework, our experimental manipulation (the Invest in Invention frame) represents a controlled shock to subjects' underlying risk preferences, possibly inducing them to think about risk aversion differently than they would otherwise behave were the equivalent economic choice framed as a strict gamble.

The discussion below proceeds in two stages. First, we discuss the underlying choice-theoretic framework, and the predicted effect of the manipulation. Second, we consider an empirical calibration and identification strategy and we give results from the first set of "baseline" experiments.

A. Choice Theoretic Framework

Our aggregate results can also be situated in a decision-theoretic context, where one can conceive of the Invest in Invention frame as causing a downward shift in subjects' manifest risk aversion, thereby causing them to embrace a risky choice more readily than they would in the absence of the manipulation. Below, we develop a framework for controlling for subjects' baseline risk aversion parameter (α_0) and other demographic variables (X_i) in order to estimate the local average treatment effect of a downward shock ($\lambda < 0$) that an experimental condition might introduce (i.e., revealed risk aversion goes down in the presence of the manipulation).

Suppose that the relevant population exhibits CRRA preferences scaled by a (type dependent) CRRA risk aversion parameter $\alpha(X_i)$, so that:

$$\alpha(X_i) = \alpha_0 + \lambda \cdot \tau_i + \beta \cdot X_i + \varepsilon_i,$$

where τ_i is a dummy variable set to one if the subject is assigned to the treatment group, and ε_i represents a noise term (which we assume to be have zero mean and to be distributed according to the cumulative distribution function for the population, $\Phi(\varepsilon_i)$).[156]

155. *See* Colin Camerer & Eric Talley, *Experimental Study of Law*, *in* 2 HANDBOOK OF LAW AND ECONOMICS 1619, 1625–26 (A. Mitchell Polinsky & Steven Shavell eds., 2007) ("[T]he crucial component of generalizability is whether a theory draws a clear distinction between an artificial experimental environment and a naturally-occurring one.").

156. A natural assumption given the structure of our data is that ε_i is normally distributed (implying a Probit specification), but it easily confirmed that a variety of other distributional assumptions for $\Phi(\varepsilon_i)$ work as well.

It is important to note that our experimental data on risk preferences can be compared to that found in the prior literature more generally. We could deploy this literature in two ways. Under the first (a "bootstrapping") approach, we would use the baseline preference parameter estimates from pre-existing studies to impose similar structural constraints on the risk preference distributions of our own subjects. Under the second, we would use the results of the literature as a rough benchmark of comparison for our own sample of subjects, but then (after ensuring rough comparability) use our subjects' own behaviors to identify the distribution of preferences. The advantage of the first approach is that it facilitates comparability of our results to the existing literature. The advantage of the second approach is that it allows us to control for an assortment of variables (e.g., demographic differences) that might be predictive of risk aversion but not easily observed in summary statistics reported in the existing literature.

We employ the latter approach. Below, we first confirm that our experimental data appear comparable to what has been found in prior literature, focusing particularly on HL as a benchmark; and second, having found our experimental control group data to be comparable, we proceed to use those data as a baseline for teasing out the effect of our manipulation.

Each subject i is presumed to have individual risk preference characteristics summarized by a (potentially type-dependent) risk aversion parameter $\alpha(X_i) \in \mathbb{R}$, where X_i represents a vector of subject characteristics (e.g., demographics). While $\alpha(X_i)$ could take any functional form, we will frequently concentrate on linear relationships, so that:

$$\alpha(X_i) = \alpha_0 + \beta \cdot X_i,$$

where α_0 is a constant representing a "baseline" level of risk aversion and β is a vector of coefficients on subject characteristics X_i.

In both treatment and control groups, the subject faces a choice between a "sure thing" (ST) and a "risky venture" (RV). Project ST pays off $V > 0$ with certainty, while RV pays off $V_H > V$ with probability q and $V_L \in (0, V)$ with probability $(1 - q)$, where $q \in (0,1)$. We assume that $qV_H + (1 - q)V_L > V$, so that an unbiased, risk-neutral party would always prefer RV to ST. As noted above, the experimental vignette set forth V = \$8; V_H = \$30; V_L = \$3; and q = 1/3, which clearly satisfies this condition.

We suppose for concreteness that subjects are heterogeneously risk-averse, exhibiting constant relative risk aversion (CRRA) utility functions. Equivalently, the utility subject i gets from realized income y_i, or $u(y_i; \alpha_i)$, can be represented as follows:

$$u(y_i; \alpha_i) = \frac{{y_i}^{1-\alpha(X_i)}}{1-\alpha(X_i)}$$

This function converges to $\ln(y_i)$ as $\alpha(X_i) \longrightarrow 1$. The special case of $\alpha(X_i) = 0$ corresponds to risk neutrality, while $\alpha(X_i) > 0$ corresponds to risk aversion, and $\alpha(X_i) < 0$ corresponds to a preference for risk.

Given this set of preferences, subject *i* will (weakly) prefer the risky venture (RV) to the sure thing (ST) if and only if:

$$u\big(RV; \alpha(X_i)\big) = q \cdot \frac{{V_H}^{1-\alpha(X_i)}}{1-\alpha(X_i)} + (1-q) \cdot \frac{{V_L}^{1-\alpha(X_i)}}{1-\alpha(X_i)}$$

$$\geq \frac{V^{1-\alpha(X_i)}}{1-\alpha(X_i)} = u\big(ST; \alpha(X_i)\big),$$

or equivalently:

$$q \cdot {V_H}^{1-\alpha(X_i)} + (1-q) \cdot {V_L}^{1-\alpha(X_i)} \geq V^{1-\alpha(X_i)}$$

Given our parameterization, there is a unique risk aversion level, $\alpha(X_i) = \alpha^*$, in which the above expression is satisfied at equality, and the subject is indifferent between ST and RV. She thus prefers ST when $\alpha(X_i) > \alpha^*$, and prefers RV when $\alpha(X_i) < \alpha^*$. For the specific numerical values utilized in our experimental setting,[157] it is easily verified that the unique indifference point occurs at $\alpha^* \approx 0.66$.

We represent our experimental manipulation as potentially introducing a "shock" to the baseline level of risk aversion, or α_0 from above, to a new value $\alpha_1 = \alpha_0 + \lambda < \alpha_0$. Note that because our Invest in Invention frame is designed to *reduce* manifest aversion to risk, we hypothesize the shock to be negative, so that $\lambda < 0$. The shock need not affect all subjects equally: For infra- and extra-marginal subjects (for whom risk aversion $\alpha(X_i)$ was much less or much greater than the critical switch value α^*), the manipulation will not affect preference orderings. However, for near "marginal" subjects where $\alpha(X_i)$ is in the vicinity of α^*, our manipulation can induce a change in behavior from favoring ST to favoring RV. That is, denoting the dummy variable τ_i to represent assignment to the control (0) or treatment (1) group, we would expect to find a group of subjects for which:

157. I.e., *V* = \$8; *VH* = \$30; *VL* = \$3; and *q* = 1/3.

$$\alpha_0 + \beta \cdot X_i + \lambda < \alpha^* < \alpha_0 + \beta \cdot X_i$$

In other words, if our manipulation has the effect we posit, we would expect a disproportional preference for RV relative to ST in the treatment group compared to the control group. We therefore seek an identification strategy that will allow us to estimate λ, and to test the null hypothesis that $\lambda = 0$ against the (one-sided) alternative that $\lambda < 0$.

B. Calibration to the Literature

As noted above, one unavoidable limitation of drawing on results from prior literature is that granular information on the subjects' demographics (or the X_is) is rarely if ever reported in usable form. Thus, the best one can do is to benchmark on summary statistics (effectively dropping all of the X_is other than a dummy variable indicating whether the subject was in our experimental control group).

Moreover, in both our experiment and in the prior literature, one cannot observe subjects' true baseline values of α_0. The best one can do is to infer plausible ranges of values from revealed preference orderings within a specific hypothetical vignette. A common vignette in the literature concerns the "switch point" on the HL scale at which the probability of a successful outcome grows sufficiently favorable that a subject first chooses the high-variance project (Option B in the table below, with respective high and low payoffs of V_{HH} and V_{LL}) over the low variance project (Option A, with respective payoffs of V_H and V_L, where $V_H < V_{HH}$ and $V_L > V_{LL}$). Specifically, if the subject first switches from Option A to Option B when the success probability is equal to q_k, it follows that:

$$q_k \cdot {V_{HH}}^{1-\alpha} + (1 - q_k) \cdot {V_{LL}}^{1-\alpha} \geq q_k \cdot {V_H}^{1-\alpha} + (1 - q_k) \cdot {V_L}^{1-\alpha}$$

Because the subject did not switch at success probability q_{k-1}, it must also be true that:

$$q_{k-1} \cdot {V_{HH}}^{1-\alpha} + (1 - q_{k-1}) \cdot {V_{LL}}^{1-\alpha} < q_{k-1} \cdot {V_H}^{1-\alpha} + (1 - q_{k-1}) \cdot {V_L}^{1-\alpha}$$

Plugging the numerical values from Table 1A into each of these expressions and then solving for the unknown coefficient α allows one to use the first switch point to infer plausible *ranges* of risk aversion coefficient values (α), depicted in the final column of the table below:[158]

Table 1A: Holt-Laury (2002) Risk-Aversion Elicitation Bins

Option A (Low Variation)	**Option B (High Variation)**	**Switch Point => α**
10% chance of $2.00 and 90% chance of $1.60	10% chance of $3.85 and 90% chance of $0.10	$\alpha \leq -1.713$
20% chance of $2.00 and 80% chance of $1.60	20% chance of $3.85 and 80% chance of $0.10	$-1.713 < \alpha \leq -0.947$
30% chance of $2.00 and 70% chance of $1.60	30% chance of $3.85 and 70% chance of $0.10	$-0.947 < \alpha \leq -0.487$
40% chance of $2.00 and 60% chance of $1.60	40% chance of $3.85 and 60% chance of $0.10	$-0.487 < \alpha \leq -0.143$
50% chance of $2.00 and 50% chance of $1.60	50% chance of $3.85 and 50% chance of $0.10	$-0.143 < \alpha \leq 0.146$
60% chance of $2.00 and 40% chance of $1.60	60% chance of $3.85 and 40% chance of $0.10	$0.146 < \alpha \leq 0.411$
70% chance of $2.00 and 30% chance of $1.60	70% chance of $3.85 and 30% chance of $0.10	$0.411 < \alpha \leq 0.676$
80% chance of $2.00 and 20% chance of $1.60	80% chance of $3.85 and 20% chance of $0.10	$0.676 < \alpha \leq 0.971$
90% chance of $2.00 and 10% chance of $1.60	90% chance of $3.85 and 10% chance of $0.10	$0.971 < \alpha \leq 1.368$
100% chance of $2.00 and 0% chance of $1.60	100% chance of $3.85 and 0% chance of $0.10	$\alpha > 1.368$

In addition, we must further allow for the possibility that a subject would *never* switch within the HL experimental protocol, even when the chance of the high payoff reached 100%. This is no doubt inconsistent with any type of rational choice theoretically, but we found that approximately 2.7 percent of our subjects never switched to option B in our HL elicitation. We therefore place these subjects into an 11th bin, which we call A_{11}, and which cannot be rank-ordered against the others.[159] Through the HL elicitation question, we observe a series of dummy variables $z_{i,k}$, which reflect whether bin A_k contains the first bin at which *i* switches to Option B, for bins $k \in \{1,2,\dots,10,11\}$.

To assess our experimental data side-by-side against the HL results, we simulated a data set replicating the summary statistics of HL. Because the HL data do not include any granular controls, we control (at this stage) only for a single dummy variable: whether the subject was part of our experimental data, and in particular part of the

158. The HL elicitation subdivides the risk aversion domain A into K=10 ordered "bins" coinciding with:

$\{A_1|A_2 \dots A_9|A_{10}\} = \{(-\infty,-1.713]|(-1.713,-0.947]|\dots|(0.971,1.368]|(1.368,\infty)\}$

159. Our results change little if the "never switch" subjects are dropped entirely from our data set.

control group. Note that if the error terms are normally distributed, an ordered probit is the natural choice.

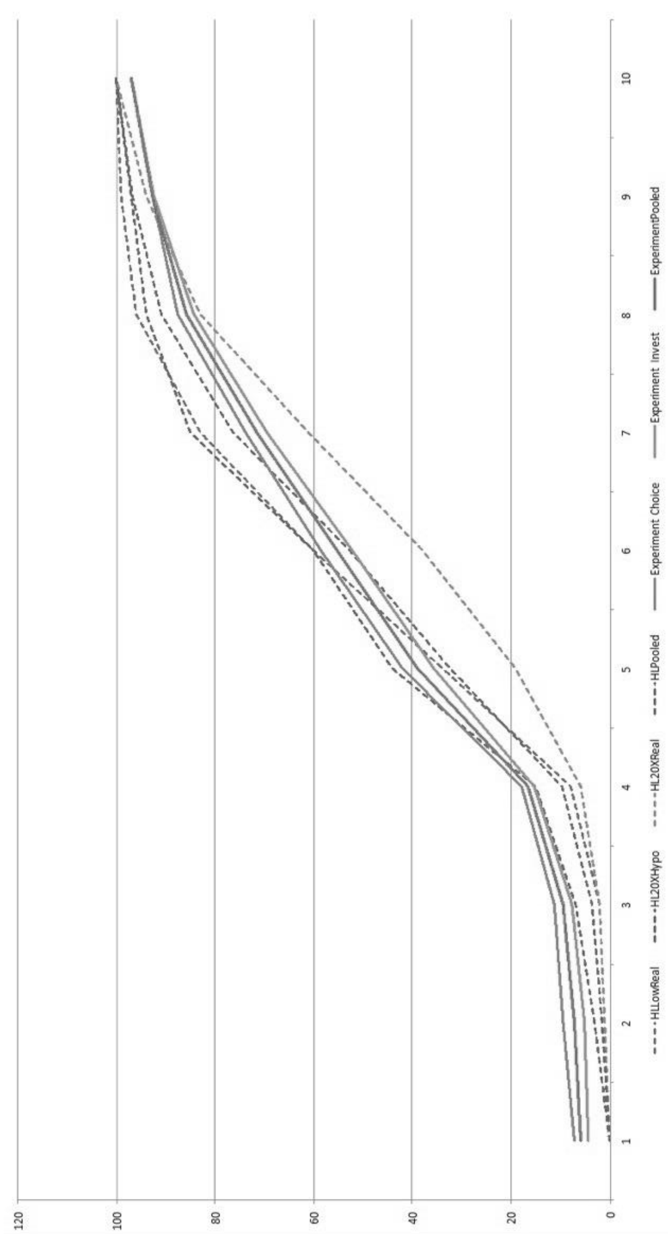

Figure 1A: Subjects' Holt-Laury Switch Bins (Solid Lines; Gains Only & Lose-Money Condition) versus Original Holt-Laury (2002) Switch Distribution (Dotted Lines)

Consider Figure 1A, which illustrates the cumulative frequency of switch-point bins, both for the four original HL conditions (dashed lines) and our various experimental baseline subjects (solid lines). As can be seen from the figure, our subjects appear to manifest a somewhat greater degree of risk aversion at the upper end of the HL scale than most of the HL conditions (other than the 20x real stakes condition). That said, our subjects appear to behave consistently in a manner that sits comfortably within the range of responses in HL. Moreover, note that our treatment and control subjects manifest nearly identical switch point distributions — a fact that we will utilize in our identification strategy below. Overall, we consider this to be reasonable grounds to believe that our data are highly comparable to HL, albeit possibly skewed slightly (but insignificantly) towards greater risk aversion.[160] This comparison provides some comfort that our data are comparable to prior literature, regardless of whether subjects were randomly assigned to the control or treatment group.

C. Identification

Let $y_i \in \{0,1\}$ denote whether the subject takes the {risky, safe} decision.[161] We use the standard limited dependent variable approach to estimate coefficients underlying the binary choice between projects. Assume that there is some "latent" risk aversion variable $\hat{y}_i$ for each experimental subject, which cannot be observed directly. For subject *i* the latent variable is defined by:

$$\hat{y}_i = \alpha_0 + \lambda \cdot \tau_i + \beta X_i + \delta z_i + \varepsilon_i$$

The subject's action is dictated by this latent variable, such that:

$$y_i = \begin{cases} 1 \; if \; \hat{y}_i \geq 0 \\ 0 \; else \end{cases}$$

In the above setup, α_0 is an estimated constant, representing baseline risk aversion; β is a vector of control-variable coefficients on demographic variables X_i, and δ is a vector of "fixed effect" coefficients for (K-1) of the HL "bins" subjects fall into. Our coefficient of interest in this expression will be λ, which embodies the marginal effect of being placed in the innovation "language" treatment group, (where $\tau_i = 1$), as opposed to the pure risk frame (where $\tau_i = 0$). The ε_i denotes an error term on the latent variable. Because we predict that

160. Beyond eyeballing, we checked whether our subjects appeared comparable to the simulated HL data based on switching bins in an ordered probit/logit specification. When we compared the pooled HL data to our control group, we found a modest bias in the direction of risk aversion among our experimental controls. However, this bias is not statistically significant under conventional measures (z = 1.55 & 1.63, respectively).

161. Note that we normalize the "safe" decision as $y_i = 1$, so that this fits into the standard framework for limited dependent variables.

the Invest in Invention frame will make subjects *less* risk-averse and *more* risk-seeking, we will test a null hypothesis that $\lambda = 0$ against the one-sided alternative that $\lambda < 0$.[162]

Given the framework from above, the risky choice will be taken whenever:

$$\varepsilon_i \leq -(\alpha_0 + \beta X_i + \delta z_i + \lambda \tau_i)$$

which occurs with probability:

$$\Phi\left(\frac{-(\alpha_0+\beta X_i+\delta z_i+\lambda \tau_i)}{\sigma}\right)$$

And the safe choice will be taken whenever:

$$\varepsilon_i > -(\alpha_0 + \beta X_i + \delta z_i + \lambda \tau_i)$$

which occurs with probability:

$$1 - \Phi\left(\frac{-(\alpha_0+\beta X_i+\delta z_i+\lambda \tau_i)}{\sigma}\right)$$

Suppose that out of our N subjects, we observe *n<N* of them choose the safe choice ($y_i = 1$) and the remaining *N-n* choose the risky choice ($y_i = 0$). The appropriate likelihood function is defined as follows:

$$\Lambda(\alpha_0, \beta, \delta, \lambda) = \prod_{i=1}^{N} \left[\Phi\left(\frac{-(\alpha_0+\beta X_i+\delta z_i+\lambda \tau_i)}{\sigma}\right)\right]^{1-y_i} \left[1 - \Phi\left(\frac{-(\alpha_0+\beta X_i+\delta z_i+\lambda \tau_i)}{\sigma}\right)\right]^{y_i}$$

The log likelihood function is:

162. One caveat deserves mention here: Because our other control variables (X_i and z_i) are both elicited after the experimental manipulation, it is conceivable that the experimental manipulation itself affected post-manipulation responses. This fear is less salient with the demographic variables X_i, such as age, left-handedness, etc. However, the HL risk aversion elicitation, z_i, might well be altered by being assigned to the treatment or control group. Were this to happen, it would likely attenuate any results we find, which is good news for us. That said, this possible treatment effect on an RHS variable is worth keeping in mind in interpreting the regressions below; we will thus consider specifications that both exclude and include fixed effects for HL bins reported by the subjects. We note, however, that the HL elicitations from our experimental control and treatment subjects appear virtually identical, giving us some confidence that the HL bins are not infected by our experimental manipulation shown in Figure 1.

$$\ln\big(\Lambda(\alpha_0,\beta,\delta,\lambda)\big) =$$

$$\sum_{i=1}^{N}(1-y_i)\cdot\ln\left(\Phi\left(\frac{-(\alpha_0+\beta X_i+\delta z_i+\lambda\tau_i)}{\sigma}\right)\right)+y_i \cdot\ln\left(1-\Phi\left(\frac{-(\alpha_0+\beta X_i+\delta z_i+\lambda\tau_i)}{\sigma}\right)\right)$$

The maximum likelihood approach chooses $\alpha_0, \beta, \delta, \lambda$ — as well as σ — to maximize the above function. As before, given our normality assumptions on ε_i, a Probit specification is appropriate.

As noted above, if the Invest in Invention frame has no effect, then one would predict $\lambda = 0$. If, in contrast, treatment makes subjects *less* risk-averse and *more* risk-preferring on the margin, then we would predict $\lambda < 0$, we will test the null hypothesis that $\lambda = 0$ against the one-sided alternative that $\lambda < 0$.

APPENDIX B: ROBUSTNESS TEST: KEEP VS. INVEST IN INVENTION

The following tables report on alternative probit and logit estimations of Tables 6 and 7 in the text, which used OLS linear probability models. Converting to average marginal effects, these estimates imply that for a subject with a median level of risk aversion, we would predict a 16% to 18% lower rate of opting for the certain option when in the invention frame.

	Probit 1	Probit 2	Probit 3	Probit 4	Probit 5	Probit 6	Logit 1	Logit 2	Logit 3	Logit 4	Logit 5	Logit 6
INVENTION FRAME	-0.291*	-0.421***	-0.421***	-0.384***	-0.488**	-0.487**	-0.470*	-0.685***	-0.686***	-0.646***	-0.849*	-0.851**
	(-2.31)	(-3.11)	(-3.10)	(-2.80)	(-2.41)	(-2.41)	(-2.31)	(-3.01)	(-3.01)	(-2.77)	(-2.32)	(-2.34)
GAMBLED			0.064	-0.049	-0.125	-0.122			0.115	-0.097	-0.209	-0.208
			(0.44)	(-0.31)	(-0.77)	(-0.76)			(0.47)	(-0.36)	(-0.74)	(-0.74)
AGE				0.027***	0.004	0.002				0.047***	0.008	0.004
				(3.40)	(0.40)	(0.19)				(3.41)	(0.48)	(0.25)
MALE				-0.059	-0.159	-0.018				-0.07	-0.251	0.011
				(-0.42)	(-1.08)	(-0.09)				(-0.29)	(-0.99)	(0.03)
HAND				-0.052	-0.056	-0.056				-0.084	-0.1	-0.094
				(-0.28)	(-0.29)	(-0.29)				(-0.26)	(-0.30)	(-0.28)
ETHNICITY				0.181	0.139	0.126				0.316	0.265	0.239
				(1.07)	(0.82)	(0.74)				(1.11)	(0.92)	(0.83)
TURK					0.626*	0.836**					1.003*	1.363**
					(2.32)	(2.53)					(2.23)	(2.48)
MALE x TURK						-0.304						-0.533
						(-1.05)						(-1.07)
CONSTANT	-0.144	0.254	0.202	-0.471	-0.081	-0.093	-0.23	0.412	0.321	-0.81	-0.15	-0.168
	(-1.62)	(0.64)	(0.49)	(-1.05)	(-0.18)	(-0.21)	(-1.62)	(0.65)	(0.49)	(-1.15)	(-0.21)	(-0.24)
Chi-sqd	5.335	74.016	74.127	76.842	92.892	92.718	5.314	66.627	66.658	68.9	81.338	80.747
p	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
N	412	412	412	412	412	412	412	412	412	412	412	412
HL Switch FE	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes

Table B1: Baseline Experiments - Probit and Logit Specifications when Losing Money Not Possible

T-Statistics in Parentheses

+ = Significant at 5% (one tailed test); 10% (two tailed test)

** = Significant at 2.5% (one tailed test); 5% (two tailed test)*

*** = Significant at 1% (one tailed test); 2% (two tailed test)*

**** = Significant at 0.5% (one tailed test); 1% (two tailed test)*

	Probit 1	Probit 2	Probit 3	Probit 4	Probit 5	Probit 6	Logit 1	Logit 2	Logit 3	Logit 4	Logit 5	Logit 6
LANGUAGE	-0.225+	-0.268*	-0.265+	-0.272*	-0.291*	-0.298*	-0.359+	-0.442*	-0.437*	-0.448*	-0.483*	-0.493*
	(-1.69)	(-1.96)	(-1.94)	(-1.98)	(-2.07)	(-2.12)	(-1.69)	(-1.99)	(-1.96)	(-2.00)	(-2.10)	(-2.14)
GAMBLED			-0.11	-0.104	-0.086	-0.095			-0.174	-0.163	-0.134	-0.151
			(-0.77)	(-0.69)	(-0.57)	(-0.62)			(-0.75)	(-0.67)	(-0.55)	(-0.61)
AGE				0.002	0.009	0.007				0.004	0.014	0.012
				(0.33)	(0.90)	(0.75)				(0.32)	(0.92)	(0.76)
GENDER				-0.082	-0.046	0.064				-0.144	-0.085	0.091
				(-0.56)	(-0.31)	(0.30)				(-0.61)	(-0.35)	(0.27)
HAND				-0.034	-0.051	-0.044				-0.042	-0.06	-0.055
				(-0.12)	(-0.19)	(-0.16)				(-0.09)	(-0.13)	(-0.12)
ETHNICITY				-0.017	0.023	0.012				-0.024	0.047	0.032
				(-0.09)	(0.11)	(0.06)				(-0.07)	(0.14)	(0.10)
TURK					-0.2	-0.053					-0.338	-0.097
					(-0.92)	(-0.18)					(-0.95)	(-0.20)
MALE x TURK						-0.212						-0.345
						(-0.73)						(-0.73)
CONSTANT	0.082	0.54	0.628	0.598	0.519	0.508	0.131	0.885	1.028	0.985	0.857	0.835
	(0.88)	(1.39)	(1.53)	(1.30)	(1.11)	(1.09)	(0.88)	(1.36)	(1.50)	(1.28)	(1.10)	(1.07)
Chi-sqd	2.87	24.304	25.083	25.373	25.748	26.139	2.863	22.608	23.384	23.578	23.751	24.1
p	0.09	0.012	0.014	0.064	0.079	0.097	0.091	0.02	0.025	0.099	0.126	0.152
N	360	360	360	360	360	360	360	360	360	360	360	360
HL Switch FE	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes

Table B2: Baseline Experiments - Probit and Logit Specifications when Losing Money Possible

T-Statistics in Parentheses

+ = Significant at 5% (one tailed test); 10% (two tailed test)

** = Significant at 2.5% (one tailed test); 5% (two tailed test)*

*** = Significant at 1% (one tailed test); 2% (two tailed test)*

**** = Significant at 0.5% (one tailed test); 1% (two tailed test)*

APPENDIX C: ROBUSTNESS TEST: KEEP VS. INVEST

Table C1: Robustness Experiments - Invest with no Invention (OLS Estimates)

	Model 1	Model 2	Model 3	Model 4	Model 5
INVENTION FRAME	-0.015	-0.008	-0.005	-0.019	-0.019
	(-0.21)	(-0.11)	(-0.07)	(-0.26)	(-0.26)
GAMBLED			0.077	0.062	0.062
			(0.89)	(0.73)	(0.73)
AGE				0.005	0.005
				(1.48)	(1.48)
GENDER				-0.023	-0.023
				(-0.31)	(-0.31)
HAND				0.1	0.1
				(0.86)	(0.86)
ETHNICITY				-0.137	-0.137
				(-1.31)	(-1.31)
CONSTANT	0.611***	0.576***	0.508**	0.405	0.405
	(11.83)	(2.93)	(2.44)	(1.60)	(1.60)
R-sqd	0.00	0.059	0.064	0.097	0.097
p	0.832	0.149	0.222	0.045	0.045
N	184	184	184	184	184
HL Switch FE	No	Yes	Yes	Yes	Yes

T-Statistics in Parentheses
+ = Significant at 5% (one tailed test); 10% (two tailed test)
** = Significant at 2.5% (one tailed test); 5% (two tailed test)*
*** = Significant at 1% (one tailed test); 2% (two tailed test)*
**** = Significant at 0.5% (one tailed test); 1% (two tailed test)*

APPENDIX D: ROBUSTNESS TEST: ENDOWMENT ONLY

Table D1: Robustness Experiments Endowment Only (OLS Estimates)

	Model 1	Model 2	Model 3	Model 4	Model 5
KEEP LANGUAGE	-0.051	-0.036	-0.038	-0.046	-0.05
	(-0.73)	(-0.52)	(-0.54)	(-0.65)	(-0.71)
GAMBLED			-0.046	-0.046	-0.02
			(-0.50)	(-0.50)	(-0.22)
AGE				0.003	0.001
				(0.77)	(0.35)
GENDER					-0.131+
					(-1.76)
HAND					0.01
					(0.08)
ETHNICITY					0.012
					(0.12)
CONSTANT	0.461***	0.669***	0.702***	0.617***	0.675***
	(9.29)	(4.80)	(4.57)	(3.22)	(3.29)
R-sqd	0.003	0.103	0.105	0.107	0.123
p	0.094	0.469	0.010	0.011	0.016
N	202	202	202	202	202
HL Switch FE	No	Yes	Yes	Yes	Yes

T-Statistics in Parentheses:
+ = Significant at 5% (one tailed test); 10% (two tailed test)
** = Significant at 2.5% (one tailed test); 5% (two tailed test)*
*** = Significant at 1% (one tailed test); 2% (two tailed test)*
**** = Significant at 0.5% (one tailed test); 1% (two tailed test)*