Utah Law Review

Volume 2021 | Number 4 Article 3

11-2021

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Recommended Citation
Clark Asay & Stephanie Plamondon Bair, COVID-19 and Its Impact(s) on Innovation, 2021 ULR 805 (2021).
https://doi.org/10.26054/0d-2gwe-sehk

COVID-19 AND ITS IMPACT(S) ON INNOVATION

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In previous work, we explored how certain characteristics of adversity are often more conducive to innovation than others. In this Article, prepared as part of the Lee E. Teitelbaum Utah Law Review Symposium—The Law & Ethics of Medical Research, we review some of that work and apply it specifically to the COVID-19 context. We conclude by assessing certain policy implications in light of how the COVID-19 pandemic has both spurred and hindered innovation.

INTRODUCTION

Sometimes adversity hinders innovation, but sometimes it promotes it. In other work,[1] we draw on various literatures to identify which characteristics of adversity are most conducive to innovation and which are most likely to stifle it. That work suggests that for adversity to have the best chance of promoting innovation, it should satisfy the Goldilocks principle: the adversity should be neither too much nor too little, neither too intense nor too temperate, neither too pervasive nor too narrow, but "just right." Furthermore, adversity collectively experienced, with severe consequences if left unaddressed, is also more likely to trigger innovation. But again, if the consequences are too severe or the adversity impacts too many in a community, those characteristics may hinder innovative responses.

Of course, these principles are not ironclad. Many people and organizations innovate despite the adverse conditions they face being less than ideal, while many parties fail to innovate despite being confronted with adverse conditions conducive to innovative activity. In other words, individual and organizational characteristics also matter in terms of whether a party responds to adversity with innovation. But overall, based on the existing literatures, adversity that satisfies these principles stands a better chance of promoting innovation, all else being equal.

In this Article, we review some of our findings on adversity and innovation and apply them specifically to the COVID-19 context. The COVID-19 case study offers a number of examples of how adversity may either inhibit or promote innovation, depending on its characteristics, and this Article explores some of these examples.

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[1] *See generally* Clark D. Asay & Stephanie Plamondon Bair, *Innovation in Adversity*, 49 FLA. ST. U. L. REV. (forthcoming), https://dx.doi.org/10.2139/ssrn.3801184 [https://perma.cc/8S2W-9X45] (presenting the theory of innovation applied in this Article).

We first review some of the key takeaways from our separate work. For each of these takeaways, we then examine examples in the COVID-19 context that illustrate these principles at play. Finally, we consider some possible policy implications that follow from adversity's role in both promoting and inhibiting innovative efforts during the COVID-19 pandemic.

I. ADVERSITY'S RELATIONSHIP TO INNOVATION AND THE COVID-19 PANDEMIC

Adversity, broadly defined, can be both a conduit and a roadblock to innovation.[2] But what are the clues as to which role adversity will play in any given instance? In our other work, we drew on research from diverse literatures to identify four features of adversity that can affect an organization or individual's capacity to innovate: the discreteness of the adversity across both spatial and temporal domains, the intensity of the adversity, how widely the adversity is experienced, and the potentially harmful consequences of the adversity if left unaddressed.[3]

In this Part, we briefly review these findings and then analyze how they apply to the COVID-19 pandemic and the innovation (or lack thereof) that has taken place in response to it. Specifically, we examine the extent to which features we previously identified as relevant to innovation in adversity have been present in the COVID-19 context and how those features may have affected the course of innovation.

A. The Goldilocks Principle

In our other research, we identified a so-called Goldilocks relationship between four features of adversity and the likelihood that parties will respond to adversity with innovation.[4] According to this relationship, adversity should fall within a favorable range of temporal and spatial discreteness, intensity, collectiveness, and consequences to have the best chance of stimulating innovative responses.[5]

The Goldilocks principle can be understood in terms of a balancing of motivation and resources. On the one hand, adversity tends to provide strong incentives for individuals and organizations to innovate.[6] The challenges adversity presents naturally invite innovative responses, as individuals react to adversity with

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[2] *See* Asay & Plamondon Bair, *supra* note 1, at 9–10. In this work, we defined adversity broadly to include any event or set of circumstances, major or minor, that challenged an individual or organization in pursuit of their goals. Adversity could occur at the individual level, as in instances of illness or job loss; at the organizational level, as with financial or human resources challenges; or at the societal level, like with natural disasters or the COVID-19 pandemic. *Id.* at 9–12.

[3] *Id.* at 12.

[4] *Id.* at 6.

[5] *Id.* at 6–7.

[6] *See, e.g.*, Bhaskar Chakraorti, *Finding Competitive Advantage in Adversity*, HARV. BUS. REV. (Nov. 2010), https://hbr.org/2010/11/finding-competitive-advantage-in-adversity [https://perma.cc/PVH6-9GN5] (discussing entrepreneurs using adversity as a competitive advantage in innovation).

creativity as a means of overcoming their challenges[7] or simply as an emotional coping mechanism.[8] On the other hand, however, creativity and innovation tend to be resource-intensive endeavors.[9] They often require time, money, cognitive power, and emotional and social support to succeed. Ideally, then, adversity should be significant enough in a particular domain to provide the necessary motivation to innovate without being so significant that it drains the very resources necessary to do so.

For example, a party is unlikely to respond to adversity with innovation if the adversity is spatially and temporally unbounded. Take long-term poverty, which can work to prevent many of those experiencing it from responding to their circumstances with innovation.[10] This is so in part because the adversity is overwhelming across both temporal and spatial domains. On the temporal front, the long-term nature of their impoverished state tends to sap the suffering individuals' motivation to innovate and monopolizes the mental and economic resources necessary for innovation. On the spatial front, poverty tends to drain a person's cognitive, financial, and emotional assets by making constant demands in every facet of their life, thus further eroding their ability to think and act creatively in response to their adverse life circumstances.[11]

On the other hand, adversity that is too fleeting in time or narrow across an individual's life or an organization's operational domains is less likely to spur innovation. For instance, parties that experience a brief bout of adversity may often fail to respond to it with innovation because it has come and gone so quickly that the motivational nudge never materializes. Instead, an innovative response is more likely when a party experiences adversity that demands action in part because the adversity lingers (at least long enough to inspire a creative response). Adversity that is too narrow in scope is similarly unlikely to trigger a creative response because that adversity is sufficiently confined in a party's life or operations that the adversity may hardly register. Even if it does register, it is simply too limited in scope to motivate an innovative response.

The same principles hold for the intensity of a challenge. Adversity that is too intense often precludes innovative responses to that adversity for the same reasons temporally and spatially unbounded adversity are innovation killers: the adversity's high intensity monopolizes a party's motivation and resources such that innovation

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[7] *Id.*

[8] Mark A. Runco, *Tension, Adaptability, and Creativity*, *in* THE SERIES IN CLINICAL AND COMMUNITY PSYCHOLOGY: AFFECT, CREATIVE EXPERIENCE, AND PSYCHOLOGICAL ADJUSTMENT 165, 167 (Sandra W. Russ ed., 1999).

[9] Glenda Claire Jones, An Exploration of Experiences and Expression of Artistic Creativity During Adversity and Resilient Recovery 291–93 (May 2013) (Ph.D. dissertation, Saybrook University) (ProQuest).

[10] Stephanie Plamondon Bair, *Impoverished IP*, 81 OHIO ST. L.J. 523, 554–56 (2020).

[11] *See* Cara Feinberg, *The Science of Scarcity: A Behavioral Economist's Fresh Perspectives on Poverty*, HAR. MAG. (May-June 2015), https://harvardmagazine.com/2015/05/the-science-of-scarcity [https://perma.cc/U4EK-QMNM] (providing an overview of economist Sendhil Mullainathan's work on the impact of scarcity on economic behavior).

is either extremely difficult or simply out of the question. Conversely, when adversity is not intense enough, it can fail to stimulate innovative responses, in part because parties deem that the adversity's low intensity does not merit a response.

Another feature of adversity that affects its relationship to innovation is whether the adversity is experienced collectively or in isolation. When adversity is experienced collectively, it is more likely to trigger innovative responses than when it is experienced in isolation. This is so because shared adverse experiences tend to increase feelings of relatedness and interpersonal support,[12] and a significant body of research shows that when people feel related to and supported by those around them, they tend to be more productive and motivated in ways conducive to creativity, including the ability to generate novel ideas.[13] Conversely, when parties experience adversity in isolation, that adversity is less likely to trigger successful innovation. Unlike parties experiencing adversity in common, the isolated party often lacks the support structures in their life or operations necessary to innovate effectively.[14]

Adversity experienced collectively is also more likely to trigger innovation when the consequences of failing to do so are severe. History is full of examples of governments and organizations responding to the challenges presented by various severe threats to society with impressive and groundbreaking innovation.[15] Conversely, when adversity falls short of posing dire consequences if left unaddressed, those impacted are less likely to respond to it with innovative solutions. This principle is related to the discussion above about adversity intensity: when parties judge that the consequences of leaving adverse conditions unaddressed are not dire enough, they may simply lack the motivation to respond to the adversity with innovation.[16] This may be particularly so when other concerns demand society's collective energy.

But consistent with the Goldilocks principle, when adverse conditions are too commonly shared or their consequences are simply overwhelming, those conditions may hinder successful innovative responses. For instance, if an entire community is impoverished, that adversity poses significant obstacles to innovation because the entire community may lack the resources necessary to innovate its way out of those hardships, despite the fact that the shared adversity might otherwise create feelings of connectedness.

Again, we wish to emphasize that a particular party's individual characteristics certainly play a role in whether that party responds to adversity with innovation. In

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[12] Indeed, much research shows that a variety of adverse experiences, including natural disasters, can often increase a community's bonds and result in mutual support for members within the community. *See, e.g.*, Lisa Grow Sun, *Disaster Mythology and the Law*, 96 CORNELL L. REV. 1131, 1138 (2011) (reviewing some of this literature).

[13] *See* Asay & Plamondon Bair, *supra* note 1, at 24-26 (reviewing some of the literature).

[14] *Id.* at 26–27.

[15] *See id.* at 28–29 (discussing the examples of satellite, GPS, internet, and nuclear weapons technologies, all of which arose at least in part due to perceived severe threats to the interests of particular governments or societies).

[16] *See* discussion *infra* Section I.C.

other words, whether some party responds to adversity with innovation is not always determined by whether the adversity is conducive to innovation. For instance, we all know inspiring stories of individuals and organizations that have overcome long odds with their creativity and ingenuity.[17] And this may be so even when the adversity is excessively intense, spatially unbounded, of extreme duration, or is experienced in isolation. On the other hand, we may also know stories of parties facing "just right" amounts of adversity that have nevertheless fallen short in responding with creativity. Be that all as it may, the characteristics of the adversity that a party faces appear to affect the likelihood that the party will respond to the adversity with innovative responses, all else being equal.

B. The Goldilocks Principle: Examples of COVID-19's Impact on Innovation

We have seen many examples of the COVID-19 pandemic as both a stimulant and hindrance to innovation. In this Section, we review several examples of the Goldilocks principle at play.

1. Suboptimal Intensity and Scope

Perhaps the most obvious example of COVID-19 failing to satisfy the Goldilocks principle and thereby stymieing innovation is when the disease proves fatal. Millions of people across the globe have succumbed to this awful disease, and those lives represent significant lost sources of innovation.[18] In such cases, the Goldilocks principle is clearly unsatisfied because the adversity's intensity is so great and unbounded that those affected are literally unable to survive, let alone engage in innovation.

Even many who have survived or have not been infected with the virus are enduring significant impacts that in many cases may make it more difficult for them to engage in creative endeavors. For example, the obstacles in dealing with one's

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[17] *See, e.g.*, Renee Jacques, *16 Wildly Successful People Who Overcame Huge Obstacles to Get There*, HUFFPOST (Dec. 16, 2017), https://www.huffpost.com/entry/successful-people-obstacles_n_3964459 [https://perma.cc/JN9D-ASNS].

[18] *See, e.g.*, Gabe Friedman, *Those We Lost in 2020: Remember the Rabbis, Pioneers, Innovators, and Family Members*, Obituaries, JEWISH TELEGRAPHIC AGENCY (Dec. 28, 2020, 11:46 AM), https://www.jta.org/2020/12/28/obituaries/those-we-lost-in-2020-remembering-the-rabbis-pioneers-innovators-and-family-members [https://perma.cc/T5C6-FN2N]; *Those We've Lost*, N.Y. TIMES (Feb. 13, 2021), https://www.nytimes.com/interactive/2020/obituaries/people-died-coronavirus-obituaries.html [https://perma.cc/H33D-JB5N]; *Faces of the Dead*, WASH. POST (July 31, 2020), https://www.washingtonpost.com/health/2020/04/24/coronavirus-dead-victims-stories/?arc404=true#DeLeon [https://perma.cc/A9F7-E3TZ].

own or a loved one's illness,[19] the loss of typical routines,[20] the financial challenges associated with job losses that many have experienced during the pandemic,[21] and the loss of emotional and social support systems due to social distancing, alone or combined in individual cases, are often significant enough to drain the motivation and resources necessary to innovate.[22]

There is reason to believe that those who are already struggling with various forms of adversity in their lives are also the most likely to be affected in severe ways by the COVID pandemic.[23] For these populations, including those struggling with financial challenges, racial bias, mental health challenges, and lack of access to medical services, the challenges presented by the COVID pandemic are often the "straw that breaks the camel's back" in terms of pushing them out of the ideal range of innovation-promoting adversity.[24] This is concerning in part because there is already significant evidence that these populations are innovating at lower levels

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[19] *Grief and Loss*, CTRS. FOR DISEASE CONTROL AND PREVENTION (June 11, 2020), https://www.cdc.gov/coronavirus/2019-ncov/daily-life-coping/stress-coping/grief-loss.html [https://perma.cc/NTF2-GW68] (providing resources for coping with grief stemming from COVID-19, particularly with respect to the loss of loved ones).

[20] *Coronavirus Grief: Coping with the Loss of Routine During the Pandemic*, MAYO CLINIC (Oct. 13, 2020), https://www.mayoclinic.org/diseases-conditions/coronavirus/in-depth/coping-with-coronavirus-grief/art-20486392 [https://perma.cc/56ZR-76EE] (discussing how loss in routine stemming from COVID-19 can result in grief and listing coping mechanisms for dealing with that grief).

[21] Kim Parker, Rachel Minkin & Jesse Bennett, *Economic Fallout from COVID-19 Continues to Hit Lower-Income Americans the Hardest*, PEW RESEARCH CENTER (Sept. 24, 2020), https://www.pewsocialtrends.org/2020/09/24/economic-fallout-from-covid-19-continues-to-hit-lower-income-americans-the-hardest/ [https://perma.cc/CJA3-SWER] (discussing the significant financial strains COVID-19 has caused in American society, particularly with respect to low-income individuals).

[22] Catriona R. Mayland, Andrew J.E. Harding, Nancy Preston & Sheila Payne, *Supporting Adults Bereaved Through COVID-19: A Rapid Review of the Impact of Previous Pandemics on Grief and Bereavement*, 60 J. PAIN SYMPTOM MGMT. e33, e33 (2020) ("Owing to social isolating measures and lack of usual support structures, [COVID-19] also is likely to influence experiences of grief and mourning.").

[23] *See, e.g.*, Cong S. Pham & Devashish Mitra, The Color of Coronavirus (Dec. 31, 2020) (unpublished manuscript) https://ssrn.com/abstract=3757854 [https://perma.cc/8WFK-XMM4] (summarizing in the Abstract that the paper finds "robust evidence that the COVID-19 death ratio and infection ratio are positively associated with income inequality, higher non-White/White residential segregation index, and higher percentage of adults aged 65 and below without health insurance").

[24] Indeed, many have pointed to the negative mental health effects of prolonged isolation as possibly more damaging than the actual virus itself. *See, e.g.*, Jennifer Rigby, *Is the Cure Worse than the Disease? The Hidden Harms of the COVID-19 Lockdowns*, TELEGRAPH (June 5, 2020, 12:00 PM), https://www.telegraph.co.uk/global-health/science-and-disease/cure-worse-disease-hidden-harms-covid-19-lockdowns/ [https://perma.cc/9FV4-67WS].

than one might expect.[25] The distributional effects of COVID-19, considered in conjunction with the Goldilocks principle, may mean that society will see even lower levels of innovation from these groups in the short term, as they attempt to deal individually and in their communities with the fallout from the pandemic.

Some of the same holds true with respect to organizations. For instance, lockdown measures taken in response to the pandemic have created adverse conditions that are simply too intense, enduring, and all-encompassing for many parties to effectively cope with, let alone innovate their way out of. We have all heard stories of many restaurants necessarily shuttering their operations for lack of customers, and the mounting empirical evidence about COVID-19's impact on the restaurant industry looks grim.[26] While some restaurants were able to respond to the pandemic with innovation,[27] many others were likely too overwhelmed by the challenges precipitated by it to do so. Other small enterprises without the resources to effectively weather the COVID-19 storm have similarly suffered.[28] Even once thriving, large companies have succumbed to the adverse conditions that the pandemic has brought.[29] For many of these parties, the pandemic may have been the final straw that transformed the challenges they faced from possible innovation promoters to certain innovation killers.

Further, in addition to the cognitive impacts that severe adversity itself imposes,[30] there is increasing evidence that COVID-19 may have an even more direct effect on the ability of those infected with the virus to innovate due to the impacts of the virus on patients' brains. Reports from the medical community range

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[25] Plamondon Bair, *supra* note 10, at 554–56 (discussing the research demonstrating that members of poor and minority populations innovate at lower levels than those from more privileged populations).

[26] Colman Andrews, *Restaurants Closing: 35 of the Most Popular that Won't Reopen After the Coronavirus Pandemic*, USA TODAY (Aug. 13, 2020, 7:00 AM ET), https://www.usatoday.com/story/money/2020/08/13/the-35-most-popular-restaurants-that-wont-reopen-after-the-pandemic/42198639/ [https://perma.cc/C6VG-4CQT] (reviewing the pandemic's negative impacts on the restaurant industry, including the permanent closing of 57,000 restaurants).

[27] *See, e.g.*, Eve Turow-Paul, *How Restaurants Are Innovating During the COVID-19 Pandemic*, FORBES (Mar. 23, 2020, 9:00 AM EDT), https://www.forbes.com/sites/eveturowpaul/2020/03/22/how-restaurants-innovating-during-the-covid-19-pandemic/?sh=6cb59daf2c2b [https://perma.cc/JDB5-UD5K].

[28] *See* Alexander W. Bartik, Marianne Bertrand, Zoe Cullen, Edward L. Glaeser, Michael Luca & Christopher Stanton, *The Impact of COVID-19 on Small Business Outcomes and Expectations*, 117 PNAS 17656 (2020) (reviewing growing evidence of negative effects on small enterprises and their financial fragility).

[29] *See* Hank Tucker, *Coronavirus Bankruptcy Tracker: These Major Companies Are Failing Amid the Shutdown*, FORBES (Nov. 10, 2020, 3:00 PM EDT), https://www.forbes.com/sites/hanktucker/2020/05/03/coronavirus-bankruptcy-tracker-these-major-companies-are-failing-amid-the-shutdown/?sh=1d9448ce3425 [https://perma.cc/HV3T-7APN] (listing a number of major companies that have filed for bankruptcy during the pandemic).

[30] *See* Asay & Plamondon Bair, *supra* note 1, at 14–15.

from relatively common and minor neurological symptoms arising from an infection like the loss of taste or smell[31] to more concerning outcomes like long-lasting brain fog,[32] the possibility of cognitive decline after recovery,[33] and even psychosis in a small number of cases.[34] Even when cognitive capacity otherwise remains intact, some victims of COVID-19, so-called "long haulers," appear to suffer from a range of other long-term adverse effects, including extreme fatigue, and these effects may similarly inhibit innovative responses now and in the future.[35] Although it will be quite some time before the cognitive and other long-term effects of COVID-19 are fully understood, these preliminary reports suggest that the pandemic will have long term consequences for the collective potential of society to engage in innovative endeavors due to the significant drain on resources it has imposed on millions of people.[36]

Finally, another direct and severe effect of the pandemic on society's innovative potential may arise from the widespread disruption to education that has resulted from the closure of schools in response to the risk of infection. This adversity, which

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[31] *See, e.g.*, Xiangliang Chen, Sarah Laurent, Oezguer A. Onur, Nina N. Kleineberg, Gereon R. Fink, Finja Schweitzer & Clemens Warnke, *A Systematic Review of Neurological Symptoms and Complications of COVID-19*, 268 J. NEUROLOGY 392, 399 (2021).

[32] *See, e.g.*, Masoud Mardani, Editorial, *Post COVID Syndrome*, 15 ARCHIVES CLINICAL INFECTIOUS DISEASE e108819 (Sept. 13, 2020), https://sites.kowsarpub.com/archcid/articles/108819.html [https://perma.cc/MZK5-73QM].

[33] *See, e.g.*, Carrie Arnold, *The Link Between Delirium and Dementia*, 588 NATURE 22 (2020) (reporting on research exploring the relationship between the common COVID-19 symptom of delirium and an increased risk for dementia and cognitive decline); Gabriel A. de Erausquin, Heather Snyder, María Carrillo, Akram A. Hosseini, Traolach S. Brugha & Sudha Seshadri, *The Chronic Neuropsychiatric Sequelae of COVID 19: The Need for a Prospective Study of Viral Impact on Brain Functioning, Alzheimer's & Dementia*, J. ALZHEIMER'S ASS'N (Sept. 16, 2020) (proposing a research agenda to study the "key questions on the impact [of COVID-19] for risk of later life cognitive decline, AD, and other dementia").

[34] *See, e.g.*, Andrew Joseph, *When Covid-19 Hits the Brain, It Can Cause Strokes, Psychosis, and Dementia-like Syndrome, New Survey Shows*, STAT (June 25, 2020), https://www.statnews.com/2020/06/25/covid-19-brain-complications/ [https://perma.cc/9CS5-2S5P] (reporting the results of a survey of 125 hospitalized patients with COVID-19 and neurological complications, and finding that ten of those patients were newly diagnosed with psychosis).

[35] Sandi Dougton, *Many of the Earliest COVID 'Long-Haulers' Still Suffer; Seattle Researchers Are Trying to Figure Out Why*, SEATTLE TIMES (Jan. 25, 2021, 7:58 AM), https://www.seattletimes.com/seattle-news/health/nearly-a-year-on-many-of-the-earliest-covid-19-long-haulers-are-still-not-back-to-normal/ [https://perma.cc/X8RV-CDDD] (discussing other long-term effects for some COVID-19 victims, including extreme fatigue).

[36] In fact, one study, which has not yet completed the peer review process, suggests that infection with COVID-19 may age the brain up to ten years and result in an IQ drop of up to 8.5 points in some patients. Carolyn Crist, *Study Shows COVID-19 May Cause Brain Aging*, WEBMD (Oct. 29, 2020), https://www.webmd.com/lung/news/20201028/study-shows-covid-19-may-cause-brain-aging [https://perma.cc/NZ7P-PNTA].

has been severe for many,[37] has not only potentially reduced the current ability of students at all levels to innovate in classrooms and laboratories but may also have long-term negative consequences for societal innovation as important developmental windows for learning pass without appropriate education taking place.[38] As with the other forms of adversity introduced by COVID-19, there is increasing concern that these impacts will disproportionately impact already-vulnerable populations, thereby further increasing the likelihood that the Goldilocks principle will not be satisfied for these groups either in the short or long term and resulting in even lower levels of innovation from these groups.[39]

2. "Just Right" Intensity and Scope

On the flip side, one can also observe examples of the Goldilocks principle for intensity and scope being satisfied during COVID-19. For each person who has been significantly impacted by the pandemic, there are a number of people and organizations for whom the adversity appears to have been less severe and, in fact, has fallen in that sweet spot of duration, breadth, and intensity conducive to innovation.[40] For these people and organizations, the pandemic may have provided the appropriate motivation to engage in creative and innovative activities.

Indeed, society has experienced a surge in COVID-related innovation in response to the challenges the disease poses. Examples include the development of new types of protective gear and medical equipment, novel approaches to business operations, and even legal innovations designed to facilitate COVID-related

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[37] *See, e.g.*, *Adverse Consequences of School Closures*, UNESCO, https://en.unesco.org/covid19/educationresponse/consequences [https://perma.cc/H6G2-MZCN] (last visited Feb. 9, 2021) (listing some of the significant impacts of school closures on individuals, families, and communities, including social isolation, reduced access to healthcare, increased vulnerability of children to exploitation, decreased ability for caregivers to work due to childcare challenges and provide financially for their families).

[38] *See, e.g.*, Bruno V. Manno, *The Awful Economic Impact of School Closings*, REALCLEAR EDUC. (Oct. 9, 2020), https://www.realcleareducation.com/articles/2020/10/09/the_awful_economic_impact_of_school_closings_110485.html [https://perma.cc/2VNQ-PL5E] (citing an Organization for Economic Cooperation and Development (OECD) report estimating that the loss of learning and reduced individual skill level attributable to COVID-related school closures will result in a 1.5% loss of the U.S.'s future Gross Domestic Product, which represents a loss of 14.2 trillion 2020 U.S. dollars over the next 80 years).

[39] *See, e.g.*, *Adverse Consequences of School Closures*, *supra* note 37 (noting that the negative impact of school closures "is particularly severe for the most vulnerable and marginalized boys and girls and their families . . . exacerbat[ing] already existing disparities within the education system but also in other aspects of their lives").

[40] One survey of academic researchers, for example, found that the majority of researchers surveyed had not experienced any significant disruptions to their daily work and had been able to continue with most of their professional duties. Chantelle Rijs & Frederick Fenter, FRONTIERS PUB. HEALTH, *The Academic Response to COVID-19*, 5–6 (Oct. 28, 2020), https://doi.org/10.3389/fpubh.2020.621563 [https://perma.cc/33SQ-RSYG].

research.[41] Perhaps the most striking example of innovation in response to the pandemic is the research that has led to the development of a number of effective COVID vaccines on a timeline unprecedented for modern vaccine development.[42] This innovative response to the adversity imposed by COVID has not gone unnoticed, with a number of commentators discussing the ways in which the COVID pandemic has motivated and mobilized innovative communities.[43]

In the context of the vaccine developments in particular, we can see aspects of the Goldilocks principle in play. For instance, the disease has proved deadly enough to inspire action in the form of vaccine development, but not so deadly as to make responding to it practically impossible.[44] Furthermore, though the disease presents significant obstacles for individuals and organizations alike, those involved in creating the vaccines have found ways to collaborate and engage in unprecedented amounts of information sharing on their way to the development of several successful COVID-19 vaccines.[45] Hence, the disease's middling intensity and relative spatial discreteness (at least for some) have made it in some ways an ideal candidate for innovative solutions, though that is cold comfort for those that have suffered from it. Finally, even early on in the pandemic, promising signs emerged that the disease need not be an enduring plague, though many questions about the

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[41] Asay & Plamondon Bair, *supra* note 1, at 2–3.

[42] *See, e.g.*, Philip Ball, *The Lightning-Fast Quest for COVID Vaccines—and What It Means for Other Diseases*, 589 NATURE 16, 16 (2021) (discussing how the speedy rate of vaccine development in response to COVID has revolutionized the field by "challeng[ing] our whole paradigm of what is possible in vaccine development") (quoting Natalie Dean, Biostatistician at the University of Florida in Gainesville).

[43] *See, e.g.*, Goda Naujokaitytė, *COVID-19 Triggered Unprecedented Collaboration in Research*, SCI. BUS. (Jan. 12, 2021), https://sciencebusiness.net/covid-19/news/covid-19-triggered-unprecedented-collaboration-research [https://perma.cc/HFN3-CDKS] (summarizing the findings from a January 2021 report on Science and Technology by the Organisation for Economic Co-Operation and Development (OECD) that the pandemic has "further opened access to data and publications, increased the use of digital tools, enhanced international collaboration, spurred a variety of public-private partnerships, and encouraged the active engagement of new players").

[44] *See, e.g.*, Eskild Petersen, Marion Koopmans, Unyeong Go, Davidson H. Hamer, Nicola Petrosillo, Francesco Castelli, Merete Storgaard, Sulien Al Khalili & Lone Simonsen, Personal View, *Comparing SARS-CoV-2 with SARS-CoV and Influenza Pandemics*, 20 LANCET INFECTIOUS DISEASES e238, e238 (Jul. 3, 2020), https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(20)30484-9/fulltext [https://perma.cc/5DFV-6QC7] (discussing COVID-19's death and transmission rates and effective strategies for combating them).

[45] *E.g.*, Ian Le Guillou, *COVID-19: How Unprecedented Data Sharing Has Led to Faster-Than-Ever Outbreak Research*, HORIZON (Mar. 23, 2020), https://horizon-magazine.eu/article/covid-19-how-unprecedented-data-sharing-has-led-faster-ever-outbreak-research.html [https://perma.cc/3PK6-A2HU] (discussing some of these efforts).

disease's long-term prospects remain unanswered.[46] The pandemic was thus characterized by at least reasonably hoped-for temporal discreteness. That discreteness seems to have contributed to the massive dedication of resources aimed at eliminating the pandemic forever and as quickly as possible.[47]

C. Collective Nature and Consequences: Examples from COVID-19

One obvious example of both the collectiveness and severity principles motivating innovation is that many have deemed the consequences of not addressing the COVID-19 pandemic significant enough to undertake remarkable amounts of collective innovation to address the disease. These efforts include scientists, pharmaceutical companies, and governments around the world working together to develop, at a record pace, vaccines and other treatments for the disease.[48]

In particular, the widespread and shared nature of the COVID-19 pandemic—one would be hard-pressed to find an individual who has not been impacted by it in some way—can help explain why society has seen unprecedented amounts of collaboration and sharing of data by scientists in response.[49] Shared adversity increases cooperation,[50] and collaboration and data sharing are cooperative behaviors that do not always spontaneously occur in scientific and research settings. Indeed, a number of researchers have remarked on the surprising and unprecedented nature of the current levels of sharing and collaboration now taking place in COVID-related research.[51]

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[46] Michael Greshko, *COVID-19 Will Likely Be with Us Forever. Here's How We'll Live with It*, NAT'L GEOGRAPHIC (Jan. 22, 2021), https://www.nationalgeographic.com/science/2021/01/covid-19-will-likely-be-with-us-forever-heres-how-well-live-with-it/ [https://perma.cc/S6YA-XUWM] (suggesting that COVID-19 will never fully be eradicated, though ending the pandemic phase of the disease looks promising).

[47] *See* Jon Cohen, *The $1 Billion Bet: Pharma Giant and U.S. Government Team Up in All-Out Coronavirus Vaccine Push*, SCIENCE (Mar. 31, 2020, 5:50 PM), https://www.sciencemag.org/news/2020/03/1-billion-bet-pharma-giant-and-us-government-team-all-out-coronavirus-vaccine-push [https://perma.cc/6DZ4-BHDD] (discussing efforts by the U.S. government and the pharmaceutical industry to develop effective vaccines).

[48] *The Coronavirus Vaccines Were Developed in Record Speed. Now, the Hard Part*, Editorial, N.Y. TIMES (Dec. 9, 2020), https://www.nytimes.com/2020/12/09/opinion/coronavirus-vaccine-distribution.html [https://perma.cc/2JUC-RMG2].

[49] *See, e.g.*, Naujokaitytė, *supra* note 43 (summarizing the findings from a January 2021 report on Science and Technology by the Organisation for Economic Co-Operation and Development that the pandemic has led to "unprecedented global collaboration between scientists"; for example, the report found that a quarter of all COVID-19-related academic articles with a U.S. or Chinese co-author were co-authored with researchers from other countries, and that more than three quarters of COVID-19-related articles were published as open access, making them "freely available to other researchers").

[50] *See, e.g.*, Sun, *supra* note 12, at 1138.

[51] For a sense of the striking and unusual nature of the current level of academic sharing, see, e.g., Alvin Powell, *How Far Are We from a Vaccine? Depends on Who 'We' Is*, HARV.

Another clear example in the COVID-19 context of shared, consequential adversity increasing cooperation comes in the form of legal innovation. Jorge Contreras, Mark Lemley, and others created several legal instruments meant to enable parties to effectively donate their intellectual property rights to the fight against COVID-19.[52] Those that make the so-called Open COVID Pledge commit, depending on the license terms they sign up for, to forego enforcing certain of their intellectual property rights against those making use of those rights to diagnose, prevent, contain, or treat COVID-19.[53] This is no small matter. Intellectual property rights are often quite valuable, and companies are frequently quite protective of them for that and other reasons.[54] Despite that reality, many parties with highly valuable intellectual property portfolios have taken some form of the Open COVID Pledge, all in hopes of helping address the significant consequences that failing to address the shared adversity of COVID-19 would entail.[55]

The perceived severe consequences of inaction have also spurred massive investment by governments into the search for a solution to the pandemic. A report by the Organisation for Economic Co-Operation and Development (OECD), for example, found that national research funding organizations in countries for which data was available collectively spent about five billion dollars on COVID-19-related research funding in the first few months of the pandemic alone.[56]

GAZETTE (May 7, 2020), https://news.harvard.edu/gazette/story/2020/05/assessing-where-vaccine-efforts-stand-and-the-challenges-ahead/ [https://perma.cc/CJ8H-ZB2V] (quoting Harvard public health research professor and former dean of the Harvard T. H. Chan School of Public Health Barry Bloom as saying that he has "not seen anything like [the current level of sharing] in my entire career"); Matt Apuzzo & David D. Kirkpatrick, *COVID-19 Changed How the World Does Science, Together*, N.Y. TIMES (Apr. 14, 2020), https://www.nytimes.com/2020/04/01/world/europe/coronavirus-science-research-cooperation.html [https://perma.cc/H9ZV-4C6Y] ("While political leaders have locked their borders, scientists have been shattering theirs, creating a global collaboration unlike any in history. Never before, researchers say, have so many experts in so many countries focused simultaneously on a single topic and with such urgency.").

[52] *About Us*, Open COVID Pledge, https://opencovidpledge.org/about/ [https://perma.cc/UL4L-V5TT] (last visited Mar. 31, 2021); Matthew Bultman, *Scientists, Lawyers, Create Coronavirus IP Pledge*, BLOOMBERG LAW (Mar. 27, 2020, 3:52 PM), https://news.bloomberglaw.com/ip-law/scientists-lawyers-create-coronavirus-ip-pledge [https://perma.cc/L5RB-ZZTM] (detailing the effort by professors and others to create legal instruments that enable parties to donate their intellectual property rights).

[53] Bultman, *supra* note 52.

[54] Randy Sabett, *Protecting Your Company's Intellectual Property*, COOLEYGO, https://www.cooleygo.com/protecting-your-intellectual-property/ [https://perma.cc/8RTR-FXCH] (last visited Feb. 9, 2021) (detailing the value of intellectual property rights and ways to protect them).

[55] *See, e.g.*, Jorge Contreras, *Top Patent Holders Make Open COVID Pledge*, OPEN COVID PLEDGE (May 25, 2020), https://opencovidpledge.org/2020/05/25/top-patent-holders-make-open-covid-pledge/ [https://perma.cc/YCZ4-FJCE] (detailing some of the large companies that have dedicated their valuable intellectual property rights to the fight against COVID-19).

[56] Naujokaitytė, *supra* note 43.

Of course, on the flip side, a sizeable number of people have deemed that the severity of the pandemic is overblown[57] and that vaccines and other treatments are wasteful and even harmful in light of other pressing needs.[58] For instance, some have argued that COVID-19 poses minimal risk of death or other serious consequences for most of the population, and so society should simply let the disease run its course without completely disrupting day-to-day life.[59] Other countries, including Sweden, have at least partially followed this course.[60] Others believe that the vaccines are unsafe or are part of a conspiracy to track or otherwise harm people.[61]

This divide underscores an important point: even when adversity is collectively experienced, not all parties experiencing the adversity will share the same views about the consequences of leaving the adversity unaddressed. Some may not even recognize the adversity as reality. But to the extent that a majority view develops, that majority is likely to dictate society's collective response, even if the minority position affects or hinders the majority's innovative solutions to the problem. For instance, the vaccines developed in response to the COVID-19 pandemic may fall short of their potential when many people choose not to be vaccinated, even if they help address the disease for many.[62]

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[57] Amna Nawaz, *Why Do Some Americans Feel Pandemic Fears Are Overblown?*, PBS NEWSHOUR (Oct. 6, 2020, 6:50 PM EST), https://www.pbs.org/newshour/show/why-do-some-americans-feel-pandemic-fears-are-overblown [https://perma.cc/8GL9-5BGE].

[58] *10 Myths About the COVID-19 Vaccine that Aren't True*, HENRY FORD HEALTH SYS. BLOG (Dec. 21, 2020), https://www.henryford.com/blog/2020/12/vaccine-myths [https://perma.cc/659G-7WYP] (discussing opposition to the vaccine and why the concerns are not merited).

[59] *See, e.g.*, Joshua Cohen, *The Trump Administration Goes All In on Herd Immunity*, FORBES (Oct. 10, 2020, 8:43 AM EDT), https://www.forbes.com/sites/joshuacohen/2020/10/10/where-does-the-trump-administration-stand-on-herd-immunity/?sh=7a48324572f5 [https://perma.cc/N9B9-KRGU] (detailing the Trump Administration's promotion of pursuing herd immunity rather than implementing strict isolation policies).

[60] Misha Gajewski, *Stop Trying to Make 'Herd Immunity' Happen: Sweden's Attempt at COVID-19 Herd Immunity Failed*, FORBES (Aug. 11, 2020, 7:20 PM EDT), https://www.forbes.com/sites/mishagajewski/2020/08/11/stop-trying-to-make-herd-immunity-happen-swedens-attempt-at-covid-19-herd-immunity-failed/?sh=3cf32fb541cb [https://perma.cc/3A9N-773J] (discussing this effort and explaining that Sweden implemented herd immunity and has had "higher rates of viral infection, hospitalisation and mortality compared with neighbouring countries").

[61] Jack Goodman & Flora Carmichael, *Coronavirus: Bill Gates 'Microchip' Conspiracy Theory and Other Vaccine Claims Fact-Checked*, BBC (May 29, 2020), https://www.bbc.com/news/52847648 [https://perma.cc/FUH9-4JQ9] (discussing a conspiracy theory that "the coronavirus pandemic is a cover for a plan to implant trackable microchips and that the Microsoft co-founder Bill Gates is behind it").

[62] *See, e.g.*, Philip Elliot, *Science Delivers the COVID-19 Vaccine. Too Bad Not Enough People Want It*, TIME (Dec. 4, 2020, 2:45 PM EST), https://time.com/5918040/coronavirus-vaccine-hesitancy/ [https://perma.cc/MR6L-TSP8] ("Back in May, 27% of Americans surveyed by Pew said they would either "probably" or "definitely" not get a COVID-19 vaccine when it comes online. By November, that number surged to 39%. Among the

Another important example of the severity and commonality principles at play concerns the long-term effects of COVID-19 and so-called "long haulers." As briefly discussed above, long haulers are people who have been infected with COVID-19 and continue to suffer the disease's effects months (and perhaps even years) after the initial infection.[63] Scientists and others have begun to monitor and study people suffering in this way and have also begun to study and speculate about the possible long-term effects for anyone that has been infected with COVID-19.[64] To the extent that serious long-term effects are shown to result in significant numbers of COVID-19 sufferers, it becomes more likely that society will respond to these realities with innovation because of the collective, serious nature of the ongoing adversity.

On the other hand, assuming that most people infected with COVID-19 fully recover and show no significant long-term effects, the small group of long haulers may be left in the dark. And this may be so in part because the adversity does not pose significant enough repercussions for enough people.[65] Consistent with the principles discussed above, innovation to address the problems faced by this minority thus becomes less likely, even if that outcome is unjust.

II. POLICY IMPLICATIONS

The COVID-19 pandemic and its role in both stimulating and hindering innovation has several important policy implications. In this Part, we briefly review some of the more important ones.

A. In the Face of Adversity: When Intellectual Property Rights May Be Unnecessary or Counterproductive

Predominant theories behind intellectual property laws, including patent, copyright, and trade secret laws, view each of these bodies of law—to varying degrees—as necessary to incentivize parties to undertake socially beneficial

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diehards who said they definitely would not participate in a vaccination regime, the number climbed from 11% to 18%.").

[63] *See supra* notes 31–36 and accompanying text; Anthony Komaroff, *The Tragedy of the Post-COVID "Long Haulers*,*"* HARV. HEALTH BLOG (Oct. 15, 2020, 2:30 PM), https://www.health.harvard.edu/blog/the-tragedy-of-the-post-covid-long-haulers-2020101521173 [https://perma.cc/LB5Q-8TEQ].

[64] *See* Francis Collins, *Trying to Make Sense of Long COVID Syndrome*, NIH DIRECTOR'S BLOG (Jan. 19, 2021), https://directorsblog.nih.gov/2021/01/19/trying-to-make-sense-of-long-covid-syndrome/ [https://perma.cc/84SX-PAPG] (finding that out of the "3,762 individuals who responded to the survey . . . 2,464 respondents reported COVID-19 symptoms lasting six months or longer").

[65] Some long haulers, in fact, already worry about this very dynamic playing out. Matt Reynolds, *COVID-19 Long-Haulers Want You to Know That They're Still Not Okay*, WIRED (Jan. 18, 2021), https://www.wired.co.uk/article/covid-19-long-haulers [https://perma.cc/JUF6-FGR7].

activities.[66] The thinking goes something like this: without rights in their intellectual creations, parties will be loath to create them in the first place because others can so readily replicate them at little or no cost. Intellectual property rights purportedly save the day by enabling developers of intellectual goods to prevent such low-cost copying. That ability, in turn, enables creators to recoup their costs of development and thus provides them with incentives to create.[67]

Yet the COVID-19 pandemic in particular, and the relationship of adversity to innovation more generally, suggests that adversity often stimulates innovation without the need for intellectual property rights as incentives. For instance, as discussed above, the shared adversity of the COVID-19 pandemic has led researchers the world over to widely share their research findings in hopes of helping address the global pandemic.[68] In such instances of widespread sharing, scientists have often eschewed credit or rights talk and instead focused on working toward solutions to the pandemic; intellectual property rights seem to be the last thing on their minds.[69] Others have sprung to action to develop solutions to pandemic-related problems, including, early on, a shortage of ventilators and other breathing equipment.[70] Furthermore, as discussed above, in many cases, parties have actually donated their intellectual property rights to the fight against COVID-19.[71] In all of these and many other cases, intellectual property rights do not appear to motivate the action. Rather, the shared adversity does.

This identification of adversity as a stimulator of innovation adds to an already rich literature highlighting significant areas of innovation that either lack formal

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[66] *See* Clark D. Asay, *Artificial Stupidity*, 61 WM. & MARY L. REV. 1187, 1198–1225 (2020) (reviewing these theories).

[67] Elizabeth L. Rosenblatt, *A Theory of IP's Negative Space*, 34 COLUM. J.L. & ARTS 317, 318 (2011) ("American intellectual property law is grounded in incentive theory.").

[68] Apuzzo & Kirkpatrick, *supra* note 51 (discussing how scientists all over the world have engaged in unprecedented levels of sharing research results).

[69] For a discussion of a successful effort to obtain pledges from intellectual property owners to forego enforcing their intellectual property rights against those pursuing solutions to the COVID-19 pandemic, *see* Jorge L. Contreras, Michael Eise, Arial Ganz, Mark Lemley, Jenny Molloy, Diane M. Peters & Frank Tietze, *Pledging Intellectual Property for COVID-19*, 38 NATURE BIOTECH. 1146 (2020), https://www.nature.com/articles/s41587-020-0682-1 [https://perma.cc/TYF3-Z6R9].

[70] Cristian Fracassi & Alessandro Romaioli, Opinion, *We Made Copies of Ventilator Parts to Help Hospitals Fight Coronavirus*, N.Y. TIMES (Mar. 22, 2020), https://www.nytimes.com/2020/03/22/opinion/ventilators-coronavirus-italy.html [https://perma.cc/VGL6-TVB8] (discussing the efforts of two Italian engineers to help fight coronavirus by creating ventilators and other breathing aids).

[71] *Open COVID Pledge Rolled Out to Make Patents and Other IP Available for COVID-19 Response*, NAT'L L. REV. (Apr. 21, 2020), https://www.natlawreview.com/article/open-covid-pledge-rolled-out-to-make-patents-and-other-ip-available-covid-19 [https://perma.cc/5XX3-EKGW] (reviewing key aspects of the Open COVID Pledge effort).

intellectual property protections[72] or otherwise do not appear to rely on them heavily.[73] We do not have space here to review this literature comprehensively. One of its main takeaways, however, is that norms, rather than formal intellectual property rights, are often a key driving force behind significant amounts of innovation.[74] For instance, in the world of stand-up comedy, comedians often rely on norms rather than intellectual property rights to protect their joke innovations and to encourage the creation of new jokes.[75] Over the last several decades, in the software world, norms of openness and sharing have often predominated over concerns about intellectual property rights, even among fierce commercial competitors.[76] This norms-based mode of innovation holds true with respect to many areas of adversity-inspired innovation, including specifically in the COVID-19 context: as discussed above, norms of sharing and mutual support in response to adversity have contributed to a number of innovations meant to address the COVID-19 pandemic, including with regards to vaccines and treatments.

This role of adversity in inspiring innovation may mean that, in such adverse conditions, intellectual property rights are not only unnecessary, but harmful. For instance, intellectual property rights are known to impose significant societal costs, including limiting access to intellectual goods.[77] These costs are necessary, the theory goes, because of what we discussed above: we fear that many societal goods will never be developed if their developers cannot recoup the costs of creation.[78] Yet as we have seen, in the context of COVID-19 and other adverse conditions, that theory simply is not true, at least in its entirety. Parties have rushed to develop vaccines and other solutions to COVID-19 problems, not necessarily because of the promise of rights, but because of the hope of a pandemic-free future. Admittedly, it is difficult to generalize this point too much because deciphering the motivations of millions of heterogeneous people and organizations the world over is impossible. But what seems absolutely clear is that, without the global pandemic, many, perhaps most, of the innovations that we have seen developed would not have come about, intellectual property rights notwithstanding.

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[72] *See generally* Kal Raustiala & Christopher Sprigman, *The Piracy Paradox: Innovation and Intellectual Property in Fashion Design*, 92 VA. L. REV. 1687, 1764 (2006) (discussing IP's "negative spaces," or areas of significant innovation where formal intellectual property protections do not play a role).

[73] *See generally* Dotan Oliar & Christopher Sprigman, *There's No Free Laugh (Anymore): The Emergence of Intellectual Property Norms and the Transformation of Stand-Up Comedy*, 94 VA. L. REV. 1787 (2008) (arguing that intellectual property law is an ineffective means of promoting stand-up comedians' creativity and that social norms provide a substitute for such protections).

[74] *Id.*

[75] *Id.*

[76] For a brief review of the open source software movement, see Clark D. Asay, *A Case for the Public Domain*, 74 OHIO ST. L.J. 753 (2013).

[77] Mark A. Lemley, *Property, Intellectual Property, and Free Riding*, 83 TEX. L. REV. 1031, 1059–65 (2005) (reviewing some of these costs).

[78] *Id.* at 1060.

This putative lack of necessity of intellectual property rights for innovation in response to crisis becomes all the more troubling if the known social costs of intellectual property rights limit the innovations' impact in solving the very problems brought on by that crisis. For instance, if vaccines developed in response to COVID-19 are subject to patent rights, those patents can be wielded to raise the price of those vaccines and thereby limit access to them.[79] Therefore, the end result may be that fewer people get vaccinated, and the pandemic-induced solution does not solve the problem as thoroughly as it otherwise might. Other pandemic-induced innovations may similarly fail to reach their potential in solving pandemic-induced problems when proprietary rights get in the way. Indeed, even when parties pursue an innovation for reasons having nothing to do with the promise of intellectual property rights, the presence of those rights often distorts such parties' motivations later on, resulting in an assertion of rights that ultimately inhibit society's access to helpful innovations.[80]

Of course, the role of intellectual property rights can certainly be more nuanced than meets the eye, even when adversity is the primary stimulant to some innovation. For instance, though the current pandemic pushed a host of researchers and companies to pursue safe and effective vaccines at record speeds, intellectual property rights in the form of patents may still be vital to success on that front.[81] After all, large pharmaceutical companies such as Pfizer still need the ability to recoup some of their billions of dollars spent developing, manufacturing, and distributing vaccine dosages the world over.[82] Indeed, pharmaceutical companies are the poster child for supporters of strong patent rights because, it is argued, these companies would never invest the billions of dollars it takes to develop life-saving products without patent protections in place.[83] In other cases of adversity-inspired innovation, too, it may be that intellectual property rights, by providing innovators a means by which to recoup their costs of development and distribution, play an important role in parties pursuing innovation meant to help solve adversity-induced problems.[84] Indeed, commentators have frequently argued that intellectual property

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[79] Aisling McMahon, *How Patents Will Affect Pandemic Vaccines and Treatments*, RTE (July 3, 2020, 4:06 PM), https://www.rte.ie/brainstorm/2020/0702/1150969-patents-coronavirus-vaccines-medicine-ireland/ [https://perma.cc/M8C8-NX4D].

[80] Clark D. Asay, *Patent Schisms*, 104 IOWA L. REV. 45 (2018) (discussing this phenomenon in the patent context).

[81] For an opinion along these lines, see Thomas Cueni, *The Risk of Suspending Vaccine Patent Rules*, Opinion, N.Y. TIMES (Dec. 10, 2020), https://www.nytimes.com/2020/12/10/opinion/coronavirus-vaccine-patents.html [https://perma.cc/8ZF6-CF7D].

[82] *See* Henry Grabowski, *Patents, Innovation and Access to New Pharmaceuticals*, 5 J. INT'L ECON L. 849, 852–53 (2002) (reviewing some of the literature claiming that patents are particularly important in the pharmaceutical industry's ability to recoup costs allowing them to innovate, grow, and prosper).

[83] *Id.* at 850–53.

[84] Aude S. Peden & Antoinette F. Konski, *Coronavirus Innovation Guideposts on the Eve of the COVID-19 Pandemic*, NAT'L L. REV. (July 30, 2020),

rights, even when they are not crucial to incentivizing parties to create things, are vital to incentivizing further development, distribution, and commercialization of those creations.[85] In the COVID-19 context, it may be the case that many parties moved to action by the pandemic would be unable to continue pursuing their innovations without intellectual property rights as a means of recouping their investment and commercialization costs.

But, as others have long pointed out, in many cases, intellectual property rights are not the only, or even the best, means by which to enable developers of intellectual goods to recoup their costs of development and commercialization.[86] Another option is direct government funding, including government payments, grants, prizes, tax breaks, and other types of subsidies.[87] In fact, when what is needed to address a problem is generally known, these types of funding mechanisms are often preferable to intellectual property rights because development and distribution of the solution can be more precise, whereas intellectual property rights and the market leave solutions susceptible to market pressures and attendant distortions.[88] We can see these principles at play in the case of COVID-19, where one of the most needed solutions is one or more effective vaccines. Governments have responded by directly paying significant amounts for vaccine development and distribution, though more may be needed.[89]

Intellectual property rights may be a particularly bad fit for COVID-19 vaccine development and distribution for other reasons as well. First, patents typically take years to obtain and enforce, whereas the timeline for developing and distributing

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https://www.natlawreview.com/article/coronavirus-innovation-guideposts-eve-covid-19-pandemic [https://perma.cc/Q75J-X28B] (highlighting the fact that patent applications relating to coronaviruses skyrocketed once the COVID-19 outbreak occurred).

[85] Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265, 267 (1977) (discussing prospect theory as it applies to the patent system and its effects on innovation). *See generally* Ted Sichelman, *Commercializing Patents*, 62 STAN. L. REV. 341 (2010) (discussing commercialization and its significant importance within the patent system); Jonathan M. Barnett, *Copyright Without Creators*, 9 REV. L. & ECON. 389 (2013) (discussing the importance of copyright as a means of encouraging distribution and commercialization of copyrighted works).

[86] *See generally* Daniel J. Hemel & Lisa Larrimore Ouellette, *Beyond the Patents–Prizes Debate*, 92 TEX. L. REV. 303 (2013) (discussing some of these alternatives such as prizes, grants, and tax incentives and the rich existing literature about each).

[87] *Id.*

[88] *Id.* at 317–26 (comparing the use and applicability of patents, prizes, grants, and R&D tax incentives in practice).

[89] *See, e.g.*, Karen Weintraub & Elizabeth Weise, *Federal Spending on COVID-19 Vaccine Candidates Tops $9 Billion, Spread Among 7 Companies*, USA TODAY (Aug. 10, 2020, 9:32 AM ET), https://www.usatoday.com/story/news/health/2020/08/08/feds-spending-more-than-9-billion-covid-19-vaccine-candidates/5575206002/ [https://perma.cc/YT8W-EW7W] (detailing the significant amount of investment from the U.S. government in vaccine development).

COVID-19 vaccines has proven to be much shorter.[90] Hence, direct government action, rather than leaving matters to market forces, is perhaps the only real solution, in part because solely relying on intellectual property rights for recoupment purposes is simply too delayed and uncertain. Second, as Qiwei Claire Xue and Lisa Larrimore Ouellette have argued, vaccines are generally subject to significant underinvestment because they are not as profitable as repeat-purchase treatments.[91] Because of this, significant amounts of direct government funding are likely necessary to encourage the development of effective COVID-19 (and other) vaccines, and we have seen this borne out by the involvement of governments the world over in underwriting COVID-19 vaccine development and distribution. This latter point also highlights the need for greater amounts of funding for basic research to lay a scientific foundation for vaccines and other solutions that market forces may otherwise leave underdeveloped. We take up this discussion further in the next Section.

Of course, developers of such vaccines may still wish to patent the technologies for future uses and profits; vaccine technologies developed during the COVID-19 pandemic, after all, may prove useful in future crises. In fact, the mRNA technology behind several of the COVID-19 vaccines is the first successful application of that technology as part of a vaccine, as much of it was developed and patented as part of earlier research efforts.[92] Furthermore, outside of the vaccine context, it is not entirely clear what other specific innovations would be worthwhile and helpful in responding to the pandemic. In such cases, leaving things to market forces rather than direct government intervention may be the most prudent approach, though, as discussed above, intellectual property rights are not the only means for incentivizing private action. But for at least some parties, they may remain an important one.

B. Counteracting Harmful Path Dependencies by Funding Basic Research

While adverse conditions may stimulate innovation in the short term, leading to the various implications for intellectual property policy discussed above, the long-term effects of the adversity on innovation pathways should not be overlooked. In particular, innovation that arises in response to adversity will almost certainly lead to path dependencies that impact future research efforts, for good or ill. While path dependencies are not good or bad in and of themselves, and indeed may send society down productive paths as well as addressing immediate adverse conditions, there is a possibility that these path dependencies could lead to suboptimal innovation outcomes in the long term and leave society vulnerable to future crises.

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[90] *See* Dennis D. Crouch, *Nil: The Value of Patents in a Major Crisis Such As an Influenza Pandemic*, 39 SETON HALL L. REV. 1125 (2009) (making this argument).

[91] Qiwei Claire Xue & Lisa Larrimore Ouellette, *Innovation Policy and the Market for Vaccines*, 7 J.L. & BIOSCIENCES 1 (2020).

[92] *See* Damian Garde, *The Story of mRNA: How a Once-Dismissed Idea Became a Leading Technology in the Covid Vaccine Race*, STAT (Nov. 10, 2020), https://www.statnews.com/2020/11/10/the-story-of-mrna-how-a-once-dismissed-idea-became-a-leading-technology-in-the-covid-vaccine-race/ [https://perma.cc/U8KD-3HGQ].

The idea behind path dependency is relatively intuitive. When parties focus their efforts on specific products, knowledge, and routines, those efforts influence future innovation choices.[93] In a sense, parties become locked in by their previous research efforts because it is more efficient and profitable to continue moving in the same general direction while adopting the same general norms and approaches.[94] These locked-in trajectories may present no problems for, and indeed may benefit, future innovation. However, there is also a real possibility that they may lead to suboptimal innovation outcomes because the innovation that takes place is not the most socially beneficial,[95] other important areas of research are left un- or under-explored,[96] the approaches adopted are not the most efficient,[97] or some combination of all of these.

In the context of COVID-19, the potential long-term effects on future research precipitated by the pandemic are already making themselves felt, with potential positive and negative implications for innovation. On the positive side, there is significant optimism that the pandemic has instigated lasting beneficial changes, both in how researchers approach their work and how the resulting innovations reach the public. For example, an OECD report on the effects of COVID-19 on academic research notes that the pandemic has "further opened access to data and publications, increased the use of digital tools, enhanced international collaboration, spurred a variety of public-private partnerships, and encouraged the active engagement of new players," and predicts that these developments will lead to long-lasting changes and speed a transition to a more open, collaborative global scientific community.[98] As one researcher approvingly noted, these changes are "pretty cool, right? You cut the crap, for lack of a better word, and you get to be part of a global enterprise."[99]

Furthermore, all the attention on vaccines in the short term may help address the longstanding problem of underinvestment in vaccine technologies going

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[93] *See, e.g.*, Rod Coombs & Richard Hull, *'Knowledge Management Practices' and Path-Dependency in Innovation*, 27 RSCH. POL'Y 237, 237 n.4, 242–43 (1998) (discussing the characteristics of path dependency).

[94] *See, e.g.*, Zachary Liscow & Quentin Karpilow, *Innovation Snowballing and Climate Law*, 95 WASH. U. L. REV. 387 (2017); Stephanie Plamondon Bair & Laura Pedraza-Fariña, *Anti-Innovation Norms*, 112 NW. U. L. REV. 1069, 1074 (2018) (discussing how norms that influence the way innovation proceeds arise and are perpetuated in scientific and innovative communities).

[95] *See, e.g.*, Liscow & Karpilow, *supra* note 94 (discussing how path dependencies in climate technologies result in more innovation occurring in dirty technologies than clean technologies).

[96] *See id.* at 415, 440 n.184.

[97] Plamondon Bair & Pedraza-Fariña, *supra* note 94, at 1074; Stephanie Plamondon Bair, *Innovation's Hidden Externalities*, BYU L. REV. (forthcoming 2021) (on file with author).

[98] ORG. FOR ECON. COOP. & DEV., OECD SCIENCE, TECHNOLOGY AND INNOVATION OUTLOOK 13 (2021), https://www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-innovation-outlook-2021_75f79015-en [https://perma.cc/CN7T-TDTX] [hereinafter OECD OUTLOOK].

[99] Apuzzo & Kirkpatrick, *supra* note 51.

forward. As discussed above, because vaccines are not as profitable as repeat-purchase items, they are sometimes neglected in research and development efforts.[100] However, the substantial investment in vaccine technologies spurred by the pandemic may lead to extensions of those efforts in the future that significantly benefit society.[101]

On the bureaucratic end of the equation, the comparatively nimble governmental and regulatory responses to COVID-19 across the globe in facilitating clinical trials and approving treatments have also been seen by many as the first step toward a future where this efficiency is the norm rather than the exception.[102] Of course, the extent to which these promising developments will lead to true path dependencies that change the way science is done and the resulting innovation is disseminated remains to be seen. However, many policy analysts and scientists believe that these changes are predictive of future trajectories rather than isolated responses.[103]

We have seen similar innovations in the private sector, where many companies have, out of necessity, become more efficient and nimbler or repurposed their operations significantly in order to survive the pandemic's lashings. For instance, some predict that innovations in workspace arrangements, remote communications, and delivery services that the pandemic spurred will outlast it and prove fruitful going forward.[104] Other companies have successfully pivoted their businesses to take

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[100] Xue & Ouellette, *supra* note 91.

[101] *See, e.g.*, Jillian Kramer, *How COVID-19 Vaccines May Lead to New Shots for Other Deadly Viruses*, NAT'L GEOGRAPHIC (Jan. 29, 2021), https://www.nationalgeographic.com/science/2021/01/how-covid-vaccines-may-lead-to-new-shots-for-other-deadly-viruses/ [https://perma.cc/MG32-ED8Z] (discussing how technologies behind COVID-19 vaccines may help address other deadly diseases).

[102] *See, e.g.*, Apuzzo & Kirkpatrick, *supra* note 51 (quoting an Italian researcher's characterization of the "normally laborious" governmental approval process for a potential COVID-19 treatment, which took only ten days, as "a lesson for the future"); Ball, *supra* note 42 (quoting Dan Barouch, director of the Center for Virology and Vaccine Research at Harvard Medical School in Boston, who notes that the COVID response "has shown that the development process can be accelerated substantially without compromising on safety").

[103] *See, e.g.*, OECD OUTLOOK, *supra* note 98 (noting that many of the changes to the way science is done resulting from the COVID-19 pandemic are merely an acceleration of existing trends and trajectories); Ball, *supra* note 42 ("The COVID-19 experience will almost certainly change the future of vaccine science.") (reporting on an interview with Dan Barouch).

[104] Joe Guszkowski, *4 Trends Defining Delivery During COVID-19*, RESTAURANT BUS. (Aug. 4, 2020), https://www.restaurantbusinessonline.com/operations/4-trends-defining-delivery-during-covid-19 [https://perma.cc/6PWL-EMS8] (discussing delivery services and their improvements during COVID-19 and the likelihood of those services outlasting COVID-19); Philippa Fogarty, Simon Frantz, Javier Hirschfeld, Sarah Keating, Emmanuel Lafont, Bryan Lufkin, Rachel Mishael, Visvak Ponnavolu, Maddy Savage & Meredith Turits, *Coronavirus: How the World of Work May Change Forever*, BBC, https://www.bbc.com/worklife/article/20201023-coronavirus-how-will-the-pandemic-

advantage of and survive the pandemic's economic tumult. In many cases, those altered operations are helping ensure both short-term survival and long-term growth opportunities.[105] These positive innovations may spur further developments in these and other areas, and those developments may very well continue to benefit society going forward.

On the flip side, however, there is also a very real possibility that many of these COVID-19-induced innovations will have negative long-term impacts on innovation. One of these impacts may be a sustained overinvestment in biomedical research, to the detriment of other crucial areas of interest. For example, a *New York Times* article reports that currently, "[n]early all [non-COVID-related] research has ground to a halt," and that "[a]s a practical matter, medical scientists today have little choice but to study the coronavirus if they want to work at all."[106] This is partly due to lockdowns and work-from-home restrictions,[107] but it is also due to a diversion of research funding from other areas to COVID-related investigation.[108] Indeed, a recent survey of academic researchers published in a report by the Frontiers open access publisher shows significant concern among academics outside the biomedical community that there will be a sustained reduction in funds available to them due to such diversions.[109] That concern is not unfounded, as an OECD report on the effects of COVID-19 on academic research suggests. The report warns that the widespread engagement spurred by the pandemic "risks diverting research efforts indiscriminately away from non-COVID-19-related topics."[110] As scientists and laboratories reconfigure their priorities and research agendas to adjust to this new funding reality, path dependencies may, in turn, lead to a sustained move towards biomedical research and away from other areas of interest. Indeed, in the context of vaccine technology, path dependencies may swing the pendulum from underinvestment to significant overinvestment. While those investments may help address serious diseases, the excess may leave other important areas of innovation underexplored.

One crucial area of study that might suffer as a result of this potential shift is the field of environmental science. In the Frontiers survey of academic researchers, environmental and geological scientists expressed the greatest concern about losing

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change-the-way-we-work [https://perma.cc/38AQ-TN8S] (last visited Feb. 9, 2021) (discussing some of these dynamics).

[105] Mauro F. Guillén, *How Businesses Have Successfully Pivoted During the Pandemic*, HARV. BUS. REV. (July 7, 2020), https://hbr.org/2020/07/how-businesses-have-successfully-pivoted-during-the-pandemic [https://perma.cc/HA45-B3XV] (reviewing a number of companies and industries where parties have responded to the pandemic with successful innovations).

[106] Apuzzo & Kirkpatrick, *supra* note 51.

[107] *Id.*

[108] At a personal level, I am familiar with a biomedical researcher whose project came to a halt when her co-author, a lung specialist, diverted all of her attention to COVID-19. These types of anecdotes are common.

[109] Rijs & Fenter, *supra* note 40, at 18–23.

[110] OECD OUTLOOK, *supra* note 98.

future funding opportunities due to the COVID-19 pandemic.[111] This is significant because of a consensus in the academic community that climate change is one of the biggest threats facing society today, requiring an immediate and substantial response from both scientists and governments if it is to be properly addressed.[112] Indeed, some scientists have drawn parallels between climate change and the COVID-19 pandemic, suggesting that a similar coordinated global response is necessary to properly address the threats it poses,[113] threats that include leaving society more vulnerable to future pandemics.[114] But if path dependencies arising from increased investment in biomedical science lead to a subsequent dearth of resources for developing solutions to climate change, society will very likely suffer as a result.

The private sector's focus on innovation responsive to the pandemic may similarly result in ongoing innovation efforts that leave crucial areas of innovation underdeveloped. For instance, innovations in remote learning and communications that the pandemic has inspired may become so entrenched that companies continue iterating on those improvements while neglecting other innovation opportunities that promise greater improvements in learning, communications, or otherwise. Similarly, an overemphasis on improving and focusing on "last-mile" delivery services may cause companies to neglect other areas of operations that could benefit from innovative efforts.[115] Again, while iterating on all these pandemic-induced innovations may prove at some level fruitful, the focus on them may leave other important areas of innovation unexplored.

How might policymakers address the potential negative consequences of path dependencies resulting from the innovation community's response to COVID-19 and other adverse events? One possible solution lies in increased investment in basic research funding across a wide swath of fields.

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[111] Rijs & Fenter, *supra* note 40, at 23.

[112] *See, e.g.*, Post Opinions Staff, Opinion, *How We Can Combat Climate Change*, WASH. POST (Jan. 2, 2019), https://www.washingtonpost.com/news/opinions/wp/2019/01/02/feature/opinion-here-are-11-climate-change-policies-to-fight-for-in-2019/ [https://perma.cc/LNN7-5H8T] (quoting a 2018 report from the Intergovernmental Panel on Climate Change that a "rapid and far-reaching" response from scientists and governments was required to prevent the potentially catastrophic consequences of global warming); Rijs & Fenter, *supra* note 40, at 44, 46 (reporting that surveyed researchers reported climate change as a key threat that could nevertheless be addressed "with proper preparation").

[113] Rijs & Fenter, *supra* note 40, at 46 (quoting a surveyed researcher as being "more concerned about climate change than COVID-19. The pandemic was handled in such a manner—at least in European countries—that the actual threat was low for the majority of people. Similar drastic steps should be taken to prepare for much harder-to-control events, foremost climate change").

[114] *Id.* (reporting that surveyed researchers "warned that climate change will only increase the threat of new epidemics").

[115] *See, e.g.*, Sandy T. Melendez, *The Impact of Coronavirus on Last-Mile Delivery*, ALL THINGS SUPPLY CHAIN (Nov. 11, 2020), https://www.allthingssupplychain.com/the-impact-of-coronavirus-on-last-mile-delivery/ [https://perma.cc/FC6Q-MKVJ] (discussing how the pandemic has caused significant innovation in last-mile delivery services).

By maintaining a commitment to basic research across all fields, society avoids the problem researchers are currently foreseeing, where resources become diverted and monopolized by the needs of the moment, potentially leading, through path dependencies, to long-lasting lacunae in other areas that leave society vulnerable to future crises.

While some of these crises, like climate change, are foreseeable, many others are not. Because basic research, by definition, is practiced with no practical ends in mind,[116] it is particularly suited to developing a body of knowledge that may help prevent or mitigate a host of future unforeseen adverse events. Indeed, researchers have pointed out how the impressively fast response to developing a COVID-19 vaccine was made possible only by years of basic research that laid the scientific foundation for this endeavor.[117]

It is no surprise, then, that researchers surveyed about the effects of COVID-19 on their profession primarily called for increased investments in basic research.[118] One surveyed researcher framed the path dependency problem and its solution in this way: "The continuous reduction of regular funding to the basic sciences can be [exacerbated] by reorienting funding to hot topics. The long-term solution is to strengthen regular funding so that, if such crises arise again, the scientific community is properly armed."[119]

Even before the current pandemic, "hot-topic" research had become the norm, not the exception. Indeed, responding to budget crunches, universities have increased pressure on their faculty researchers to focus their efforts on research that is more readily monetized, through patenting or the creation of commercial enterprises.[120] Our point is not that these types of endeavors lack merit or that researchers should not focus their efforts on immediate problems as well. Instead, it is simply to highlight the importance of basic research funding in preparing society to tackle both known and unforeseeable obstacles.

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[116] *See, e.g.*, Jeffrey Mervis, *Data Check: U.S. Government Share of Basic Research Funding Falls Below 50%*, SCIENCE MAG. (Mar. 9, 2017, 1:15 PM), https://www.sciencemag.org/news/2017/03/data-check-us-government-share-basic-research-funding-falls-below-50 [https://perma.cc/L9NG-UTGQ] (defining basic research as "activity aimed at acquiring new knowledge or understanding without specific immediate commercial application or use" in mind).

[117] Ball, *supra* note 42, at 16–18 ("The research that helped to develop vaccines against the new coronavirus didn't start in January" but rather "began at least 25 years ago, and RNA vaccines have benefited from 10–15 years of strong research. . . . [N]o amount of money will help [solve future crises] without a solid platform of basic science to build on.").

[118] Rijs & Fenter, *supra* note 40, at 24 (finding that the top request for policymakers from surveyed researchers was a greater investment in basic research).

[119] *Id.* at 21.

[120] *See* Brian J. Love, *Do University Patents Pay Off?: Evidence from a Survey of University Inventors in Computer Science and Electrical Engineering*, 16 YALE J.L. & TECH. 285, 329–33 (2014) (discussing the reasons universities and research faculty pursue patents).

C. Reforming Bayh-Dole to Minimize Harmful Implications for Innovation in Adversity

A discussion of intellectual property rights, basic research, and path dependencies would be incomplete without considering how the Bayh-Dole Act figures into the equation. Implemented in 1980, Bayh-Dole provides, among other things, for the patenting of inventions arising from federally funded research.[121] This change was made in part because of concerns that the research being performed with government money, primarily in university laboratories, was not being sufficiently commercialized.[122] Offering patent protection to inventions arising from this research was thought to be a way to incentivize the creation and marketing of useful inventions from the basic research being performed in federally funded university labs.[123]

Forty years later, the implications of Bayh-Dole for innovation policy have been widely debated.[124] While many have praised the Act's success in achieving its stated goal of increasing commercialization of university research,[125] others have argued that Bayh-Dole has contributed to deadweight loss,[126] interfered with productive scientific norms,[127] and stymied innovation by creating patent anticommons in certain areas.[128] For example, empirical work suggests that academic sharing norms suffer when university researchers plan to patent their findings, which they now increasingly do under Bayh-Dole.[129] Arti Rai and Rebecca

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[121] *See* 35 U.S.C. §§ 200–212 (2018).

[122] 35 U.S.C. § 200 (stating the statutory goal of "promot[ing] the utilization of inventions arising from federally supported research or development").

[123] *See* Lita Nelsen, *Identifying, Evaluating, and Reporting Innovative Research Developments at the University*, *in* UNDERSTANDING BIOTECHNOLOGY LAW 25, 26–27 (Gale R. Peterson ed., 1993).

[124] *See, e.g.*, Daniel J. Hemel & Lisa Larrimore Ouellette, *Bayh-Dole Beyond Borders*, 4 J.L. BIOSCI. 282–84 (2017) (describing the debate); Ian Ayres & Lisa Larrimore Ouellette, *A Market Test for Bayh-Dole Patents*, 102 CORNELL L. REV. 271, 272–75 (2017) (describing the debate).

[125] *See, e.g.*, Ayres & Ouelette, *supra* note 124, at 276–77 (stating that "[t]here is no question that university technology transfer can create enormous value and that the Bayh-Dole system is an improvement on the prior system of uncertain patent rights in government hands," and describing how "[t]he success of Silicon Valley can be attributed in part to Stanford's encouragement of faculty or students who wanted to commercialize inventions created with university resources; companies spawned include Hewlett-Packard, Cisco, Yahoo!, Sun Microsystems, and Google (for which Larry Page's web-crawling efforts at one point used almost half of Stanford's internet bandwidth)").

[126] *Id.* at 278–79.

[127] Arti Kaur Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 NW. U. L. REV. 77, 85–86 (1999).

[128] Arti K. Rai & Rebecca S. Eisenberg, *Bayh-Dole Reform and the Progress of Biomedicine*, 66 L. & CONTEMPORARY PROBS. 289, 297–98 (2003).

[129] Jeremy M. Grushcow, *Measuring Secrecy: A Cost of the Patent System Revealed*, 33 J. LEGAL STUD. 59, 75–79 (2004).

Eisenberg have argued that, in addition to spurring commercializable innovation, Bayh-Dole has led to a counterproductive surge in patenting of basic research in biotechnology, a properitization of the basic building blocks of science that risks impeding the advance of science by creating an anticommons that raises transaction costs and makes progress in the field more challenging.[130]

These potential unfortunate consequences of Bayh-Dole have implications for innovation in times of adversity. First is the concern about anticommons. If the increased patenting of basic research under Bayh-Dole does indeed lead to anticommons problems, there is a real danger that researchers will be less nimble in their ability to respond to various crises as they arise. Rather than focusing all of their efforts on finding solutions to a problem, they will instead be required to spend valuable time navigating the permissions necessary to do the work they would like to do. They may also be dissuaded from pursuing particular research agendas altogether.

The increased academic secrecy that has resulted from Bayh-Dole is also a particular concern for innovation in adversity. If researchers seeking to find solutions to adverse events do this work with an eye to patenting their findings, which has increasingly become the norm under Bayh-Dole, they may be less willing to share these findings with others. This is troubling because, as we have seen, the sharing of research results has been a critical factor in the speed and success of the scientific community's search for solutions to the COVID pandemic. Of course, as we discussed above, the pandemic likely spurred increased sharing behaviors, which may mitigate this concern somewhat—perhaps adversity itself, when it arises, will counter the detrimental secrecy norms triggered by Bayh-Dole. But the concern remains that university researchers will still be less willing to share and collaborate under Bayh-Dole than if they could not patent their findings.

Finally, there is another potential adverse effect of Bayh-Dole on research norms and basic research beyond incentivizing university labs to patent their basic research work (and to maintain secrecy while seeking to do so). Because of the increased focus on patenting in academic settings that Bayh-Dole has set in motion and university technology transfer offices have embraced and encouraged,[131] the Act may have initiated a shift in academic norms, however subtle, away from basic research and towards research that has clear commercial or practical application and is thus more easily patented.[132] And due to path dependencies, this shift in norms could lead to a long-term trend away from basic research and towards work that has

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[130] Rai & Eisenberg, *supra* note 128, at 291 ("Th[e] frenzy of proprietary claiming [of basic research in biotechnology] . . . [p]aradoxically . . . in the long run . . . may hinder rather than accelerate biomedical research.").

[131] For a discussion of the role university tech transfer offices have played in the patenting of university research subsequent to Bayh-Dole, *see* Mark A. Lemley, *Are Universities Patent Trolls?*, 18 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 611 (2008).

[132] *See, e.g.*, CONG. RSCH. SERV., RL32076, THE BAYH-DOLE ACT: SELECTED ISSUES IN PATENT POLICY AND THE COMMERCIALIZATION OF TECHNOLOGY 13 (Dec. 3, 2012) (stating a concern held by some experts that Bayh-Dole has led to "a greater emphasis on applied rather than basic research").

foreseeable applications. While that could be positive for responding to the immediate adverse events that threaten society, like climate change, it also risks leaving society vulnerable to future, unforeseen adverse events, events that, to be dealt with efficiently, will likely require a foundation of basic research for which the application is not yet clear.

These potential negative consequences of Bayh-Dole for responding to societal adverse events do not necessarily lead us to conclude that the Act should be jettisoned entirely. But they do offer an additional perspective on the costs and benefits of allowing federally funded research to be patented. Other scholars have proposed various reforms to the Bayh-Dole system that could alleviate some of these concerns. For example, Arti Rai and Rebecca Eisenberg argue that the National Institutes of Health should be given the power to prevent the patenting of some federally funded inventions, with the caveat that this power be used only in exceptional cases to prevent the patenting of the basic building blocks of science.[133] Ian Ayres and Lisa Larrimore Ouellette have proposed implementing a market test to determine whether a federally funded invention requires a patent to incentivize its commercialization.[134] The specific implications of Bayh-Dole for society's ability to respond nimbly and successfully to adversity strengthen the case for proposals like these.

CONCLUSION

In this Article, we have highlighted several characteristics of adversity that tend to promote innovation and others that often inhibit it. The basic takeaway is what we might call a Goldilocks principle: adversity that is either too intense or too mild, too fleeting or too enduring, too encompassing or too narrow, too severe or too insignificant, or too commonly shared or too isolated, is less likely to inspire innovation. Instead, adversity that is "just right," or somewhere in the middle of these extremes, stands the best chance of inspiring innovation, all else being equal. We then applied those learnings to specific examples in the COVID-19 context, illustrating instances of the pandemic both spurring and blocking innovative efforts.

That discussion has shed light on several possible policy implications. First, applying intellectual property rights to adversity-inspired innovations, including COVID-19 vaccines, may be unnecessary; and, worse, might actually stand in the way of those innovations solving the problems they were designed to address. Direct government funding is often a better route to helping fund adversity-inspired innovators, particularly when the wanted solution is well understood, as others have pointed out. Second, adversity-inspired innovation can result in path dependencies that both benefit and harm society in the future, and we point to a greater commitment to basic research funding as one means to help address those possible future harms. Finally, we join a chorus of others who have advocated for a reexamination of federal laws that allow for patenting of federally funded research.

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[133] Rai & Eisenberg, *supra* note 128, at 310.

[134] Ayres & Ouellette, *supra* note 124, at 301–04.

We believe this reexamination is important in light of the role that intellectual property rights may play in both inhibiting access to adversity-inspired innovations and entrenching negative path dependencies in research pathways. In particular, the focus on patenting federally funded research may frequently steer researchers away from basic research and its solutions to unforeseen societal problems.