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This article is available in Northwestern Journal of Technology and Intellectual Property:
https://scholarlycommons.law.northwestern.edu/njtip/vol17/iss1/1
PATENTLY UNCERTAIN

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ABSTRACT—Innovation is an inherently uncertain process. Success is typically coupled with risk and we can only hope that those with great ideas will persevere. To encourage innovation, society reduces some of the innovation risk through structures like funding systems, regulation, and of course intellectual property rights. But what happens when uncertainty strikes the legal protection devices themselves? Faced with unclear rules and increasingly speculative rewards, some innovators may simply stop playing the game.

Such uncertainty has recently been a topic of great concern in the U.S. patent system. Some believe that the suddenly unknowable nature of fundamental questions like what is patentable has had the effect of dramatically undermining legal incentives. Others question whether a crisis really exists. They point out that uncertainty can have positive effects, and even, be a source of strategic advantage. How can we tell good uncertainty from bad?

This article provides a novel framework for evaluating patent uncertainty that explains how complaints and complacency can exist contemporaneously. It draws on the behavioral economics literature to provide a deeper understanding of how innovators react to unknown legal environments. Based on this analysis, the article identifies three different types of legal uncertainty: (1) investment-killing; (2) if-then; and (3) remedial uncertainty. It asserts that only the first creates a problem that must be addressed by legal reform, while the others are actually essential to a healthy innovation system. The article concludes with specific prescriptions for addressing negative uncertainty that depend on both firm and policymaker action.

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INTRODUCTION

Uncertainty and innovation go hand-in-hand. Changing consumer preferences, unforeseen advances in technology, and the shifting sands of global trade are among the innumerable complicating factors that are impossible for inventors to predict. To engage in such an endeavor, one must be comfortable with risk. Thus, society incentivizes risk-taking by providing limited exclusivity through rights like patents that, in turn, convey monopoly profits. At least, this is the traditional innovation policy.


Hon. Paul R. Michel (Ret.).

I spent twenty-two years on the Federal Circuit and nine years since dealing with patent cases, and I cannot predict in a given case whether eligibility will be found or not found. If I can’t do it, how can bankers, venture capitalists, business executives and all of the other players in the system make reliable predictions and sensible decisions?
saw that undergirds the modern intellectual property system. But what happens when uncertainty strikes the very legal protection devices themselves? Incentives may suddenly become unclear and the rewards more speculative. At some point, uncertain rules may simply cause some innovators to stop playing the game.

This is no idle concern, as there is evidence that intellectual property uncertainty may be growing. The United States, in particular, has been singled out for its drift toward unstable and unpredictable standards in such fundamental areas as patentable subject matter and enforceability. According to the U.S. Chamber of Commerce, “the U.S. is no longer a global leader [in patent protection]... owing to uncertainty over patentability standards and a relatively low score for opposition proceedings.” The Chamber’s 2018 global index of the environment for patent rights ranks the U.S. tied for twelfth in the world, down significantly from past years. Other voices in the business and inventor community have reflected similar apprehension. The sentiments are worthy of attention, because they capture rising innovator and investor concern, which can ultimately impact innovative activity.

Is the anxiety justified? Unfortunately, our traditional policy tools are not up to the task of assessing whether there really is an uncertainty risk. Standard legal analysis is consumed with the pursuit of doctrinally correct

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5 Id.


outcomes, or advocating for a strong or weak IP system, necessarily undervaluing the ex-ante impact of uncertainty. Moreover, commentators typically consider the post hoc intellectual property environment without necessarily addressing the innovators who are dissuaded from participating. For example, in a recent statistics-driven article, noted patent academic, Mark Lemley, reflects on the “resiliency” of the patent system. He finds that, despite concern over bad patents, trolling owners and uncertain standards, the number of applications continues to go up. So do the number of litigations. The natural conclusion is that innovation survives intact despite uncertainty, but such an assessment cannot count the inventors who abandoned their activity or chose secrecy rather than the risk of the patent system.

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11 Id. at 14–18.

12 Id. at 19–21.

13 This is not to say that no one has attempted to model the shift. In a fascinating historical study, economist Petra Moser looked at innovation displayed at the nineteenth-century World’s Fairs. Petra Moser, How Do Patent Laws Influence Innovation? Evidence from Nineteenth-Century World’s Fairs, 95 AM. ECON. REV. 1214 (2005). She determined that countries without strong patent protection produced innovation from industries in which patents are less important and secrecy is possible. Id. at 1231–32.
To truly model the impact of uncertainty, a behaviorist point of view that considers the pre-investment world of the innovator is required. From this perspective, patents are innovation incentives only because they are uncertainty reduction mechanisms. And when the patent bargain is undermined due to ex post revision of the standards and terms, ambiguity arises, and the promise of uncertainty reduction is less effective. The system is not only weakened, but rather provides an inconsistent and unknown pathway that allows others to chaotically capture rights. However, a behaviorist view also acknowledges that uncertainty can be useful at times. An innovator believing that she has superior knowledge of the future may have a competitive advantage in an uncertain environment. Because innovation is a process rather than an event, one can make strategic choices in terms of claiming or enforcement that may dissuade others confronting the unknown. Uncertainty can even be beneficial in framing remedies that prevent opportunistic actors from behaving immorally just up to the point of liability.

How can we tell whether the bad uncertainty is overwhelming the good? This article cuts through the fog by looking at the issue from the perspective of those who create. It provides a novel framework for evaluating uncertainty that better explains why complaints and complacency seem to exist at the same time. The article is a significant departure from the literature on uncertainty that describes the impact of uncertain patents, uncertain enforcement, overall system uncertainty, or

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16 Raghu Garud et al., Perspectives on Innovation Processes, 7 Acad. Mgmt. Annals 773, 774–75 (2013) (describing innovation as “more than the emergence of novel ideas”).


simply the idea that unknowns in patent law are bad. Rather, it looks to the behavioral economics literature for clues on how to identify problematic uncertainty, and actually separate it from beneficial uncertainty or the inherent risk in innovation. Using this lens, this article for the first time identifies three different types of legal uncertainty that are likely to impact innovators: (1) investment-killing uncertainty, (2) if-then uncertainty, and (3) remedial uncertainty. It asserts that only the first creates a problem that must be addressed by policy makers and suggests appropriate action.

Part I describes the nature of innovation and unknowns, explaining how risk and uncertainty impact the innovation process in both positive and negative ways. Part II explains how mechanisms like patents are supposed to work to reduce harmful uncertainty and facilitate innovation. Part III describes the rise of new legal uncertainty and introduces a framework for evaluating its effect. The issue of patentable subject matter is highlighted as a focal point and potential target for reform, but it is contrasted with the law of obviousness and fee-shifting to demonstrate uncertainty that is less harmful. Part IV provides a prescriptive outlook on the optimal way to address ambiguity, at both the policy level and for the firm. In the end, the article concludes that we cannot—and should not—try to eliminate all uncertainty in patent law, but we can find a better way to cohabitate.


I. RISK AND UNCERTAINTY IN INNOVATION

Whether groundbreaking or merely incremental, innovation is a critical driver of increased productivity on the firm and country level. Innovation can be described as the “invention, development, and implementation of new ideas.” Although it is common to think of innovation as a eureka-like moment that falls upon a prescient inventor or creator, academics studying the field see a more complex picture. Whereas the initial invention may correlate with that moment of insight (with a reduction to something concrete), innovation is the ability to take new ideas and commercialize or otherwise make them available. This rarely is accomplished by an individual working in isolation. Rather, realized innovation is a non-linear process with many steps, interactions and contributing stakeholders. Embedded in this viewpoint is the idea that there are systemic attributes that promote innovation, as well as dynamic and relational properties that shape the path of innovation. The process is something that can be managed and optimized. It can also be derailed by systemic uncertainty.

The presence of uncertainty appears troubling at first. If societal rules are ill-defined and subject to shifting interpretations, the structure of the legal system would seem to be weakened. This is a natural assumption in the case of patent law, which many see as reliant on strong property origins.


22 Garud et al., supra note 16, at 774. See also Vernon W. Ruttan, Usher and Schumpeter on Invention, Innovation, and Technological Change, 73 Q.J. ECON. 596, 603 (1959) (reviewing Schumpeter’s and Usher’s work and concluding that innovation designates “any ‘new thing’ in the area of science, technology, or art”).

23 Garud et al., supra note 16, at 774–76 (describing literature on innovation processes and their support of an “evolutionary” perspective on innovation).


25 Consider generally ANDREW H. VAN DER VEN, DOUGLASS E. POLLEY, RAGHU GARUD & SANKARAN VENKATARAMAN, THE INNOVATION JOURNEY (1999) (reviewing multiple examples of innovation in a longitudinal study and noting how messy and ad hoc the process can be).

26 See, e.g., Maria Weimer & Luisa Marin, The Role of Law in Managing the Tension between Risk and Innovation: Introduction to the Special Issue on Regulating New and Emerging Technologies, 7 EUR. J. RISK. REG. 469, 469–70 (2016) (describing generally how law can be viewed as a barrier to innovation and an important societal protection, and the key is understanding how to accomplish the latter without the former).

27 Garud et al., supra note 16, at 775.

28 See Anthony D’Amato, Legal Uncertainty, 71 CALIF. L. REV. 1, 6 (1983) (“What is really undesirable about uncertain rules of law is that they leave persons unsure of their entitlements while affording unfettered discretion to official decisionmakers.”).
requiring predictable rules. One might presume that any uncertainty in patent law necessarily reduces innovation incentives, and the cure is to clarify the rules by rigid statute if necessary. However, the impact of uncertainty in the law is more nuanced, particularly when it applies to the inherently indefinite area of innovation. To the individual innovator, some sources of uncertainty may create substantial roadblocks. But others may be neutral or even spur innovation. A single-minded effort to eliminate legal uncertainty could be counterproductive, and it is therefore, useful to consider its broader role in innovator decision making.

It is useful to first appreciate how uncertainty can manifest as an innovation problem. With that in mind, it is possible to unpack the nature of uncertainty in innovation and identify the attributes that define its impact on an individual inventor or firm. A behavioral economics approach appropriately grounds such an assessment. From this more contextualized understanding, the idealized role of patent legal instruments is apparent, as well as the negative impacts when they are the source of uncertainty.

A. Uncertainty Matters: An Invention Story

Despite the inherent risks in innovation, participants in the system count on some predictability and certainty in legal structures to justify their investments. When patent certainty is undermined, the benefits of playing the innovation game are threatened. Consider the case of Dr. Francesco Pompei and his forehead thermometer, an invention that may not have transformed medical science, but surely made life with a minor illness just a bit better.
In 1998, Dr. Pompei, a researcher associated with Harvard University,32 invented a method for measuring body temperature based on heat flow at the surface of the forehead.33 Existing thermometer technology depended on invasive techniques that required some bodily enclosure.34 The most advanced (and least objectionable) alternatives at the time—eardrum or underarm thermometers—still required some intrusion into the body. Dr. Pompei’s idea of using the temporal artery as an infrared measurement site and comparing it to ambient temperature to obtain an accurate body temperature was radical and not readily accepted by the medical community.35 But such a non-invasive technique was highly desired by patients and significant market interest was evident.36 In order to convince physicians and regulators that his methods were medically reliable and establish that a marketable product could be produced with the idea, Dr. Pompei was required to undertake significant investments of time and money.37 Such investments would only be reasonable if he could retain some control over the invention in the future.

Thus, Dr. Pompei filed for a patent on a “Temporal Artery Temperature Detector,” which was eventually granted and issued in 2001.38 With this, and several other related patents, he built a highly successful firm called Exergen to manufacture and sell non-invasive thermometers.39 According to the company’s materials, the thermometers are used in half of U.S. hospitals and are in the hands of over four million consumers.40 Such success breeds competition, and other firms have an obvious interest in using Dr. Pompei’s patented methods to carve out their own portions of this

32 Dr. Pompei has been profiled as a successful entrepreneur related to his work in non-invasive thermography. See Allyson Every, Father and Son Tackle Heat, Sound, MIT TECH. REV. (June 1, 2005), https://www.technologyreview.com/s/404219/father-and-son-tackle-heat-sound/ [https://perma.cc/7YAV-Q6PJ].


34 Id. at 5.


36 Karel Allegaert et al., Tympanic, Infrared Skin, and Temporal Artery Scan Thermometers Compared with Rectal Measurement in Children: A Real-Life Assessment, 76 CURRENT THERAPEUTIC RES. 34, 36 (2014) (describing the desire for non-invasive thermometers in the treatment of children, and noting that, while all are second-best, temporal artery scans are closest to traditional methods).

37 Exergen’s Opposition, supra note 33, at 6. See also About Exergen Corporation, supra note 31.

38 U.S. Pat. No. 6,292,685 (issued Sept. 18, 2001).

39 See About Exergen Corporation, supra note 31 (“Exergen holds over 100 issued and pending U.S. and foreign patents . . . .”).

40 Id.
valuable market. Thanks to his patents, Dr. Pompei could expect a continued return on his investment... unless it turns out that Dr. Pompei did not claim a patentable invention.

In two cases, one against Brooklands, Inc. and the other against Thermomedics, Inc., separate district courts ruled that a continuation of the original patent was invalid under 35 U.S.C. § 101 for claiming a natural phenomenon with no inventive step. One of the invalid claims, no. 51, reads:

A method of detecting human body temperature comprising: measuring temperature of a region of skin of the forehead; and processing the measured temperature to provide a body temperature approximation based on heat flow from an internal body temperature to ambient temperature.

According to the two district courts, the “measuring” and “processing” aspects of the claims added nothing inventive.

However, a third, contemporaneous case against another defendant, Kaz, yielded a completely different result. That case involved the following claim from the same patent, claim no. 14:

A method of detecting human body temperature comprising: making at least three radiation readings per second while moving a radiation detector to scan across a region of skin over an artery to electronically determine a body temperature approximation, distinct from skin surface temperature.

The district court in that case found that, although the steps beyond the natural phenomenon were generally known, they were not “well understood or routine” in the context of measuring body temperature.

In an unpublished opinion, the U.S. Court of Appeals for the Federal Circuit affirmed the Kaz court’s determination that the patent was not invalid. The claims at issue in these two cases are extremely similar, and

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41 U.S. Pat. No. 7,787,938 (issued Aug. 31, 2010).
44 Exergen Corp., 125 F. Supp. 3d at 317 (“Measuring temperature or radiation is simply not an inventive or unconventional step in the field of thermometry”); Exergen Corp., 132 F. Supp. 3d at 208 (“The asserted claims lack an inventive concept outside of the laws of nature and are not eligible for patent protection.”).
45 U.S. Pat. No. 7,787,938 (issued Aug. 31, 2010). The actual claim that was litigated at the district court level and appealed was claim 24, which was dependent on claim 14. Exergen Corp. v. Kaz USA, Inc., 725 F. App’x 959, 962 (Fed. Cir. 2018). This means that the case involved claim 14 with the additional limitation that the artery referred to in the claim is a temporal artery. Id.
the difference in validity appears to rest on what is sufficient to transform an otherwise unpatentable phenomenon into a protectable invention. In dissent, Judge Hughes argued that the district court erred because, “Rather than finding that the claim elements were not routine or conventional, [it] focused on whether those elements were routinely or conventionally used for the purpose of calculating core body temperature.” This is arguably a different legal test than prescribed by precedent. In fact, Judge Hughes noted that the Federal Circuit had rejected such a test in an earlier case.

Two invalidations and one not-invalid verdict over three cases, all in the District of Massachusetts. How is an innovator expected to navigate such a mix of derived-on-the-fly tests, years before the invention is litigated? Following a substantial investment of time and materials, as well as a commitment to disclosure through the patent system. Dr. Pompei and Exergen were ultimately left with no real basis for valuing the risk. They could only look forward to an uncertain legal environment and hope for the best. A less committed innovator might not opt for such a challenge, and the world might be worse off.

It is cases like Dr. Pompei’s that worry many in the intellectual property community, particularly small inventors. His invention is not a mere arrangement for taking pictures against a white background or a method of swinging on a swing, but a rather a concrete, useful advance in medical technology. A larger entity may be in a better position to fund a risky patent application or negotiate with the examiner. But those without such protection may abandon a project or rely on secrecy. Thus, the key question: to prevent a suboptimal outcome, how much do we need to protect the “Dr. Pompeis” of the world from uncertainty?

B. A Behavioral Economics View on Uncertainty and Decision-Making

Uncertainty imbues every decision about the future to some extent. There are so many factors that can impact what will eventually occur that no one can move ahead with complete security. But not all unknowns confronted by decision-makers are equal. Some can be characterized in

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47 Exergen Corp., 725 F. App’x at 966–67.
48 Id. at 975.
49 Id.
50 U.S. Pat. No. 8,676,045 (issued Mar. 18, 2014).
51 U.S. Pat. No. 6,368,227 (issued Apr. 9, 2002).
52 Professor Lemley has argued that one should not focus on incentivizing a particular inventor, since few advances depend on one person. Lemley, supra note 24, at 712–13. Rather, we are incentivizing patent races. Id. at 750–51. Regardless, the impact of uncertainty in dissuading an individual or participants of a race may not be significantly different.
53 Moser, supra note 13, at 1231–32.
terms of probability and effectively managed, while others may be so fraught with undefined radicals and factors as to defy conception. Some may arise through the actions of the decision-maker, while others may be generated by outside forces. Some may involve issues present before or at the time of investment, yet others may arise after costs have been sunk. At base, uncertainty can be positive or negative, depending on the nature and context. This rich environment of uncertainty means that there is no one-size-fits-all solution or path. Not every uncertainty must be resolved, and a misaligned system for addressing uncertainty can actually create more problems than it solves.

In conceptualizing the nature of unknowns, there is perhaps no more cited academic than economist Frank Knight. He is credited with articulating the difference between risk and true uncertainty that has helped guide modern analysis of innovation and business decision-making. According to Professor Knight, risk exists when the future is unknown, but the probabilities of the future outcomes can be assessed with certainty. With this knowledge, one can reasonably decide on the best path, even if there are many possible outcomes. When those outcomes have a financial impact, one can value each path based on the probabilities and an appropriate time-related discount. This is the basis of many business valuation techniques. It is also well represented by decision tree analysis, which attempts to place a value on decision “nodes” according to the probability of receiving payoffs along different paths.

On the other hand, true uncertainty exists when one cannot even identify the systems or factors that would give rise to the probabilities of future outcomes. As Donald Rumsfeld famously declared in the wake of the 2001 terrorist attacks on the United States, these are “unknown unknowns.” Without an understanding of how the future could shift, it is essentially impossible to know with any confidence the risk of any particular path. Professor Knight describes states in which some of these

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55 FRANK H. KNIGHT, RISK, UNCERTAINTY AND PROFIT 233 (1921) (reprinted 1964).
56 Id.
57 GORDON V. SMITH & RUSSELL L. PARR, VALUATION OF INTELLECTUAL PROPERTY & INTANGIBLE ASSETS 165 (3d ed. 2000).
58 See David Teece & Sohvi Leih, Uncertainty, Innovation and Dynamic Capabilities: An Introduction, 58 CAL. MGMT. REV., no. 4, 2016, at 5, 8 fig.1 (graphically depicting the difference between risk and uncertainty using a decision tree as compared to radiating probability questions).
59 KNIGHT, supra note 55, at 233–34.
uncertainties could be grouped, such that paths could be broadly assessed, but he noted that there are states of uncertainty that are incapable of even this level of analysis.61

To be fair, Knight’s risk/uncertainty distinction has been criticized for lack of relevance in the real world.62 On paper, it seems reasonable to qualify some issues as being solvable through probability analysis, but in fact, reality is almost always more complicated. Any determination about the future implicates a number of systems that are hard to fully ascertain. Moreover, when other actors are involved, biases and heuristics make human behavior inherently uncertain. Thus, it has been suggested that nearly everything beyond lotteries and casino gambling is a question of uncertainty, not risk.63 But this criticism, while technically correct, does not capture the distinction Knight intended. He was comparing issues that we can reasonably wrap our heads around leading to informed decisions with those that have too many unknown variables, and for which, we have only “partial knowledge.”64 This is a distinction that realistically impacts individuals and firms.

Other economists have discussed the existence of uncertainty in business decision-making, often in the context of financial markets. John Maynard Keynes, for example, reflected Knight’s distinction between risk and uncertainty and noted that investment decisions are typically made under conditions of uncertainty.65 Keynes also noted that there are differences in individuals regarding their uncertainty preferences, and entrepreneurs are often more willing to move forward with a lack of knowledge.66

Although unknowns cannot be avoided, classical economists have traditionally assumed that individuals and firms can still behave rationally. If one does not know exactly which probability distribution among many

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61 Knight, supra note 55, at 238–240.
62 See Geoffrey T.F. Brook, Uncertainty, Profit and Entrepreneurial Action: Frank Knight’s Contribution Reconsidered, 32 J. HIST. ECON. THOUGHT 221, 226 (2010) (“Risk refers only to instances where there is certainty about the distribution of possible outcomes, and this certainty exists only in the textbook theories of perfect competition.”).
63 Id.
65 John Maynard Keynes, A TREATISE ON PROBABILITY 355–56 (1921).
66 Richard A. Posner, Keynes and Coase, 54 J.L. & ECON. S31, S37 (2011) (comparing an entrepreneur’s willingness to take “noncalculable risks” to others of equal intelligence by setting forth “empirical evidence that economic growth is indeed . . . positively correlated with tolerance for uncertainty (low uncertainty aversion) and, a closely related point, that entrepreneurs are less averse to uncertainty than are other persons.”).
will result from a decision, one can still engage in rational decision making using one’s own subjective expected utility (SEU). Using this model, individuals determine subjective probabilities based on their knowledge and make the move that results in the highest individual utility given the probabilities. It does not matter if the individual does not actually know which probability distribution applies. This is obviously a model that depends on some conception of potential probabilities. When probabilities associated with outcomes knowingly cannot be determined at all, behavioral economists would argue that irrationality will at times prevail.

To distinguish the specific kind of uncertainty that is not amenable to subjective expected utility theory, economists use the term “ambiguity.” Ambiguity is a situation in which an individual has no basis for assessing future outcomes because, essentially, the games that will be played are unknown. Daniel Ellsberg described this state in 1961 as a situation that cannot be resolved with subjective expected utility, demonstrating instead that ambiguity leads to irrational behavior. The field of behavioral economics owes much to this work. Unfortunately, the terms uncertainty and ambiguity are frequently interchanged outside of formal economics, so it is important to keep in mind the basic premise of Ellsberg’s ambiguity: inability to determine the probabilities that exist.

Given the nature of missing information in ambiguity scenarios, the state is often temporal. In other words, as one gains additional knowledge, particularly about probabilities of occurrence, aspects of ambiguity disappear, and the choices become clearer. This is analogous to Bayesian updating in expected utility, in that subsequent information is used to revise previous estimates of figure probabilities. In some cases, it may be possible for a decision maker to engage in efforts to attain the missing information or realign the decision after the conditions become more evident. But for decisions that must take place at a particular time period,

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72 Id.
73 Gary Charness & Dan Levin, When Optimal Choices Feel Wrong: A Laboratory Study of Bayesian Updating, Complexity, and Affect, 95 Am. Econ. Rev. 1300, 1300 (2005).
74 Id.
against information that will only be available ex post, the impact of the ambiguity will be present.

Significantly, the very existence of uncertainty or ambiguity can be a disincentive in and of itself. The description and study of this negative impact of the unknown is an important area of behavioral economics. Termed “ambiguity aversion,” it is the idea that individuals will avoid economically rational choices when uncertainty is present, or at least require an uncertainty premium. Ellsberg is credited with identifying this phenomenon. His work employed a game theoretic approach to demonstrate the behavior subjects exhibit in the face of ambiguity that manifests in a kind of conservatism that protects against the worst-case scenario. It violates subjective utility theory. Even explaining the rational choice to a subject will not necessarily dispel the aversion. Certainly, this behavior will not occur every time there is an unknown. But it explains that individuals are not always operating on some sense of the probabilities of future outcome and that uncertainty should have measurable effects.

In the wake of Ellsberg’s work, multiple studies have confirmed that ambiguity aversion is a real behavioral phenomenon and have added multiple dimensions. For example, subjects will pay a premium to avoid ambiguity. They will respond with more aversion when the range of probabilities increases. And they do not appear to be reacting to the psychology that some hostile bias is creating the ambiguity—the ambiguity itself is the factor underlying the aversion.

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75 David Weisbach, Introduction: Legal Decision Making Under Deep Uncertainty, 44 J. LEGAL STUD. S319, S322 (2015) (“Only by increasing the payoffs for the ambiguous bet can individuals be made indifferent.”).
76 Id. at S321.
77 Ellsberg, supra note 71, at 646.
78 See SAVAGE, supra note 67.
79 Weisbach, supra note 75, at S323.
Ambiguity or uncertainty has even been demonstrated to have real world consequences beyond the laboratory. Professors Camerer and Weber collected and summarized a number of studies and showed that uncertainty is impactful in medicine and health; insurance, liability and taxes; marketing; and financial markets. In particular, studies show that markets have specific reactions to uncertainty that are distinguishable from those resulting in new valuation or risk information. For example, Caballero and Krishnamurthy describe “flight to quality” episodes—moving risky investment to safer investments—following economic crises that present an unanticipated form of Knightian uncertainty. Essentially, investors anticipate the worst-case scenario posed by the uncertainty and become overly conservative, reducing market liquidity. The fact that such episodes are fairly unique to the time and nature of each crisis suggests that these are not merely reactions to increased risk. Similarly, Cao, Wang and Zhang find that average individuals avoid participating in the stock market when there is dispersed uncertainty about market payoffs.

Daniel Farber described the phenomenon of uncertainty in the regulatory context (particularly environmental harm). He notes that the distinction between risk and unascertainable uncertainty or ambiguity applies here as well, and describes the fact that regulators prefer to ignore it and individuals try to avoid it. Farber explains that a well-established model for predicting the impact of uncertainty is the so-called, “α-maxmin,” which suggests that individuals can overweight the possibility of bad consequences (worst possible outcome) when the upside is not great. The natural result of this aversion is the precautionary principle, which compels action to reduce harm even when the potential for bad outcomes is uncertain.

The fact that ambiguity or uncertainty has impact may be established, but one must consider how it is particularly relevant in the context of innovation. The remaining parts of this article make this application. However, for the sake of clarity and consistency with the existing legal

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84 Camerer & Weber, supra note 68, at 353–357.
87 Id. at 909–11, 928–29.
88 Id. at 929–30.
89 Id. at 914–15, 930.
literature, it will favor the use of the term “uncertainty,” rather than “ambiguity,” to describe future unknowns that cannot be defined probabilistically. This is an important lexicographic distinction because the present article deals with patents, and the term ambiguity has a specific meaning there. As language-based rights they include a rich literature on the problems with claims qualified as “ambiguous,” a completely different use of the term. “Uncertainty” is a better term for the non-ascertainable probability context addressed in this article.

C. Uncertainty and the Will to Innovate

Many uncertainties confront the particular world of innovators. It might be uncertain whether one can obtain funding to carry out research and development to perfect a product. The availability of important raw materials may depend on environmental, political and legal environments that are unclear at the time of invention; how the market will perceive the innovation, particularly if it has social implications; and, of course, whether it will be possible to negotiate the legal and regulatory structures may be extremely relevant, depending on the type of innovation. Successful firms must manage such unknowns and it shapes their decision-making. And in some cases, the lack of knowledge about the future may present an insurmountable barrier and dissuade some set of actors. If innovations lost as a result could be contributors to important social goals (medical advances, efficient energy, agricultural productivity, space exploration, etc.), managing or minimizing negative unknowns becomes

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91 For example, the most common use of the term “ambiguity” in the legal literature is to describe unclear language rather than probabilities of future events. BLACK’S LAW DICTIONARY (11th ed., 2019).


93 However, the use of “ambiguity” in economics articles should be appreciated for cross-referencing the literature in that field.


95 This has become a particularly important issue for consumer electronics that use so-called “conflict minerals.” See, e.g., Shannon Raj, Note, Blood Electronics: Congo’s Conflict Minerals and the Legislation that Could Cleanse the Trade, 84 S. CAL. L. REV. 981 (2011).

96 Garud, et al., supra note 16, at 795–96 (referring to the phenomenon of “cultural complexity,” which relates to a product’s acceptance as dependent on social norms and structure).
relevant for national innovation policy. Thus, uncertainty in the context of innovation seems particularly daunting.

Or is it? Will uncertainty in any one of these areas actually dissuade an innovator, as opposed to another type of investor or market actor? Moreover, would it be preferable to eliminate all of these uncertainties if that were possible? It is one thing to say that unknowns can produce ambiguity aversion effects in the lab or financial markets, but it is not a given that uncertainty always (or even frequently) dissuades innovators. In other words, even if uncertainty or ambiguity has a real negative impact in some cases, in others, parties can likely navigate through it or even see it as an opportunity.

Notably, Knight did not consider uncertainty to necessarily be a bad thing in the context of innovators. In fact, he believed that an entrepreneur must act on uncertainty in order to attain profit (which Knight defined as the surplus that one might attain after factoring in understood investment risks). Only one who acts in a state of uncertainty has the opportunity to take what others cannot and achieve something beyond what is possible in a state of perfect competition. Keynes also noted that moving ahead in the face of uncertainty is a characteristic of certain business people as they employ what he termed their “animal spirits.” Even Joseph Schumpeter, whose work is often considered in contrast to Knight and Keynes, could be read to support the notion that some level of uncertainty is necessary for the creative destruction carried out by entrepreneurs. The appropriate

97 See generally NATIONAL SYSTEMS OF INNOVATION: TOWARD A THEORY OF INNOVATION AND INTERACTIVE LEARNING (Bengt-Ake Lundvall, ed. 2010).
98 Engaging in a systematic literature review, Harri Jalonen attempted to categorize all of the types of uncertainty that impact innovation. Harri Jalonen, The Uncertainty of Innovation: A Systematic Review of the Literature, 4 J. MGMT. RES. E12 (2012). Jalonen derived eight general categories: 1) technological uncertainty, 2) market uncertainty, 3) regulatory/institutional uncertainty, 4) social/political uncertainty, 5) acceptance/legitimacy uncertainty, 6) managerial uncertainty, 7) timing uncertainty, and 8) consequence uncertainty.
99 KNIGHT, supra note 55, at 271.
102 Amir N. Licht, The Entrepreneurial Spirit and What the Law Can do About It, 28 COMP. L. & POL’y J. 817, 822 (2007) (“A central premise in Schumpeter’s theory—which is the focus of this article—is that entrepreneurs have special skills for innovation and for dealing with uncertainty, although the latter quality is relatively less prominent in Schumpeter’s account.”) See generally Maria Brouwer, Entrepreneurship and Uncertainty: Innovation and Competition among the Many, 15 SMALL BUS. ECON. 149 (2000).
diffusion of innovation, time of entry, and necessary finance are arguably propelled by some level of uncertainty.\textsuperscript{103}

Against the theory that uncertainty can be positive in some cases, there is not surprisingly evidence of its negative impacts on innovation as well. For example, using matched patent data for firms innovating during the Great Depression, Malhar Nabar and Tom Nicolas show that high initial uncertainty reduced innovative activity, but firms that were able to update expectations recovered.\textsuperscript{104} Additionally, Minna Allarakhia and Anthony Wensley argue that uncertainty surrounding the availability of patent rights and the blocking potential of early entrants created disincentives for innovation in the emerging field of systems biology.\textsuperscript{105} Harri Jalonen cites many other examples, and further argues that the overall gist of the literature is that uncertainty has negative innovative effects.\textsuperscript{106}

How should one reconcile these different concepts of uncertainty? One insight is that there is likely to be a personality component to this question. Some innovators may embrace a given uncertainty while others look for safer alternatives. Judge Richard Posner articulated the concept of differential behaviors in an essay written in the midst of the 2008 financial crisis, wherein he considered responses to an economic depression.\textsuperscript{107} He noted that it is not necessarily irrational to ignore some uncertainty, as much as it is a representation of a utility function that maximizes other benefits from a course of action.\textsuperscript{108} According to Judge Posner:

People respond to uncertainty aversion in a variety of ways—trying to transform it into calculable risk when they can do so, as by improving analytical techniques or gathering additional information, and, when they cannot do so, substituting other methods of decision making for cost-benefit analysis, such as simple extrapolation from the past, decision according to rules of thumb, imitation of other people, minimizing sunk costs, flipping a coin, seeking guidance in prayer, adopting a “safety-first” policy, and building

\textsuperscript{103} E.g., Brouwer, supra note 102, at 153 (“[U]ncertainty about the time of entry arrival and incumbents’ retreat prompts entrants to set price equal to incumbents’ marginal cost. Uncertainty thus needs to be inserted in a Schumpeterian model in order to achieve [these results].”).


\textsuperscript{106} See Jalonen, supra note 98, at 7 (reviewing dozens of innovation/uncertainty articles and concluding “an overwhelming majority of the reviewed literature has perceived uncertainty to be detrimental to, or problematic for, innovation.”).


\textsuperscript{108} Id. at 31.
relations of trust (often within the family) in order to create a form of insurance that does not rely on the calculation of premiums. A legal system can reduce uncertainty by, for example, requiring compensation for the taking of property by the government, since such takings are uncertain events.\footnote{109}

He further argues that the optimal government response in the face of a crisis is not necessarily to reform, but to reduce uncertainty (particularly if the reform itself introduces uncertainty).\footnote{110}

To be sure, although responses to uncertainty may be distributed, they are likely not random. Some communities may have uncertainty aversion traits in common. For example, there is significant literature supporting the idea that entrepreneurs are more likely to move forward in the face of uncertainty than others.\footnote{111} Unfortunately, while evidence of differences among personality types gives some clue as to who is likely to respond to uncertainty, it does not necessarily help identify whether the overall effect is positive, neutral or negative. Can we know prospectively that a given uncertainty has the potential to blunt innovative activity?

At base, it should be possible to make some conclusions about impact related to the magnitude or significance of the uncertainty. In other words, to what degree will the uncertainty impact the future? For example, whether it will be sunny or rainy on the day of a prospective product launch may be uncertain six months out, but this eventuality is unlikely to have much impact on innovative effort. However, other uncertainties, such as the existence of competing products or the regulatory environment, play into exactly how uncertainty impacts innovation. Again, without more, whether the swing will be positive or negative is not clear.

To answer the impact question, one should look to research in the field of behavioral economics. Here, the attributes of uncertainties that are more likely to play a dissuading role are apparent. Consider that Heath and Tversky found that subjects preferred uncertainty over chance when they believed they were more knowledgeable about the ambiguous subject matter.\footnote{112} Their experiments concerned uncertainty about events, such as presidential elections and pro football games, and when subjects had confidence about their information—competence in the form of knowledge, skill and comprehension—they elected to move ahead in spite of the

\footnote{109} Id.
\footnote{110} Id. at 38.
\footnote{111} See Jeffrey S. McMullen & Dean A. Shepherd, Entrepreneurial Action and the Role of Uncertainty in the Theory of the Entrepreneur, 31 ACAD. MGMT. REV. 132, 139 (2006) (reviewing the literature regarding the motivations of entrepreneurs in the face of uncertainty and offering the synthesis that entrepreneurs differ in their “willingness to bear perceived uncertainty”).

uncertainty.113 And subsequently, Craig Fox and Amos Tversky found that a crucial factor in subjects’ confidence was that they were comparatively more or less informed about another option.114 In other words, uncertainty aversion exists when they are comparatively less ignorant about another event.115

To be clear, the reason uncertainty produces an aversion is that subjects apparently consider the worst possible outcome and work to avoid it.116 One could argue that the precautionary principle is one iteration of such a response, wherein regulators presume a highly negative outcome in withholding approval.117 In the context of innovation, the worst possible outcome related to intellectual property might be that funds are spent, time is wasted and no rights are obtained. Considering that possibility, one who is averse to the relevant uncertainty or ambiguity might simply avoid the game.

In a different stream of research on risk preferences (rather than uncertainty per se), there is evidence that people react more strongly to sunk costs or loss of ownership than they do to the potential for gain. Termed the “endowment effect,” it was articulated most prominently by Richard Thaler (but was conceptually present in earlier descriptions of loss aversion).118 In other words, once people have something, they fear losing it more than they value an equivalent gain.119 This phenomenon may be reflected in Caballero and Krishnamurthy’s work, where ownership of securities subsequently and surprisingly worth less fueled a retreat from investment.120

By connecting the behavioral literature to the innovation problem, it is possible to finally define the aspects of uncertainty that are positive and

113 Id. at 22–23.
115 Id. at 599.
119 Thaler, supra note 118, at 44.
120 Caballero & Krishnamurthy, supra note 85.
negative. When (1) an innovator has no competence and (2) sunk costs are affected, the impact is more likely to be negative. This is particularly true if an alternative path exists that will avoid the uncertainty (e.g., secrecy, in the context of invention). The issue can be more easily understood if depicted in a bi-matrix:

**FIG. 1: LEGAL OR REGULATORY UNCERTAINTY IMPACT**

On the other hand, where there is either some level of competence or there is no future impact on investments from a decision, it is reasonable to presume that some amount of strategic opportunity exists. This is where we find entrepreneurs engaging their “animal spirits.” A risk-taking firm or individual can leverage its partial knowledge or protection over lesser qualities of others. And finally, if neither incompetence nor ex post investment impact exists, there should be no uncertainty impact. A rule or regulation existing in the context should have literally no relevance to an innovator and will not dissuade any player from moving ahead.

Even if policymakers do not entirely conceptualize the above behavioral matrix when setting up innovations systems, we do have a general idea that law and regulation moderate uncertainty. Essentially, we transform uncertainty into risk. This is particularly true in the innovation world, where patents especially can be viewed as uncertainty reduction mechanisms, or at least, this is the case when law and regulation is functioning properly.

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121 KEYNES, supra note 101, at 161.
II. THE PROPER UNCERTAINTY ROLE OF LAW AND REGULATION

In order to evaluate rising legal and regulatory uncertainty, it is important to acknowledge how our existing system attempts to manage the unknown. Given the fact that uncertainty or ambiguity has the potential to detract from desirable (and socially useful) innovative behavior, it is reasonable to have counteracting mechanisms in place that address relevant unknowns. But because not every uncertainty is problematic, we are selective to ensure that the opportunity for competition and profit is maintained. Moreover, the goal is often to transform the uncertainty or ambiguity to risk, such that there is an ascertainable set of future outcomes against which investments can be made. From this perspective, thoughtful innovation policy can be viewed as, essentially, tweaking the uncertainty reduction devices to provide optimal encouragement.

This is not to suggest that all of the uncertainty reduction mechanisms described below were necessarily designed specifically for that purpose. They may have primary goals to benefit a particular group (for example, safety regulations that protect consumers). However, from the innovator’s perspective, they all function to provide some better understanding of the future such that the probabilities in moving ahead are more defined and incentives function.

A. Patents Ideally Reduce the Innovator’s Uncertainty Problem

Innovation incentives provide a particular uncertainty reduction means by clarifying the potential for return on investment for a successful invention.\footnote{Edmund W. Kitch, The Nature and Function of the Patent System, 20 J.L. & ECON. 265, 275–80 (1977) (patents function by securing a return on investment). There have been various types employed over the years, from privileges to rewards to patent and similar exclusion devices. See, e.g., Scotchmer, supra note 2, at 3–13 (introduction co-authored with Stephen Maurer describing government manipulation of innovation among the ancient Greeks).} The function, from the behavioral point of view, is the reduction in uncertainty as to how the hard work and capital invested in creating something new will pay off.\footnote{See David J. Teece, Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy, 15 RES. POL’y 285, 287 (1986) (describing appropriability regimes).} In the absence of incentives, innovators must be concerned that ideas will be appropriated by competitors who will free-ride off of their efforts, and the uncertainty for thwarting or delaying that competition may be enough to dissuade.\footnote{Douglas C. North & Robert Paul Thomas, The Rise of the Western World: A New Economic History 154–55 (1973) (describing patents as a means of internalizing positive externalities); Kieff, supra note 29, at 717–22 (describing the use of property rights to avoid commercial unused because an innovator will be dissuaded from not being able to fully realize the rewards associated with an endeavor); Cf. Lemley, supra note 29, at 1046–50 (defending the existence of such incentives).}
Essential to modern incentive structures is the idea of attribution to the creator—we care who is responsible at some level. In earlier times, ownership of information was not as clearly celebrated, and credit played a greater role in assigning blame when something went wrong.\(^{125}\) If a brick was poorly formed or a knife blade dangerously brittle, identifying the poor craftsman with the intent of punishment was a far greater reason for recognizing individual contributions.\(^{126}\) To be sure, poets and story-tellers were recognized individually, but not with the intent of giving them space to recapture the fruits of their efforts but rather to prevent plagiarism or promote accurate copying.\(^{127}\)

There is a broadening of focus, at least in European society, around the time of the Renaissance.\(^{128}\) At that point, the mere awarding of opportunities and privileges to favored individuals or guild members gave way to means for rewarding inventors.\(^{129}\) An important reason for this was trade. As cities and regions traded more frequently, there was a more obvious advantage to those who could produce better products or utilize more efficient methods.\(^{130}\) Regions with such strong reputations gained wealth, as goods became more widely traded and competition became more robust.\(^{131}\) The emergence of more formal scientific thought and the rediscovery of the achievements of the ancient world seemed to coincide.\(^{132}\)

Among the earlier types of true invention incentive was that of contest and reward.\(^{133}\) This was particularly when some great problem presented of free-riding even in real property and explaining why some free-riding is not antithetical to intellectual property).


\(^{126}\) Id.


\(^{128}\) To be sure, innovation continued from ancient times through the Renaissance, but political disintegration and economic depression had an effect on its reporting. Lynn White Jr., *Technology and Innovation in the Middle Ages*, 15 SPECULUM 141, 149–50 (1940).


\(^{130}\) Long, *supra* note 127, at 870–875.


\(^{133}\) SCOTCHMER, *supra* note 2, at 9–10.
itself to a community. One of the most famous examples concerns the building in Florence, Italy of what was, at the time, the world’s largest free-standing dome. The path to the successful construction of Florence’s cathedral was far from certain. It was not until 1418 that a viable solution was proposed by a genius sculptor, goldsmith and architect named Filippo Brunelleschi in response to a contest. It required a massive investment in time and intellectual effort and failure in such work was not uncommon in communities without access to architects so skilled.

Why did Brunelleschi, a man who was not so wealthy that he could afford to engage in such innovation as a dalliance, agree to move forward? The Opera of Santa Maria del Fiore held a contest, with the princely sum of 200 florens offered as a reward for the inventor/architect whose design was chosen. Viewed from an uncertainty perspective, the money offered Brunelleschi some amount of financial security if he were willing to put off his other projects and business venture to dedicate a period of his life to finishing the Duomo.

This story is worth considering because it gives some insight into the shortfalls of the reward system that eventually gave way to patents. Brunelleschi was famously concerned that the benefit from his work might cease with the reward payment if he secured no other protection. His typical solution was to rely on secrecy to ensure that he would remain sought after for such work, rather than someone who might copy his designs and techniques. However, during the building of the Duomo, Brunelleschi faced a logistics problem that required a solution that could not be kept secret due to its open nature. In order to ship massive amounts of marble from Carrera, he wanted a more advanced transport mode. Thus, Brunelleschi created a large, river going ship, called Il Badalone, and petitioned and received from the Signore di Firenze one of history’s first

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134 Id. at 41–47 (describing various examples of great problems and how prize systems created incentives).
135 ROSS KING, BRUNELLESCHI’S DOME 3, 6–7 (2000); Timeline, OPERA DI SANTA MARIA DEL FIORE, https://operaduomo.firenze.it/en/history/timeline/centuries/1-13th-14th-centuries [https://perma.cc/CHB4-YCP7]. The dome, which would have none of the traditional buttresses that gothic architects would have normally employed as supports, was intended to bring glory to the city of Florence. KATHLEEN JAMES-CHAKRABORTY, ARCHITECTURE SINCE 1400 32–35 (2014).
136 See generally Frank D. Prager, Brunelleschi’s Inventions and the “Renewal of Roman Masonry Work”, 9 OSIRIS 457 (1950) (describing Brunelleschi’s techniques as modifications of Roman methods as well as entirely new ideas).
137 JAMES-CHAKRABORTY, supra note 135, at 34–36.
138 Id. at 32–33; KING, supra note 135, at 37.
139 KING, supra note 135, at 41–42.
It is apparent that contests, secrecy and guild protections were not sufficient to provide some certainty that Brunelleschi could privately appropriate the benefits of his invention. Thus, the patent was born.

In contexts such as Florentine, Italy, as well as in the Venetian Republic, as detailed by Sichelman and O’Connor, the invention patent gained traction. As with modern patents, these early rights offered no guarantee of financial benefit. Rather, they offer the possibility of profit through market exclusion only if consumers or other relevant purchasers see value. Brunelleschi could hope only that his boat was so successful that others would seek him out for the right to use the invention.

To put it in the language of decision theory: from the perspective of the innovator, modern patent law creates institutions and rules that provide probability distributions that can be assessed in determining whether to proceed. Broadly speaking, they set forth a limited market exclusion system that can be valuable if the claimed invention is an important part of a commercialized product or service. Instead of the uncertainty of secrecy, first-mover advantage, branding or some other approach against the countermoves of competitors, patents provide the probability distribution associated with property rights. The impact is extended if one considers Edmund Kitch’s prospect theory as a distribution related to exploiting the invention through broader development. For example, Gans, Hsu and Stern demonstrated that resolving patent uncertainty fosters commercial relationships (e.g., licensing) necessary to expand the market for ideas.

Underlying the general notion of patent property right protection are the more defined and ascertainable probability distributions regarding obtaining a patent from a patent office and enforcing it through either contracting systems (licensing) or litigation (courts or administrative entities in some countries). Although not guaranteed to receive a patent, innovators can consider probabilities for outcomes within an understood prosecution system that has very detailed rules and known decision-

141 KING, supra note 135, at 108–117.
142 Sichelman & O’Connor, supra note 129.
143 Id. at 1274–78.
144 Unfortunately, the boat sank on its maiden voyage. KING, supra note 135, at 116–17.
145 Smith, supra note 100, at 1724–27 (“Property itself is a response to uncertainty, and property rules derive some advantage as a response to uncertainty.”).
146 Kitch, supra note 122, at 271.
148 For example, prosecution is dictated by the voluminous Manual of Patent Examining Procedure [hereinafter MPEP]. U.S. PATENT AND TRADEMARK OFFICE, MANUAL OF PATENT EXAMINATION
makers. An applicant can estimate the likelihood of success given the field of invention, the effort put into a prior art search, the scope of the claims, etc.\textsuperscript{149}

Additionally, probability for success in enforcement can be generally determined with sufficient knowledge about the strength of the infringement case, as well as the potential for an invalidity determination.\textsuperscript{150} This is not dissimilar from real property. Adam Mossoff implied in a work criticizing the scholarship that suggests patents and real property are incongruous that, in fact, data for real property trespass claims is likely to have similar attributes.\textsuperscript{151} It will show an enforcement distribution that has an ascertainable probability that is far from certain.\textsuperscript{152}

One of the better works implicitly highlighting the above points is Mark Lemely’s and Carl Shapiro’s \textit{Probabilistic Patents}.\textsuperscript{153} In this piece, the authors discuss various aspects of the patent system that cannot be known by prospective patentees (or innovators) ex ante, using the term “uncertainties.”\textsuperscript{154} They describe such uncertainties inherent in prosecuting patents and being denied if the examiner finds the invention is not new or nonobvious.\textsuperscript{155} Further, they discuss the uncertainties in litigation and the possibility that some information will be discovered or some argument made that renders the patent invalid.\textsuperscript{156} But critically, it is obvious that Lemley and Shapiro are not talking about Knightian uncertainty or ambiguity, but rather \textit{risk}. This is made clear by the fact that they further describe patents as a kind of “lottery ticket,” which is a type of risk with known probabilities (that may be stacked against the player, but still, are not ambiguous).\textsuperscript{157} This is something that an innovator should be able to address, and though society may wish to change the probabilities (e.g., by making the prosecution process more rigorous and less error prone)\textsuperscript{158} or

\textsuperscript{149} For a graphic depiction of how a prospective patentee might assess the variability of protection through a probability framework, see Robert P. Merges, \textit{Uncertainty and the Standard of Patentability}, 7 \textit{HIGH TECH. L.J.} 1, 12–14 (1992).


\textsuperscript{152} \textit{Id.} at 1708.

\textsuperscript{153} Mark A. Lemley & Carl Shapiro, \textit{Probabilistic Patents}, 19 \textit{J. ECON. PERSPECTIVES} 75 (2005).

\textsuperscript{154} \textit{Id.} at 76.

\textsuperscript{155} \textit{Id.} at 77–79.

\textsuperscript{156} \textit{Id.} at 80.

\textsuperscript{157} \textit{Id.} at 80–83.

\textsuperscript{158} See \textit{id.} at 83–85.
eliminating the doctrine of “willful infringement” in litigation\textsuperscript{159}), the potential for ambiguity or uncertainty aversion should not rise.

Similarly, Ian Ayres and Paul Klemperer have written on the benefits of some probability rather than certainty in patent enforcement as a means to attenuate patent power without creating significant invention disincentives.\textsuperscript{160} They suggest that permitting uncertainty and delay in patent enforcement determinations reduces deadweight loss by encouraging some competitors to risk infringement until a final judgment is rendered.\textsuperscript{161} Although Ayres and Klemperer do not distinguish between risk and unascertainable uncertainty, it seems clear that by using the term “probabilistic” and including percentages of enforcement likelihood in their model, they are referring to the same kind of quantifiable risk as Lemley and Shapiro. Again, this is distinct from Knightian uncertainty or Ellsberg’s ambiguity.

Two important points about the system’s ability to substitute probability for uncertainty are worth noting. First, the reduction in ambiguity is not dependent on the legal strength of the rights. In other words, if patent rights are revised prospectively to reduce protections—for example, by precluding enforcement of certain types of inventions\textsuperscript{162} or making injunctions more difficult to obtain\textsuperscript{163} would not necessarily create uncertainty or ambiguity. Patents and other incentive rules (including tax and funding structures, in addition to property) can be adjusted to provide greater or lesser incentives. It is entirely reasonable for a society to support one type of innovation, such as renewable energy, and reduce support for another type, such as coal production. All such a revision should change is the probability distribution for the innovator related to some aspect of patent ownership or enforcement. Even a retrospective revision, if it is clear and static, can allow an innovator to engage in analysis closer to risk assessment. Therefore, an argument in favor of preventing patent uncertainty is not an argument for increased patent strength, per se. Along the same lines of Coase’s analysis of property rights vs. liability,\textsuperscript{164} the transaction costs of uncertainty are what is relevant, not where the property boundaries are set.

\textsuperscript{159} See id. at 86.
\textsuperscript{161} Id. at 993–1000 (description and model).
Second, the uncertainty that is reduced for the innovator not only relates to his or her own potentially patentable invention, but also the potentially conflicting inventions of other innovators. Although one is unlikely to know the probability distribution for blocking patents that may arise, knowing how the system is set up for such blocking patents, including the mechanisms in place for contracting, enforcing and challenging related to such patents still reduces uncertainty.

B. Additional Uncertainty Reduction Mechanisms Support Innovation

The scope of uncertainty reduction related to innovation is broader than patents. One can identify many additional mechanisms by considering the attenuation of unknowns at different points in the innovation process. Obviously, uncertainties impact industries differently, and may be more or less relevant depending on whether the innovator is an individual or firm, as well as the geography in which the activity takes place. However, the general theme of a defined structure—a set of game rules, if you will—rather than defined outcomes is present. Put another way, they are institutions: norms, traditions, and legal rules and regulations that regulate how individuals and groups interact. 165 It has been noted that, “by reducing uncertainty and, thus, the amount of information needed for individual and collective action, institutions are fundamental building blocks in all societies.” 166

At the invention stage, one can imagine uncertainties regarding the funding for research and the firm, limitations on study materials and rules about handling, and sources of information to derive and solidify the creation. The uncertainty is partially alleviated by having systems in place for early stage funding in the form of venture capital, grants, as well as securities rules. 167 Further, regulations regarding the appropriate use of data 168 or materials 169 also reduces uncertainty.

At the development stage, collaborative relationships and supply chain sourcing becomes very important. The central nature of commitments

165 BJORN JOHNSON, INSTITUTIONAL LEARNING, IN NATIONAL SYSTEMS OF INNOVATION: TOWARD A THEORY OF INNOVATION AND INTERACTIVE LEARNING 26 (Bengt-Ake Lundvall, ed. 2010).
166 Id.
167 Christensen, supra note 94, at 162–63 (describing how stable finance reduces uncertainty).
elevates contracts to the fore of uncertainty reducing tools.\textsuperscript{170} The ability of contracts to identify rights and responsibilities ensures the future will roll out along a particular path, or compensation will be available to account for the loss. In addition, understanding whether international conflict will add costs to materials\textsuperscript{171} or limit their availability\textsuperscript{172} is essential for making plans for the future.

The implementation stage benefits from less uncertainty in the event of loss (insurance), marketing approval (regulation), and appropriate relationships (antitrust). And it is significantly easier to negotiate when uncertainty related to market exclusion—the ability to keep competitors away from assists—is reduced.\textsuperscript{173} This ability is critically linked to property. As Hernando De Soto described in his highly regarded book, \textit{The Mystery of Capital}, property law serves an essential function in ensuring market actors can establish the economic potential of assets, integrate information, make assets fungible and protect transactions.\textsuperscript{174} The predictability of property law—which includes the social commitment to the system—reduces the costs of dealing with the extra-legal protection and underground transactions that must accompany informal ownership.\textsuperscript{175} Knowing this protection exists permits innovators to allocate costs to other aspects. And, of course, the failure to protect existing property rights entails the classic problem of takings or expropriation of property.\textsuperscript{176} A firm is much less likely to invest in a manufacturing facility in a country in which such private property is subject to nationalization.\textsuperscript{177} As suggested above, the impact of reduced property incentives is relevant to innovators whether in the realm of physical or intellectual.\textsuperscript{178}

\textsuperscript{170} The economics literature suggests that ambiguity-averse individuals prefer incomplete contracts. Sujoy Mukerji, \textit{Ambiguity Aversion and Incompleteness of Contractual Form}, 88 AM. ECON. REV. 1207, 1221–22 (1998).


\textsuperscript{173} See Gans, Hsu & Stern, supra note 147, at 994.


\textsuperscript{175} See id. at 162–63.


\textsuperscript{177} See id.

\textsuperscript{178} There is an academic debate regarding to what extent patents are to be analogized to tangible property rights. \textit{Compare} Adam Mossoff, \textit{Patents as Constitutional Private Property: The Historical
Additionally, the general nature of stable legal rules is particularly important. Whether securities law, regulatory interpretations or patentability qualifications, uncertainty creeps into the system when stable interpretations do not exist.\textsuperscript{179}

III. CATEGORIZING NEW UNCERTAINTY

Despite the existence of an apparently well-designed innovation incentive system, something has clearly gone wrong. As properly framed from a behavioral perspective, the problem of uncertainty should be overall reduced by modern patent law. Instead, there are complaints and concerns that innovators and firms are more confused than ever.\textsuperscript{180} Some even argue for abolishing patents altogether.\textsuperscript{181} Is there something institutionally misaligned in the system, or fundamentally corrupt?

The simple answer is, intellectual property systems are, by their nature, dynamic.\textsuperscript{182} New uncertainties arise from new technologies and evolving societies. Patent systems must evolve. Early protection regimes focused on machines, but now they must envelop software and DNA.\textsuperscript{183} However, uncertainty must be managed along with the change, lest additional unknowns arise that have a strong aversive effect. Gone sufficiently awry, the system itself may turn actors away from policies

\textsuperscript{179} See D’Amato, supra note 28, at 6. In an interesting work differentiating between narrow rules and broad standards, John Duffy argues that the latter have been proven to be significantly more durable over time. John F. Duffy, Rules and Standards on the Forefront of Patentability, 51 WM. & MARY L. REV. 609, 638–39 (2009). Such a distinction should not change the present analysis, as stability is as important in applying standards as it is in setting forth defined rules.

\textsuperscript{180} See supra notes 3–7 and accompanying text.

\textsuperscript{181} See, e.g., Michele Boldrin & David K. Levine, The Case Against Patents, 27 J. ECON. PERSPECTIVES 3, 4–7 (2013) (presenting the case that no studies definitely establish that patent systems encourage productivity growth and suggesting that society might be better off without them).

\textsuperscript{182} See Hylton, supra note 17, at 1144–48 (describing dynamic uncertainties in the patent system that are influenced by the political economy of those with power desiring a change in the rules).

intended to generate societal benefits, like public disclosure of inventions.\textsuperscript{184}

Of course, every new uncertainty is not a mole that needs to be whacked. As discussed, innovation in the patent system inherently has unknowns, and some uncertainty is actually beneficial. So how do we know what areas to target? For example, how do we know if an innovator in the position of Francesco Pompei is frustrated by a particular uncertainty in the patent system or if he has simply lost his bet on an ascertainable probability of protection? One may presume that something other than increased risk is creating a problem, but what is the dividing line? A categorization legal and regulatory uncertainty is necessary to delineate issues for reform.

Recall that two of the factors most likely to foster ambiguity or uncertainty aversion are a lack of competence about the nature of the future decision and the potential for that future decision to retroactively impact sunk costs or investments.\textsuperscript{185} Such a situation may exist when a decision involving a legal or regulatory problem must be made wherein an individual has no knowledge about a consequential future rule, but such a rule has the potential to impact retroactively impact an existing investment. In this situation, it is reasonable to prefer a path that may avoid the innovation (say, focusing on other innovations, prioritizing secrecy over patents, etc.). However, if either factor is not present, it is less likely that uncertainty aversion will occur.

This situation exists quite prominently when a critical legal test—a rule that would normally establish the probability of an outcome—is not, and apparently will not, be set forth in sufficient detail or clarity to allow one to make an informed assessment.\textsuperscript{186} Perhaps a more concrete rule will be applied to the innovator at some point in the future, but there is no way to know initially what it will be. Essentially, the innovator has no way of predicting how the law will be decided by a court or agency. It is akin to buying a lottery ticket and not knowing how many numbers, or perhaps even letters, will be used to determine the winner. As De Soto described in the context of contracts and private property in the developing world, knowing that a property system will still exist and how it will work in the future is a very important factor.\textsuperscript{187} Although an endeavor may involve high


\textsuperscript{185} See FIG. 1 and accompanying text, supra at 25.

\textsuperscript{186} D’Amato, supra note 28, at 6.

\textsuperscript{187} DE SOTO, supra note 174, at 162–63.
risk, consistent rules are necessary to provide the grounding for properly evaluating that risk.

Exacerbating the impact of the uncertainty is if the eventual clarity will come only after costs are sunk and some ownership is gained from an early use of the test. It would be as if an innovator were compelled to return the winnings from the lottery ticket after winning, when a second round simply changed the contest rules and mooted the earlier result. Applying the observation that people are averse to losing what they already possess,188 watching such a game play out could create a disincentive. Under such conditions, it would only be natural for an innovator to be inclined to choose another path with less uncertainty, even if the probabilities of success are low.

If we add on top of this uncertainty the possibility that others will play the game and end up with rights that conflict with the innovator’s eventual products or services, the negative impact is even more enhanced. These are essentially random roadblocks placed in the way of innovators. Not only would one want to avoid the particular ambiguous protection path, but perhaps one would avoid participating in the field altogether.

Uncertainty of exactly this sort exists in the context of the test for patentable subject matter in the United States. The fact that some confusion is finally shaking out of the system due to the growing number of decisions189 does not completely ameliorate the negative effects. An understanding of how this rule likely negatively impacted innovation choices versus other, less ambiguous rules, is instructive. On the other hand, uncertainty that exists in other legal contexts, such as obviousness standards and rules for fee shifting, does not create the same concerns. An understanding of how these examples fit in the investment/competency matrix offers an explanation for the distinction and provides a roadmap for reform.

A. Investment Killing Uncertainty: Patentability

Perhaps no other topic in patent law has elicited as much ink as the question of what can be patented. It obviously is important from a public policy standpoint, as a serious debate has raged regarding the extent to

188 See supra notes 121–122 and accompanying text.
which particular technology advances are encouraged or discouraged with patents.\footnote{Two articles by Professor Risch humorously bookend the broad debate. \textit{Compare} Michael Risch, \textit{Everything Is Patentable}, 75 \textsc{Tenn. L. Rev.} 591 (2008), \textit{with} Michael Risch, \textit{Nothing Is Patentable}, 67 \textsc{Fla. L. Rev.} F. 45 (2015). In addition, seminal articles on particular technologies have contextualized the debate in many areas. \textit{See} Rebecca S. Eisenberg, \textit{Proprietary Rights and the Norms of Science in Biotechnology Research}, 97 \textsc{Yale L.J.} 177 (1987) (biotechnology patents); Robert P. Merges, \textit{As Many as Six Impossible Patents Before Breakfast: Property Rights for Business Concepts and Patent System Reform}, 14 \textsc{Berkeley Tech. L.J.} 577 (1999) (business methods patents); Pamela Samuelson et al., \textit{A Manifesto Concerning the Legal Protection of Computer Programs}, 94 \textsc{Colum. L. Rev.} 2308 (1994) (software patents). Professors Burk and Lemley have discussed whether the question is inherently distinctive depending on the technology in question. \textit{See} Dan L. Burk & Mark A. Lemley, \textit{Is Patent Law Technology-Specific?} 17 \textsc{Berkeley Tech. L.J.} 1155 (2002).} And it is relevant to technology historians, who may look to the evolution of patenting to track the evolution of technology.\footnote{\textit{See generally} Gerardo Con Diaz, \textit{Embodied Software: Patents and the History of Software Development, 1946–1970}, 37 \textsc{IEEE Annals of the Hist. of Computing}, no. 3, 2015, at 8 (arguing that the history of software patenting and embodied software are inseparable).} However, it is arguably most important to those operating in innovation environments because it is the critical cutoff to this particular path for protection. Innovators may change their behavior and shift what they are doing depending on the availability of patent protection;\footnote{Czarnitzki & Toole, \textit{supra} note 14, at 151–53 (arguing that if patents are available, certain uncertain paths become more viable).} thus, the rules are important.

In recent years, uncertainty was injected into the test for patentability, and there has been significant consternation in the intellectual property community.\footnote{For various references discussing patentable subject matter, see articles and text, \textit{supra} note 19. Some practitioners have been so concerned that they have developed blogs to track the impact of subject matter uncertainty. \textit{See}, e.g., \textit{BilskiBlog}, \textsc{Fenwick & West}, https://www.bilskiblog.com/alicestorm/ [https://perma.cc/QA3B-2JG9].} Although issues have arisen in many countries (e.g., the patentability of software is debated in countries subject to the European Patent Office\footnote{\textit{See} Susan Marsnik & Robert E. Thomas, \textit{Drawing a Line in the Patent Subject-Matter Sand: Does Europe Provide a Solution to the Software and Business Method Patent Problem?}, 34 \textsc{B.C. Int’l & Comp. L. Rev.} 227, 227 (2011).}), it has become a focal point of concern about the patent system in the United States. As a context for uncertainty impacts, it is useful to consider the U.S. specifically, but the comments below should be relevant in many other countries.

Patentability issues arise in the U.S. patent system at two broad time periods. During the prosecution (agency process for initial patent examination), an objection as to appropriate subject matter can be raised by the examiner.\footnote{MPEP § 2103.} An applicant has the opportunity to rebut, and if successful, may obtain a patent if all of the other hurdles related to novelty,
obviousness and proper disclosure are surmounted. The second time period is post-grant. A subject matter challenge may arise as a defense to infringement in litigation or during an agency review process, the nature of which depends on the timing.

The test for patentability during either prosecution or post-issuance review is based in 35 U.S.C. § 101, which sets forth the categories of patentable inventions as “any new and useful process, machine, manufacture, or composition of matter,” as well as improvements. That language is broad and longstanding, though the U.S. Patent Office has identified signals, device profiles and paradigms as being excluded by the literal language. The 2011 revisions to the Patent Act additionally excluded claims directed to human organisms. This plain statutory framework is broad and not tremendously controversial in what it cuts out. However, as early as the 1850s, the courts have read in additional restrictions that have been maintained through common law precedent.

O’Reilly v. Morse (1853) was an early articulation of the concept that patents claiming broad, preemptive concepts rather than inventions (in that case, electromagnetism) were not valid. In the ensuing years, there were occasional cases dealing with the need to demonstrate inventiveness, but it was not until the 1970s, alongside the increasing prominence of software, that restrictive doctrine truly began to take shape. Even then, a rejection or invalidation based on subject matter was still relatively rare until the Supreme Court outlined a much more general rule in a 2012 case, Mayo v. Prometheus. Considering claims involving a method of administering thiopurine, the Court declared that its precedents “insist that a process that

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196 Id.
200 With the first Patent Act of 1790, Congress defined the subject matter of a U.S. patent as “any useful art, manufacture, engine, machine, or device, or any improvement therein not before known or used.” Patent Act of 1790, ch. 7, § 1, 1 Stat. 109 (1790).
201 MPEP § 2106.03.
203 LeRoy v. Tatham, 55 U.S. 156, 175 (1852) (“A principle, in the abstract, is a fundamental truth; an original cause; a motive; these cannot be patented, as no one can claim in either of them an exclusive right.”).
focuses upon the use of a natural law also contain other elements or a combination of elements, sometimes referred to as an ‘inventive concept,’ sufficient to ensure that the patent in practice amounts to significantly more than a patent upon the natural law itself.”

Following Mayo was the case that arguably is most responsible for the current uncertainty. This is, in part, because it disproportionately impacts important areas of technology, but primarily because of the unclear test it provided. In Alice Corp. v. CLS Bank, the Supreme Court endeavored to resolve a truly confusing set of opinions accompanying a per curium result from an en banc hearing of the case at the Federal Circuit. The case involved patents for mitigating settlement risk through the use of a shadow record of accounts. In considering whether the claimed invention was too abstract, the Supreme Court drew upon its decision in Mayo to fashion what has become known as the Alice two-step. First, a court is to “determine whether the claims at issue are directed to a patent-ineligible concept[s],” and second, a court must “consider the elements of each claim both individually and ‘as an ordered combination’ to determine whether the additional elements ‘transform the nature of the claim’ into a patent-eligible application.” Abandoning previous technical rules, Alice opened the patentability question to the uncertainty of either a court’s or fact-finder’s determination of concepts like “abstract,” “transform” and “conventional.”

In the wake of Alice, practitioners, courts and the PTO have worked to put together a coherent outline of what this case requires. The PTO’s efforts are a good example of the uphill battle an interpreter faces. The agency has put forth several guidance documents that consist primarily of different examples of what seems to be eligible and what is not based on

207 Id. at 72–73.
210 This invention is well represented in one of the patents termed “representative” by the Court. U.S. Patent No. 5,970,479 (issued Oct. 19, 1999).
211 Alice Corp., 573 U.S. at 217–22.
212 Id. at 217.
213 See, e.g., Berkheimer v. HP Inc., 881 F.3d 1360, 1366–68 (Fed. Cir. 2018) (describing prior cases where the court found an invention to be abstract and noting the fact-finder’s role in determining what constitutes routine or conventional activity insufficient to transform an invention into something more). The complexity of the post-Alice analysis was noted in a concurrence to the Federal Circuit’s denial of an en banc rehearing of the Berkheimer decision. 890 F.3d 1369, 1375 (Fed. Cir. 2018) (Lourie, J., concurring) (“We now are interpreting what began, when it rarely arose, as a simple § 101 analysis, as a complicated multiple-step consideration of inventiveness (‘something more’), with the result that an increasing amount of inventive research is no longer subject to patent.”).
Most illustrative are the PTO’s charts of decisions holding claims eligible and overall subject matter eligibility decisions. Thus, the best one can do is try to match an invention after reviewing all of the examples and hope a court finds a similar connection. This is a task that is difficult for an attorney, let alone a lay innovator. During a December 2016 Roundtable held by the USPTO, Mark Lemley summed up the challenge. He noted that the inherent style of “analogic reasoning” is problematic for non-lawyers because “it doesn’t provide us with particularly useful rules.” Rather, it appears “[w]e’re doing it by looking at a kind of estimate of how technological the invention is.” Professor Lemley pointed out that the courts do in the end seem to be getting to the right point from a policy perspective, but this does not dispel the ex-ante uncertainty faced by an innovator.

To be sure, there is a reasonable debate on how broad subject matter should be. The Committee Report accompanying the 1952 Patent Act suggests that Congress intended patentable subject matter to include “anything under the sun that is made by man[.]” But others have argued that patents need to be constrained to avoid an excess of monopoly power or preemption. Perhaps Alice and subsequent precedent have simply moved the line to something more restrictive. How do we know that patentability analysis presents an uncertainty problem rather than a new choice for more narrow standards?

The simplest indication that the post-Alice world is uncertain is that similar types of inventions are treated differently depending on how a particular court (or appellate panel) views either abstraction or additional inventive activity. The example of Francesco Pompei’s patents presents a case in point. A patent applicant or owner does not know what standards will apply and how those might fit with earlier arguments the innovator

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216 Chart of Subject Matter Eligibility Court Decisions, supra note 189.
218 Id. at 50–51.
219 Id. at 49.
220 S. REP. NO. 82-1979, at 44 (1952).
may have made. At the 2016 USPTO Roundtable, Marian Underweiser of IBM stated about the patentability jurisprudence:

These cases use an [ends-justify-the-means] analysis and they are thus inconsistent with each other and provide no reliable rules that can be used to predict outcomes going forward.

This is the hallmark of failed jurisprudence. Judges have no faith that applying the test will yield what they believe should be the proper outcome, so they bend the test to suit their desired result. Step two becomes step one, preemption matters, and then it doesn’t.

This is judicial anarchy aimed directly at groundbreaking technology.222

This is not simply a complaint that the standards are too narrow, but specifically that they are undeterminable. Importantly, this is uncertainty in the words of an innovator.

Even the judiciary sees an uncertainty problem as they attempt to apply responsible doctrine in patent cases. Writing in dissent in a recent infringement case involving a patent covering a manager for unused capacity of a display device, Judge Plager stated, “There is little consensus among trial judges (or appellate judges for that matter) regarding whether a particular case will prove to have a patent with claims directed to an abstract idea, and if so, whether there is an “inventive concept” in the patent to save it.”223 This view is openly shared by colleagues such as Judge Linn224 and Judge Lourie.225

Objectively, as well, is the evidence that there are swings in subject matter standards that seem based on individual whims rather than comprehensive policy. There is the fact that the courts have not been consistent in identifying the source of the rules, at times acting as textualists and looking to the breadth of the statute as opposed to finding common law restriction.226 More directly, there is the fact that subject matter substantially increased as a basis of rejection in both litigation and Patent office proceedings in certain arts (such as e-commerce) after Alice.227

224 Smart Sys. Innovations, LLC v. Chi. Transit Auth., 873 F.3d 1364, 1377 (Fed. Cir. 2017) (Linn, D., dissenting) (declaring that the Supreme Court’s subject matter test is “indeterminate and often leads to arbitrary results”).
225 Berkheimer v. HP Inc., 890 F.3d 1369, 1374 (Fed. Cir. 2018) (Lourie, A., concurring) (stating that patent eligibility law “needs clarification by a higher authority, perhaps by Congress”).
226 Duffy, supra note 179, at 622.
Attempts at reform to reduce § 101 uncertainty is, of course, on the policy table. Under Director Iancu, the Patent and Trademark Office (PTO) issued new guidelines that attempt to cabin the analysis somewhat. However, there is no guarantee that this analysis will be reflected by the courts because it is not binding. Still, indications are that rejections in the PTO have decreased since Director Iancu’s appointment. In addition, Senator Christopher Coons and Thom Tillis have circulated draft legislation that would eliminate “implicit or other judicially created exceptions to subject matter eligibility,” leaving the courts to rely on the text of the statute and the U.S. Constitution as the only limitation. However, there is opposition to such reform, and it is unclear whether uncertainty will actually be impacted by a change to the Patent Act.

What all of this means from the perspective of innovators in certain fields, such as software and life sciences, is that patentable subject matter is by over 60% post-

Alice

); Colleen Chien & Jiu Ying Wu, Decoding Patentable Subject Matter, 2018 PATENTLY-O PATENT L.J. 1, 17 (2018) (“On balance, the data confirm that 101 is playing an increasingly important role in the examination of software and medical diagnostics patents.”).

228 2019 Revised Patent Subject Matter Eligibility Guidance. 84 Fed. Reg. 50, 53 (Jan. 7, 2019). The guidance limits the potential for inventions to be found “abstract” by enumerating categories of abstract concepts and stating that a rejection should follow only if the invention is “directed to” the concept.

229 See Cleveland Clinic Found. v. True Health Diagnostics LLC, 760 Fed. Appx. 1013, 1020 (Fed. Cir. 2019) (unpublished) (“While we greatly respect the PTO’s expertise on all matters relating to patentability, including patent eligibility, we are not bound by its guidance.”).


232 See Shubha Ghosh, A Fitter Statute for the Common Law of Patents, PATENTLY-O (Aug. 1, 2019) https://patentlyo.com/patent/2019/08/fitter-statute-patents.html [https://perma.cc/QU3V-Y548] (describing opposition from the ACLU and several other organizations as well as constitutional concerns with constricting the power of courts to create common law exceptions to patent eligibility); see also Dennis Crouch, Confusing a Stylized H, PATENTLY-O (Aug. 4, 2019), https://patentlyo.com/patent?w=31 [https://perma.cc/UZ2F-9FMF] (arguing that the draft not only fails to resolve any of the issues it purports to resolve, but also, it likely will take the state of the U.S. patent system to a time of even greater uncertainty regarding patent eligibility and arguing that defining “useful” to include essentially any invention or discovery that was developed through human intervention will likely reinvigorate the argument that human genes are patent-eligible).
an uncertainty minefield. Importantly, it does not matter if, as Professor Lemley suggested, we can determine post-hoc that courts seem to be making policy-aligned, or well-reasoned decisions. If an innovator has no basis for assessing the future probabilities of that “right” decision, it does not resolve the uncertainty.

Put in terms of uncertainty impact, the current state of patentable subject matter is an issue on which innovators have little to no competence, yet the future determination will certain impact investment in the future (see Figure 2).

**FIG. 2: IMPACT OF CURRENT PATENT UNCERTAINTY**

Therefore, it would be appropriate to categorize subject matter uncertainty as highly problematic, and very ripe for reform.

**B. If-Then Uncertainty: Obviousness**

If extant uncertainty imposed upon otherwise informed inventors elicits concern, substantially less sympathetic is the innovator that creates his or her own uncertainty. If such an individual has the option of a relatively safe and more predictable path, but instead voluntarily moves in a direction with unascertainable probabilities, this “if, then” uncertainty seems self-imposed. Particularly if the innovator has made such a choice

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233 The “if, then” statement is a concept in conditional or rule-based computer programming languages. See Frederick Hayes-Roth, *Rule-Based Systems*, 28 COMM. OF THE ACM 921, 922–23 (1985) (containing examples of “if, then” programming language). It tells the computer to take a path “if” certain conditions are met. It is used here as an analogy: if an innovator makes choices that create certain conditions, then that innovator can expect more or less uncertainty.
for the potential of great gain, we have less of a societal inclination to offer more protection, as the adoption of enhanced uncertainty was self-imposed. In fact, this is exactly the kind of inclination toward unknown futures that Knight noted should be rewarded by his definition of “profit.” 234 With the choice factor, such uncertainty is not negative in its impact on incentives for the innovation process; winners and losers are likely willing to accept their fates similar to a casino gambler.

A straightforward example of “if, then” uncertainty exists in the law of patent non-obviousness or inventive step. This is a patentability standard that ensures an invention constitutes a significant enough technological contribution to deserve rights of exclusion. 235 In U.S. patent law, Section 103 of the Patent Act requires rejection if the “differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the [application’s] effective filing date [ . . . ] .” 236 Essentially, the law ensures that trivial advances that are merely predictable variations in existing technology, judged from the viewpoint of those of ordinary skill in the art, are considered part of the public domain and not subject to capture. 237 Non-obviousness exists separately from subject matter as a requirement, and has traditionally been important in erecting a barrier to “bad” patents. 238

The assessment of non-obviousness is made with reference to the patent application’s claims. 239 The reviewing body (Patent Office or court) considers all of the available prior art and determines whether the combination renders the claimed invention obvious. 240 To make a prima facie case of such obviousness, there must be a motivation to combine the teachings of the prior art to arrive at the claimed invention. 241 Without such a motivation, it is too easy to combine disparate ideas that no inventor

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234 KNIGHT, supra note 55, at 271.
237 KSR Int’l Co. v. Teleflex Inc., 550 U.S. 398, 417 (2007); Merges, supra note 149, at 12–14. The ideal outcome of the obviousness requirement is that we will be less likely to grant rights to inventions that would have been created even in the absence of the patent incentive. See generally Michael Abramowicz & John F. Duffy, The Inducement Standard of Patentability, 120 YALE L. J. 1590 (2011) (making the case that the “inducement standard” should be even more emphasized in the law).
239 MPEP § 2141; Merges, supra note 149, at 18.
240 MPEP § 2141.
would reasonably consider or otherwise engage in hindsight analysis. But how to judge this motivation is an inherently difficult problem that has evolved over the years. In the last part of the 20th century, the Federal Circuit engaged in an effort to add certainty to the analysis by creating the “teaching, suggestion, or motivation test” (“TSM test”), which required evidence of a reason to combine references. The Federal Circuit’s efforts were ultimately undermined by the Supreme Court’s decision in *KSR International Co. v. Teleflex Inc.*, which tossed out the TSM test as the sole measure of whether one of ordinary skill in the art would combine references. The *KSR* decision opened up the sources that a reviewing body can use to find the motivation to combine, and left more discretion to the district court.

Due to the renewed flexibility in the obviousness analysis, there is now more uncertainty in predicting future outcomes. But, importantly, this does not necessarily mean that innovators will be more disinclined to patent. When it comes to claims that are likely to raise an obviousness issue, the patent applicant actually has a great deal of control. It is a fundamental understanding of claim drafting that the applicant’s language determines the scope of the grant. A prospective patentee can choose broad claims that are likely to include more prior art and trigger an obviousness challenge, or narrow claims that could be untouched but have a more limited scope of protection. The reward for broad claims is, of course, more patent protection. Therefore, if a patent applicant makes the choice to reach for more exclusionary power, the additional uncertainty he

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242 *Id.*


244 See In re Gartside, 203 F.3d 1305, 1319 (Fed. Cir. 2000); In re Dembiczak, 175 F.3d 994, 999 (Fed. Cir. 1999) (detailing standard and accompanying rationale), *abrogated on other grounds*.

245 *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 415 (2007). The Court’s decision corrected the Federal Circuit’s overly rigid test from a philosophical standpoint, but also responded to complaints that the TSM test made it too likely that bad patents would issue. See Petherbridge & Wagner, *supra* note 238, at 2064–65 (noting criticism of the Federal Circuit’s test, including in recent reports on the state of the U.S. patent system).

246 Rantanen, *supra* note 235, at 721–22 (noting that the exact boundaries of the resulting test are not clear).

247 See, e.g., Adam Powell *KSR Fallout: Questions of Law Based on Finding of Fact and the Continuing Problem of Hindsight Bias*, 1 HASTINGS SCI. & TECH. L.J. 243, 246–50 (2009) (asserting that the Supreme Court injected more uncertainty into the determination by introducing a more flexible standard to be applied by district courts).


249 *Id.* at 845–49 (describing the implications of choosing broad versus narrow claims).
or she faces might be a reasonable exchange. It may even be welcome in that risk averse competitors will be disincentivized.

Framing this within the impact bi-matrix described above\textsuperscript{250}, we would say that the uncertainty in obviousness would create less of an aversion because the applicant has competence about the innovative quality of the invention (see Figure 2). Such competence may be bolstered by the development of so-called “secondary considerations,” which establish that the invention enjoyed commercial success, satisfied a long-felt need or solved a problem that others could not.\textsuperscript{251} Even if there is the potential for impact subsequent to significant investment (e.g., when a court considers obviousness in a litigation), the impact is likely to be substantially less than an unpredictable subject matter knock-out.

With this view in mind, policymakers should not attempt to eliminate all uncertainty in obviousness determinations. Not only is it unlikely to be a disincentive to invent, but it may actually propel the most innovative. Although the test can drift to total unpredictability, as it stands, obviousness uncertainty is an important opportunity for Knightian profit.

\textbf{C. Remedial Uncertainty: Fee-Shifting}

Even if one accepts that uncertainty is not always negative and can offer opportunities to savvy innovators, one might ask whether it ever can have overall positive effects. In other words, are there sources of uncertainty that can be said to promote innovative behavior, regardless of risk preferences? If such sources disincentivize bad behavior that thwarts innovation, the answer is yes. When rules can be gamed by the unscrupulous, ambiguous standards for punishment may reduce the temptation to test the system as one can never determine for certain when the hammer will fall. If this uncertainty does not conflict with the competence/investment framework above, it is reasonable to assume the overall effect is positive. The concept of such good uncertainty is perfectly illustrated by the law of fee-shifting in U.S. patent litigation.

Fee shifting is a mechanism that exists in patent and other forms of intellectual property litigation that upends the traditional system of allocating costs in order to punish a party that has engaged in bad behavior. The traditional expense allocation in the U.S., as with other civil contexts, is the “American Rule,” which states that each side pays its own costs.\textsuperscript{252}

\textsuperscript{250} See Fig 2.
\textsuperscript{251} Graham v. John Deere Co. of Kansas City, 383 U.S. 1, 17–18 (1966).
\textsuperscript{252} See Hardt v. Reliance Std. Life Ins. Co., 560 U.S. 242, 252–53 (2010) (“Our basic point of reference when considering the award of attorney’s fees is the bedrock principle known as the American Rule: Each litigant pays his own attorney’s fees, win or lose, unless a statute or contract
This is in contrast to the so-called, “English Rule,” common outside the United States, which mandates that the loser pay the winner’s costs. Also known as “fee shifting,” the English Rule exists as a principle of fairness and way to ensure that the expense of litigation does not subsume the benefit of winning. Conversely, the American Rule is more policy driven, serving as an economic tool for encouraging legitimate, but close lawsuits that might otherwise be forgone if one faced the risk of accounting for the other side’s costs.

U.S. courts have long-imposed the English Rule of fee shifting as a punishment in a variety of litigation contexts. This is particularly true in intellectual property law. In patent law, fee-shifting was codified in 1946 and incorporated in a revised form in the Patent Act of 1952. The current rule, Section 285, states that “[t]he court in exceptional cases may award reasonable attorney fees to the prevailing party.” It has been left to the courts to define “exceptional,” but it has been traditionally applied in cases where either the plaintiff brings an infringement litigation in “bad faith” and without proper basis, or where a defendant engaged in willful infringement. 

provides otherwise.” (internal quotations omitted)). See generally John Leubsdorf, Toward a History of the American Rule on Attorney Fee Recovery, 47 LAW & CONTEMP. PROBS. 9 (1984) [https://perma.cc/67FV-JR5A].


Id.

See Fleischmann Distilling Corp. v. Maier Brewing Co., 386 U.S. 714, 718 (1967) (The American Rule promotes broad access to the courts by not penalizing a party “for merely defending or prosecuting a lawsuit.”).


For example, the Copyright Act allows for fee shifting in a fairly broad set of cases. 17 U.S.C. § 505 (2012) (“In any civil action under this title, the court in its discretion may allow the recovery of full costs by or against any party other than the United State or an officer thereof. Except as otherwise provided by this title, the court may also award a reasonable attorney’s fee to the prevailing party as part of the costs.”). Fee shifting is also explicitly permitted in patent, federal trade secret, and federal trademark contexts as well. 15 U.S.C. § 1117(a) (2012) (addressing fee-shifting in trademark actions); 18 U.S.C. § 1836(b)(3)(D) (2012) (addressing fee-shifting in civil trade secret misappropriation actions); 35 U.S.C. § 285 (2012) (addressing fee-shifting in patent actions).


See Cahoy & Oswald, supra note 256.
The key uncertainty factor in fee shifting arises from the fact that bad actors cannot fully predict when it will catch and penalize them.262 Because a court has the discretion to determine if a certain act is exceptional, a party has an incentive to behave, lest their actions be fit to the statutory language. The flexibility telegraphs that the test will be outcome determinative. Conversely, if a party had a strong sense of exactly what type of behavior would trigger fee shifting, that party could push the boundaries. It could engage in problematic behavior up to the point of penalty. In the end, uncertainty is a threat that compels a party to err on the side of respectful behavior. In turn, this promotes innovation, because market actors can be more assured that litigation will serve as an appropriate vehicle for addressing disputes, rather than a sword for those who would manipulate the system.263

To see that the above narrative is more than theoretical, consider that there has actually been an opportunity to observe how uncertainty in fee shifting positively impacts the innovation environment. The fee shifting statute in the Patent Act had been interpreted with a level of flexibility and deference by the courts since its enactment through the creation of the Federal Circuit in 1982.264 A variety of circumstances could qualify as exceptional under the law.265 That flexibility ended with the Federal Circuit’s decision in Brooks Furniture Mfg., Inc. v. Dutailier Int’l, Inc., in which the court determined that fee shifting could be applied outside of litigation misconduct only when the case was both (1) brought in “subjective bad faith,” and (2) “objectively baseless.”266 This had the effect of severely narrowing the types of cases subject to the rule, and rendered it a relatively empty threat. As a result, fee-shifting awards were quite rare.267

Concurrently, concerns about abuse of the patent system from frivolous litigations brought by so-called, “patent assertion entities,” arose.268 Some openly flouted a negative litigation model, in which low quality patents were asserted against financially weak defendants for

263 Moreover, uncertainty will dissuade those with weak cases from litigating in the first place, potentially reducing litigation overall. D’Amato, supra note 28, at 16–17.
264 See Cahoy & Oswald, supra note 256, at 23.
265 Id. at 21.
267 Colleen V. Chien, Reforming Software Patents, 50 HOUSTON L. REV. 325, 377 (2012) (finding that between 2005 and 2011, fee-shifting awards were granted in 56 cases per year out of 3000 patent cases filings per year).
nuisance settlements.²⁶⁹ Although one might be inclined to challenge such behavior, the Federal Circuit’s narrow interpretation of Section 285 ensured that fee-shifting would not be the available mechanism. In essence, the fact that a statutorily broad and ill-defined rule was curtailed reduced the uncertainty that would have otherwise disincentivized bad behavior.

The U.S. Supreme Court reinvigorated the beneficial uncertainty in two paired cases: Octane Fitness, LLC v. ICON Health & Fitness, Inc.,²⁷⁰ and Highmark, Inc. v. Allcare Health Management Systems, Inc.²⁷¹ In Octane Fitness, the Court found that the Federal Circuit’s test was “rigid and mechanical” in a way that belied the intent of the statute.²⁷² Instead, the Court held that the term “exceptional” was to be interpreted according to its ordinary meaning, which meant that the case simply “stood out from others.” In Highmark, the Court followed up with the holding that a district court’s finding on exceptionality could be reviewed only for abuse of discretion.²⁷³ In the wake of the Octane and Highmark cases, fee shifting awards rose significantly.²⁷⁴

The behavioral result of the Supreme Court’s stripping down of fee shifting doctrine to a district court’s interpretation of the term “exceptional” is the creation of an effective deterrent; a litigant cannot fully know what kind of bad behavior will fit and will be more cautious. Although there are some acts that are more likely to fit, such as willful infringement,²⁷⁵ the outer boundaries are unclear. The uncertainty in the test creates an incentive to avoid any allegation that behavior creates an exceptional case. And the less abusive the litigation system is, the more innovators will believe it serves a legitimate enforcement function that is safe to interact with. In the context of fee shifting, uncertainty enhances the remedial purpose of the law. Conversely, uncertainty in fee shifting does not create aversion because it relates to acts that are in the impacted litigant’s control, implying competency. Also, the uncertainty arises in

²⁷² Octane Fitness, 572 U.S. at 550.
²⁷³ Id. at 554.
²⁷⁵ Octane Fitness, 572 U.S. at 550.
close proximity to the acts that trigger it (litigation behavior). Innovation-friendly policy and no aversion equates to a positive effect.276

Thus, a behavioral perspective on intellectual property fee-shifting uncertainty suggests that reform is not only unnecessary, it could have a broadly negative impact on innovation. So long as the uncertainty does not stray beyond capturing bad behavior, it is positive.

IV. ADDRESSING PATENT UNCERTAINTY

Once “investment-killing” uncertainty in the law is identified, as in the case of patentable subject matter, policymakers and innovators have available several possible avenues of response. The easiest is to refrain from action, and simply permit negative impacts to reduce the power of incentive systems like patents to induce innovative behavior. Another is to undertake direct legal or regulatory action to eliminate or substantially reform the uncertain rule. Finally, society can place the burden on firms to use internal capacities to foresee and prepare resources to confront or capture opportunities. In the real world, some combination of all of these responses will take place. But society’s strongest hand is with direct legal and regulatory revision, and such action should be considered when important innovation is most likely to be affected.

A. Uncertainty Aversion Should Not Substitute for Innovation Policy

Do nothing is always the easy option. And in the case of patent incentives, there is an arguable justification. If the above uncertainty simply weakens patent rights, innovators will be pushed toward other choices like secrecy.277 Those who believe that the patent system does not make a positive contribution278 may find this is one way of reducing its influence. This, however, appears to be the minority position.

More realistically, it is possible to consider the effect of uncertainty aversion on innovative behavior as merely one of a number of possible policy levers that are constantly being pulled.279 The most explicit might be patent and trademark fees in the United States, which are progressive and provide significant breaks for “micro entities” and “small entities.”280 Such

276 See Fig 2.
277 Moser, supra note 13, at 1231.
278 E.g., Boldrin & Levine, supra note 181.
279 See Dan L. Burk and Mark A. Lemley, Policy Levers in Patent Law, 89 VA. L. REV. 1575, 1661–62 (2003). See also Ayres & Klemperer, supra note 160 (calling for at least the use of increased risk as a policy lever).
fee delineations clearly make it easier for some to obtain rights more than others, and this policy probably shapes innovation in some way. The same should be true for any differential expense that treats certain inventions or individuals differently. How is uncertainty or ambiguity different? Theoretically, it could be just another lever.

The primary distinction is that unascertainable uncertainty is a scattershot approach. It is not directed policy and has unknown and unintended effects. It is possible that it will impact some slice of innovation that would have otherwise ended up being critical for some future field. Although explicitly picking winners and losers in the innovation game through policy is dangerously presumptive, at least stakeholders generally have some ability to participate in the debate (such as in the federal rulemaking context). If not explicit, then we may trust the market and the wisdom of the consumers. However, viewed as irrational decision making, uncertainty aversion has none of these intended benefits.

At its most base level, aversion is a cost that may simply end up as a blunt penalty on those with more limited funding. There is recent research indicating that in concentrated industries, patent ownership is shifting to larger firms. One explanation is that these firms are increasingly better innovators, and there are technical barriers to entry. But a contributing factor might be that small innovators in ambiguously protected industries are averse to inventing or commercializing inventions. Such an impact may mean that innovation of particular interest to small entities may be decreased.

281 Anup Malani & Jonathan S. Masur, Raising the Stakes in Patent Cases, 101 GEO. L.J. 637, 640 (2013) (noting that one of the reasons the U.S. has chosen a patent system over a reward system is to “decentralize the task of picking winners”).


283 See generally James Surowiecki, THE WISDOM OF CROWDS (2004) (describing the power of group participation over managed decision-making). Moreover, Peter Lee argues that the patent system’s cribbed focus on individual invention misses many social innovations, further suggesting that wielding patent policy to direct innovation is misguided. Peter Lee, Social Innovation, 92 WASH. U. L. REV. 1, 42 (2014).


285 Grullon, Larkin & Michaely, supra note 284, at 40.
B. Legal and Regulatory Revision with Care

The revision route is intensive in terms of political expense, but it has the greatest potential for reducing negative uncertainty impacts. If one can focus specifically on what aspect is uncertain, reform may be possible that restores the proper role of intellectual property rights. Such an effort requires broad participation from stakeholders and negotiation. But the resulting rules may be clearer and more broadly acceptable than those generated by courts that prioritize doctrinal consistency and conservative statutory interpretation.

Of course, there are significant risks to reform as well. It is possible that any revision will not sufficiently resolve uncertainty problems or even raise new ones. To be sure, if a bright line is set, the Coasian argument is that efficiency will result if obstacles to bargaining are sufficiently low. But setting that bright line is much easier in theory than in practice. Perhaps the only way to avoid this is to cut a problematic rule, either in effect or in total.

This can happen at the administrative level. Taking patentable subject matter as an example, the U.S. intellectual property community has watched with some relief as Director Iancu took steps in 2018 to deemphasize section 101 considerations in many patent cases. In remarks delivered at the Intellectual Property Owners Association (IPO) 46th Annual meeting, Director Iancu stated the PTO had crafted guidance that would eliminate section 101 considerations in many cases. That guidance issued in 2019. Specifically, the PTO will not find a claim abstract unless it is “directed to” one of three categories: mathematical concepts, certain methods of organizing human interactions, and mental processes. Even if a claim references one of the three categories, it is not directed to one if it

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286 Although patent reform has occurred over the years, with the most recent major change being the Leahy-Smith America Invents Act in 2011 (Pub. L. No. 112-29, 125 Stat. 284, 325 (2011)), wholesale revision is rare. Consider that the United States is still operating under the Patent Act of 1952.


288 Coase, supra note 165, at 15–19.


291 2019 Revised Patent Subject Matter Eligibility Guidance, supra note 228.

292 Id. at 50.
integrates it into a practical application. By cutting off the possibility of a subject matter analysis for some percentage of cases, the potential for uncertain results is greatly reduced.

A stronger reform would be to rewrite or curtail an uncertain rule so as to eliminate the possibility that any connected, uncertain assessment would be imposed. Again, with regard to patentable subject matter, there are many legislative proposals that would eviscerate section 101. A prominent example is the so-called, “Coons-Tillis draft bill,” which would add a definition of “useful” that requires “human intervention” and eliminate “judicially created exceptions to subject matter eligibility.” Such a change, if enacted, would abrogate the uncertain case law resulting from the *Alice* decision.

Broadly eliminating an uncertain rule or law can obviously have negative innovation consequences if the rule provides some important standard that is necessary for the efficient functioning of the system. Policymakers must exercise caution, and perhaps consider the lightest hand possible in changing the rules. Even in the context of patentable subject matter, it can be argued that rigorous section 101 analysis prevents some bad patents from issuing. The fact is, other patentability standards—novelty, non-obviousness, enablement, etc.—remain in place to serve as a barrier to make reduction of 101 less problematic. But the debate on the impact of revision on overall innovation policy is critical.

**C. Firms Must Develop Internal Competencies to Identify and Ameliorate Uncertainty**

Regardless of what does or does not happen at the level of legislative or administrative reform, firms should prepare. As the literature evinces, some firms are able to innovate in the face of uncertainty or ambiguity and others are slowed. The successful firms seem to be capable of strategic

293 Id. at 51.
294 Tillis, supra note 231.
297 In the end, some form of polycentric governance is likely to influence reform. As articulated by famed economist Elinor Ostrom, property resource management and allocation are not best accomplished by the government using rational actor theory, but rather individuals and institutions acting at multiple levels. See Elinor Ostrom, *Beyond Markets and States: Polycentric Governance of Complies Economic Systems*, 100 AM. ECON. REV. 641, 663–64 (2010).
298 See supra notes 97–101 and accompanying text.
foresight beyond that of their competitors. An ideal system of uncertainty management should support and encourage firm action.

At least two approaches appear to be important in moderating negative uncertainties: (1) creating a structure that is capable of flexibly responding to a variety of unknowns; and (2) investing in the production of additional information. Unfortunately, these options are generally resource-intensive. As a result, it may be that in innovation contexts, harmful uncertainties have a greater impact on individuals or small firms.

A well-regarded management process originating from the U.S. military is the volatility, uncertainty, complexity and ambiguity (VUCA) framework. Emerging from the aftermath of World War II, when the military was compelled to take on a more complex role amidst a rapidly changing global political environment, VUCA provided a strategic tool for risk management. Essentially, VUCA is a risk and uncertainty identification tool that aids in the analysis of future events. It provides perspective on the potential pitfalls of particular actions and theoretically permits more informed decision making and preparation. Theoretically, VUCA-like analysis should be useful to entrepreneurs. As noted above, the more information one has, the less likely one will be dissuaded by uncertainties.

A different technique has been promoted by many, including the RAND Corporation, for addressing deep factual uncertainties such as the impact of climate change. In situations where the underlying mechanisms of future events are so poorly understood, there is utility in conceiving of multiple future realities and planning against them. This is the idea underlying the scenario building. By playing out multiple futures, more valuable or consequential paths can be identified. Scenario building has

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300 Mack & Khare, supra note 299, at 5.

301 Bird, supra note 299, at 371.

302 Id.

303 See id. at 418.


306 Id.
been suggested in the context of product innovation\textsuperscript{307} and intellectual property regimes.\textsuperscript{308}

Although VUCA and scenario building exercises provide useful mechanisms for generating more information, to actually deal with uncertainty, the integration of a flexible adaptation system may be necessary. David Teece has written extensively on the topic of innovation and is known for his work elucidating the characteristics of firms that are better able to compete in the marketplace.\textsuperscript{309} He noted that flexibility in resource allocation and the ability to respond to unexpected situations is important for success.\textsuperscript{310} Teece refers to these attributes as “dynamic capabilities,” which he categorizes as those directed to “sensing, seizing and transforming” in the face of new information.\textsuperscript{311} These are opposed to “ordinary capabilities,” which are directed to efficiency and the status quo.\textsuperscript{312} Discussing specifically the topic of uncertainty in innovation, Teece notes that bolstering dynamic capabilities allows a firm to change direction quickly and meet unknown challenges.\textsuperscript{313} Essentially, a firm should be like a boxer ready to bob and weave in the face of a competitor’s punches instead of merely running more quickly in one direction.

Both of the above techniques make a firm more prepared, but they offer no guarantees that some surprising future consequence will not be debilitating. Moreover, since only some resource-rich firms typically prepare at this level to tackle uncertainty, it cannot entirely address the societal impact. For that, a broader policy response is called for. And indeed, institutions have evolved to better address harmful uncertainties and permit innovators the space to succeed.
CONCLUSION

Debates regarding the structure and benefits of patent systems, the proper articulation of their rules, and the potential for disparate domestic and global impact are long-standing. However, the role of true uncertainty as a supporting or undermining player in innovation system incentives is understudied. Although superficial assessments have deemed uncertainty problematic, a deeper dive into the factors that impact innovator behavior demonstrates that there can be neutral or positive effects as well. A more sophisticated understanding is necessary to identify areas for reform and guide innovators or investors.

A behavioral economics perspective highlights an innovator’s perceived competency about future events and potential for investment loss as the key factors influencing uncertainty impact. Using this guidance to review the current state of the law, one can see that three categories of legal uncertainty present themselves to inventors: (1) investment-killing; (2) if-then; and (3) remedial uncertainly. Only the first creates a problem that must be addressed by legal reform; the others should be preserved as aspects of a healthy innovation system. If policymakers and firms employ this new typology in considering legal uncertainty, we are likely to move toward a more acceptable and powerful innovation system.