TECHNOLOGICAL UN/EMPLOYMENT

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ABSTRACT

Rapid advances in automation and artificial intelligence threaten the fate of the human worker. Intellectual property plays a role in this transition—and it's not what we might expect. The conventional wisdom is that intellectual property is good for innovation *and* good for jobs. But this is not quite right. In reality, a significant subset of the innovations protected by intellectual property, from self-service kiosks to self-driving cars, are labor saving, and in many cases also labor *displacing*. They drastically reduce the need for paid human labor. Therefore, to the extent intellectual property is successful at incentivizing innovation, intellectual property also contributes to job loss—or, more specifically, to what this article terms "technological un/employment": the simultaneous creation *and* elimination of jobs resulting from technological change. The normative question is what to do about this. Several commentators have suggested using the tax system to slow down the pace of automation, and redistribute some of innovators' vast profits to displaced workers. This article yields another surprising insight: intellectual property law itself could be designed to effectuate similar goals. At the least, intellectual property rights are guaranteed to play a prominent role in society's current technological un/employment moment, both as part of the problem and as part of the solution.

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In [the year 2014], IP-intensive industries directly and indirectly supported 45.5 million jobs, about 30 percent of all employment.

U.S. Patent & Trademark Office, *Intellectual Property and the U.S. Economy*, 2016

We are being afflicted with a new disease of which some readers may not yet have heard the name, but of which they will hear a great deal in the years to come—namely, technological unemployment.

John Maynard Keynes, *Economic Possibilities for our Grandchildren,* 1930

I. Introduction

In 1589, William Lee visited Queen Elizabeth I, seeking a patent for his new stocking frame knitting machine. The machine's major benefit was that it could drastically reduce the number of hours spent hand knitting clothing and other cloth items. The Queen refused to grant the patent, observing,

> Thou aimest high, Master Lee. Consider thou what the invention could do to my poor subjects. It would assuredly bring to them ruin by depriving them of employment, thus making them beggars.

Lee thereafter failed to obtain a patent in France and again in England, when Elizabeth's successor James I also denied his patent for the same reason: automation of knitting would put

people out of work, and a patent to operate the technology would therefore be contrary to the public interest.[1]

Fast forward over four hundred years. The U.S. Patent & Trademark Office (USPTO) has just issued a report on the impact of intellectual property on the economy and workforce. According to the USPTO report, "IP-intensive industries"—defined as industries that rely heavily on intellectual property, including patents, trademarks, or copyrights[2]—create more jobs than other industries, and wages are 47% higher.[3] The report's conclusions, if true[4], appear to vindicate the views of many policymakers that functioning intellectual property laws "promote[] innovation" and "create jobs."[5]

Which story is right? Do intellectual property rights "create jobs"? Or do intellectual property rights "depriv[e] [people] of employment, thus making them beggars?" This article seriously considers this question, and seeks to bring the broader discussion of innovation's impact on human work into the intellectual property field.[6] The article's main insight is as

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[1] This story is documented in DARON ACEMOGLU & JAMES ROBINSON, WHY NATIONS FAIL 182-83 (2012).

[2] Trade secrets were not measured in the USPTO Report. Empirical studies on trade secrets are relatively rare for various reasons, not least of which because trade secrets are kept secret. *See* Michael Risch, *Empirical Methods in Trade Secret* Research in PETER S. MENELL & DAVID L. SCHWARTZ (EDS.), RESEARCH HANDBOOK ON THE ECONOMICS OF INTELLECTUAL PROPERTY LAW, VOL. II (2016).

[3] INTELLECTUAL PROPERTY AND THE U.S. ECONOMY: 2016 UPDATE, UPDATING INTELLECTUAL PROPERTY AND THE U.S. ECONOMY: INDUSTRIES IN FOCUS, 2012 ("USPTO REPORT"). *See also* Stuart Graham, Cheryl Grim, Alan Marco & Javier Miranda, *Business Dynamics of Innovating Firms: Linking U.S. Patents with Administrative Data on Workers and Firms*, U.S. CENSUS BUREAU, CENTER FOR ECONOMIC STUDIES (CES), July 2015 (finding "patenting firms, particularly young patenting firms, disproportionally contribute jobs to the U.S. economy.").

[4] The report's conclusions and methodology have been critiqued by several commentators. *See, e.g.,* Lisa Larrimore Ouellette, *Patent Experimentalism*, 101 VA. L. REV. 65, 121 (2015). For further discussion of this report, see Camilla A. Hrdy, *IP And Jobs*, WRITTEN DESCRIPTION, forthcoming 2018.

[5] In a representative quote, Senator Leahy stated to his colleagues that by strengthening the patent system, the Leahy-Smith America Invents Act of 2011 (AIA) would "create jobs, improve products and reduce costs for American companies and American consumers." Statement by Senator Leahy, March 8, 2011, 3 Patent Reform A Legislative History of the America Invents Act (William H. Manz ed., 2012).

[6] The impact of intellectual property on employment is rarely considered in the legal literature. Mark Lemley recently tackled a related issue: what is the role of intellectual property in producing artificial scarcity when technology effectively eliminates the cost of production? Lemley briefly considered the impact of "post-scarcity" technologies like 3D printing on employment. *See* Mark Lemley, *IP in a World Without Scarcity*, 90 N.Y.U. L. REV. 460, 511 (2015).

follows. Intellectual property may be partly responsible for job creation for people who work in IP-intensive industries such as software and robotics.[7] But a significant subset of the innovations protected by intellectual property, from self-service kiosks to self-driving cars, are labor saving, and in many cases also labor *displacing*, innovations. They drastically reduce the amount of labor required to complete a task.[8] These innovations, in turn, are partly responsible for what economists call technological unemployment: job loss resulting from technological change.[9]

Autonomous vehicles provide a striking example. Companies like Alphabet, Uber, and Tesla are competing feverishly to perfect "self-driving" vehicles that can drive and navigate without human drivers. These companies rely on intellectual property, such as patents and trade secrets, to achieve the excess rents of a right to exclude others.[10] The result is greater profits for owners of intellectual property covering self-driving vehicles, and higher wages for roboticists and engineers whose skills are necessary to generate this intellectual property.[11] But self-driving vehicles, if widely adopted, could spell the end of paid employment for taxi drivers, Uber drivers, truck drivers, and millions of other people whose jobs entail driving for a living. The threat to these workers' livelihoods is arguably one of the major social crises of the day.[12]

Are the intellectual property rights that helped give rise to self-driving vehicles in some sense *responsible* for these lost jobs? Are they in some sense *responsible* for the unequal division of rewards between, say, Uber—the owner of significant intellectual property relating to self-

[7] *See* USPTO REPORT, *supra* note 3, at 25-29 (listing the major industries identified as being "IP-intensive").
[8] I explain the difference between "labor saving" and "labor displacing" innovation in Part II.A.
[9] *See* citations in notes 24-27 *infra*.
[10] I explain intellectual property's right-to-exclude mechanism in Part III.B.
[11] *See* Part III.C.2.
[12] *See, e.g.*, Brishen Rogers, *The Social Costs of Uber*, 82 U. CHI. L. REV. DIALOGUE 85, 101 (2015).

driving vehicles[13]—and Uber drivers—the people whose jobs those same inventions will replace? Without overstating the causal relationship between intellectual property and innovation, I suggest that, at least at the margins, intellectual property facilitates technological unemployment and exacerbates the divide between the "have-jobs" and the "have-nots."[14]

Yet my point is not that innovation is bad for jobs. Hardly. It is that innovation is not *all good* for jobs. When legislators highlight intellectual property's "job creation" potential, they should be clearer that, like innovation itself, intellectual property's impact on employment is double-sided. Both sides of this process—what the article terms technological un/employment—must be considered in order to understand what is happening in the innovation economy, and intellectual property's role in this process.

The article proceeds in three parts. Part II lays out the current debate over innovation's impact on employment.[15] Drawing on substantial research by labor economists and economic historians[16], I explain the various mechanisms by which innovation is theorized to create jobs, which I call technological *em*ployment.[17] I then lay out evidence suggesting we are entering a new phase in which technological employment may be outpaced by technological *un*employment brought about by accelerating developments in artificial intelligence and automation.[18]

Part III explains the role of intellectual property in producing technological un/employment. There are two main effects. The first is the Incentive Effect, under which

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[13] For a complete list of Uber's patents, *see* Justia Patents, http://patents.justia.com/assignee/uber-technologies-inc?page=2 For further discussion of self-driving cars, see Part III.C.3.
[14] *See* Part III.C.
[15] *See* Part II.A.
[16] I am especially grateful to Professor James Bessen's historical research on the impact of automation on human work. *See* JAMES BESSEN, LEARNING BY DOING: THE REAL CONNECTION BETWEEN INNOVATION, WAGES AND WEALTH 71-134 (2015).
[17] *See* Part II.B.
[18] *See* Part II.C.

intellectual property magnifies existing market incentives to invent and commercialize labor displacing innovations. The second is the Distribution Effect, under which intellectual property exacerbates division between owners and generators of intellectual property, and the workers whom their innovations replace.[19]

Part IV asks what, if anything, policymakers should do differently in light of the connection between intellectual property and technological un/employment. I discuss several policy measures, ranging from bans, to a "robot tax," to a "job displacing patent bar."[20] At a normative level, I argue government should at least seek to redistribute some of the vast profits generated by labor displacing innovation, probably in the form of education and skills training programs to be administered at the state and local level.[21]

II. Technological Un/employment Defined

Technological un/employment is a word I have made up to refer to two sides of an economic phenomenon. On one side is "technological unemployment": the notion that new technologies that permit replacement of human labor with machines can generate unemployment.[22] The concern that technology has a negative impact on jobs has a long pedigree[23], and the phenomenon of technological unemployment has been widely studied in the

[19] *See* Part II.C. *See also* ERIK BRYNJOLFSSON & ANDREW MCAFEE, AGAINST THE MACHINE: HOW THE DIGITAL REVOLUTION IS ACCELERATING INNOVATION, DRIVING PRODUCTIVITY, AND IRREVERSIBLY TRANSFORMING EMPLOYMENT AND THE ECONOMY 39-47 (2011).
[20] *See* Part IV.A-C.
[21] *See* Part IV.C.
[22] *See* Joel Mokyr, Chris Vickers, & Nicolas L. Ziebarth, *The History of Technological Anxiety and the Future of Economic Growth: Is This Time Different?* 29 J. ECON. PERSP. 31, 31-50 (2015). *See also* JEREMY RIFKIN, THE END OF WORK: THE DECLINE OF THE GLOBAL LABOR FORCE AND THE DAWN OF THE POST-MARKET ERA 3, 81-89 (1995) (discussing concerns over automaton in the 1960s and 70s); MARTIN FORD, THE RISE OF THE ROBOTS: TECHNOLOGY AND THE THREAT OF A JOBLESS FUTURE 29-34 (2015) (discussing concerns over job loss as a result of technology in the 1960s and 70s).
[23] *See generally* Mokyr et al *supra* note 22, at 31-56.

realms of economics[24] and public policy.[25] But to my knowledge, all sophisticated thinkers on this topic recognize that there is another side to it, which I call "technological *em*ployment."[26] Technological employment term refers to the phenomenon—and specifically to the three main mechanisms—by which technology *creates* new work for humans, even as it takes away the old.[27] Technological un/employment is thus a term of art that I use throughout this article to encapsulate both of these phenomena.

To get a simple preview of how the two-sided process works, do a Google search for the term "self-driving car." Search for the phrase "self-driving car jobs." This will likely provide results for job postings in the field of self-driving car technology[28] and articles with titles like "Who's hiring for self-driving car jobs"?[29] Then do a Google search for the phrase "self-driving car kill jobs." This should provide a host of articles on the negative impact of autonomous vehicles on employment, and ideas for how to save the jobs of human drivers.[30]

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[24] *See, e.g.,* Carl Benedikt Frey & Michael A. Osborne, *The Future of Employment: How Susceptible Are Jobs To Computerisation?,* Oxford Martin School, University of Oxford, September 17, 2013, at 5-13 (discussing a long line of economics research on technology's impact on jobs).
[25] *See, e.g.,* DARRELL M. WEST, WHAT HAPPENS IF ROBOTS TAKE JOBS? THE EMERGING IMPACT OF ROBOTS ON EMPLOYMENT AND PUBLIC POLICY, CENTER FOR TECHNOLOGY INNOVATION AT BROOKINGS, October 2015.
[26] The phenomenon of "technological employment" is implicitly recognized in the vast literature on technological unemployment. *See, e.g.,* David Autor, *Why Are There Still So Many Jobs*, 29 J. ECON. PERSP. 3, 3-4 (2015) (discussing a variety of reasons why there are still jobs despite increasing improvements in automation). *See also, e.g.,* Lewis M. Andrews, *Robots Don't Mean the End of Human Labor,* THE WALL STREET JOURNAL, August 24, 2015, at A13 ("The invention of, say, the internal combustion engine put buggy-whip makers out of business, but it created many more jobs in the manufacture, advertising, sales and maintenance of automobiles.").
[27] *See* Part II.B.
[28] *Indeed: Google Self Driving Car Project Jobs*, https://www.indeed.com/q-Google-Self-Driving-Car-Project-jobs.html
[29] Marco della Cava, *Who's hiring for self-driving car jobs*, October 17, 2016, USA TODAY, https://www.usatoday.com/story/tech/news/2016/10/17/google-ford-not-only-names-self-driving-car-jobs/92315206/
[30] *See, e.g.,* Mark Fahey, *Driverless cars will kill the most jobs in select US states*, CNBC.COM, Friday, 2 September 2016; Jack Stewart, *Robot & Us: Self-Driving Trucks Are Coming To Save Lives and Kill Jobs*, WIRED, May 5, 2017.

How does this work? How is it that a single technology can have such a disparate impact on social welfare? This part of the article explains precisely how both sides of this process work. My hope is that, by reading this part, the reader will understand precisely what I mean when I say "technological un/employment" in Part III when I explain intellectual property's role in this process.

A. Labor Displacing Innovations

The driving force behind technological un/employment is "innovation." Innovation means a new idea or application of a new idea that generates "value." Value is usually measured in the form of higher profits.[31] These higher profits can be realized in one of two ways: either by generating some output (product or service) for which consumers are willing to pay, or by generating a new way to increase "productivity" (costs per output).[32] The first type of innovation is called a "product innovation."[33] Birth control, video games, and optical lenses are examples of product innovations.[34] The second type is called a "process innovation."[35] Using a printing press rather than human scribes and using robotic arms to manufacture furniture rather than human employees are both examples of process innovations. They drastically lower the cost of

[31] *See* Camilla A. Hrdy, *Patent Nationally, Innovate Locally*, 31 BERKELEY TECH. L. J. 1301, 1310-11 (2017) (discussing definition of innovation from the economic perspective).
[32] *See id.*
[33] A product innovation means the introduction of a new product or service, or a significant improvement on an existing product or service, for which consumers are willing to pay. CHRISTINE GREENHALGH & MARK ROGERS, INNOVATION, INTELLECTUAL PROPERTY, AND ECONOMIC GROWTH 4 (2010)).
[34] James Fallows, *The Fifty Greatest Breakthroughs Since The Wheel*, THE ATLANTIC, November 2013, at 7. Available at https://www.theatlantic.com/magazine/archive/2013/11/innovations-list/309536/
[35] A process innovation means the introduction of a process or method of operation that increases productivity (reduces the cost per output). GREENHALGH & ROGERS, *supra* note 33, at 9. Note that a process innovation does not have to be a technique or series of steps. As the Supreme Court noted in *Diamond v. Diehr* (1980), a process innovation can be made possible by a "labor saving machine" that allows a business to save labor and lower costs. *Diamond*, 450 U.S. at 182.

producing a certain output (writings and furniture, respectively)—in both cases because they require less time, money, and human labor.[36]

1. "Labor Displacing" Versus "Labor Saving"

Not all innovations reduce the need for human labor. They may possess advantages that have nothing to do with labor reduction. Anesthesia, invented in 1846, allowed doctors to alleviate pain during surgery. Its purpose was not to reduce the amount of labor it took to perform the surgery.[37] However, an important subset of innovations are "labor saving." Their primary purpose is to reduce the human labor required to complete a task.[38] Not all labor saving innovations are *labor displacing*. For instance, a chairlift, invented in 1936, carries skiers up a hill, saving them from having to climb up the hill on their own.[39] Unless skiers were previously paying other humans to carry them up the hill, the invention of the chairlift is labor saving without being labor displacing. It does not adversely affect the employment prospects of others. However, if the labor saved by the innovation would otherwise be performed by a *paid human worker*, then the innovation can be classified as labor displacing. It causes a significant reduction in the amount of paid human labor required to complete a task, and thus may lead to not-insignificant job displacement.[40]

2. The Role Of Automation

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[36] GREENHALGH & ROGERS, *supra* note 33, at 5, 16. Note that a process innovation can be tied up with a product innovation. For instance, using the printing press to facilitate copying of writings came hand in hand with a new product: printed books.
[37] Fallows, *supra* note 34, at 4.
[38] The Supreme Court has observed the existence and patentability of "labor saving" inventions several times. *See, e.g., Diamond v. Diehr*, 450 U.S. 175, 182 (1981) (discussing a "labor saving machine", "by which this process may be carried on with much saving of labor, and expense of fuel…") (quoting *Corning v. Burden*, 15 How. 252, 267–268 (1854)).
[39] http://skitheworld.com/2013/02/chairlift-invention/
[40] In Part IV.C.1., I discuss how courts and regulators might determine what is "labor displacing."

Many labor displacing innovations involve a particular type of technological development: automation.[41] Automation is a term of art that refers to using non-human technology, such as a machine, a robot, or an algorithm, to accomplish a task that would otherwise be carried out by a human.[42] The agent of automation need not be a robot that looks or functions like a human. It simply must, in an economic sense, "substitute" for a human in performing work.[43]

Automation is typically motivated by two interrelated factors: the desire to reduce the amount of human labor required to complete a task and thus lower costs; and the desire to achieve performance benefits, such as superior speed, accuracy, or quality.[44] For example, Oracle[45] is currently marketing what it calls an "Automonous Database," a software program that permits managing and updating a collection of information without human involvement.[46] As of this writing, the advertisement below is currently running on the front page of the print edition of *The Wall Street Journal*.[47]

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[41] *See* James Bessen, *How Computer Automation Affects Occupations: Technology, Jobs, and Skills* (October 3, 2016), Boston Univ. School of Law, Law and Economics Research Paper No. 15-49, at 7 (noting that "[a]utomation is not the only way that technology affects occupations[,]" but that automation can be particularly disruptive and likely to lead to job losses "because it reduces the labor needed to perform tasks.").

[42] *Id.* at 3 ("Automation of an occupation happens when machines take over one or more tasks, either completely performing those tasks or reducing the human labor time needed to perform them."); *see also, e.g.,* Raja Parasuraman et al., *A Model for Types and Levels of Human Interaction with Automation*, 30 IEEE TRANSACTIONS ON SYSTEMS, MAN AND CYBERNETICS (2000). *See also* Frey & Osborne, *supra* note 24, at 2, n. 1 ("We refer to computerisation as job automation by means of computer-controlled equipment.").

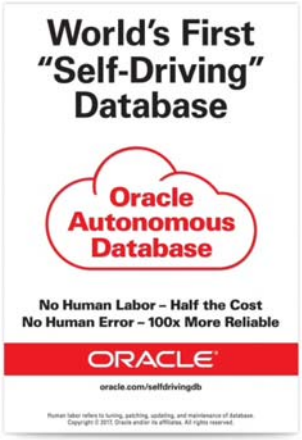
[43] Jack Balkin, *The Three Laws of Robotics in the Age of Big Data*, 78 OHIO STATE L.J. at 8-9 (2017) ("[R]obots, AI agents, and algorithms substitute for human beings. They operate as special purpose people.").

[44] MCKINSEY GLOBAL INSTITUTE, A FUTURE THAT WORKS: AUTOMATION, EMPLOYMENT, AND PRODUCTIVITY 11, (January 2017) ("The deployment of automation technologies [can] bring a range of performance benefits for companies [including but] not limited to, greater throughput, higher quality, improved safety, reduced variability, a reduction of waste, and higher customer satisfaction.").

[45] Oracle is one of the most profitable software companies in the world, based in Redwood Shores, California. http://www.oracle.com/us/corporate/oracle-fact-sheet-079219.pdf

[46] *See* https://www.oracle.com/database/autonomous-database/feature.htmland ("Oracle Autonomous Database Cloud eliminates complexity, human error, and manual management, helping to ensure higher reliability, security, and more operational efficiency at the lowest cost.").

[47] *See, e.g., The Wall Street Journal*, November 16, 2017, A1.



In this example, the express purpose of the "Self-Driving" Database is both to drastically lower the costs of human labor (by *half*, to be precise), and to obtain performance benefits such as greater reliability and improved security.[48] This is a labor displacing, not just a labor saving, innovation because it is performing work that would otherwise be done by paid human employees and, if successful, will encroach on jobs that humans would otherwise have, or at least make their skills less essential than they were before.

B. Technological *Em*ployment

When we look at the amount and pace of automation occurring around us, it is tempting to predict technology will inevitably spell the "end of work."[49] Yet even notoriously labor displacing technologies, from the spinning loom to the computer, have not eliminated all or even most jobs.[50] To the contrary, numerous economists have documented that most labor displacing innovations end up creating *more* work than they destroy.[51] I call this process "technological

[48] *Id.*
[49] *See* RIFKIN, *supra* note 22, at 3, 8-9 (predicting the end or near-end of manual labor in factories within the "next twenty to thirty years.").
[50] Autor, *Why Are There Still So Many Jobs?, supra* note 26, at 4 ("Clearly, the past two centuries of automation and technological progress have not made human labor obsolete[]…").
[51] *See id.* ("…[T]he employment-to-population ratio rose during the 20th century even as women moved from home to market; and although the unemployment rate fluctuates cyclically, there is no apparent long-run increase.").

employment." Below I identify the two main mechanisms discussed in the literature for how technological employment occurs.

1. Job Generation

The first mechanism of technological employment is job generation. Job generation refers to where an innovation creates new jobs—or, to put it more technically, creates demand for people with certain skills.[52] Pure job generation is like alchemy, creating jobs where there were previously none. The simplest example is invention of a totally new product (say, birth control or anesthesia) for which people are willing to pay. This drives demand for labor to make and distribute the product.[53] Job generation also is thought to have a "multiplier effect."[54] When people have jobs, they spend more money elsewhere in the economy, such as in the services sector, which in turn drives job generation in businesses like hair salons and restaurants.[55]

Things get more complicated when the innovation itself is labor displacing.[56] But even here there can still be job generation due to the fact that innovations tend to create "substitute" jobs to replace those they eliminate.[57] For example, the invention of the tractor reduced the need

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[52] By "job" I mean a bundle of tasks performed by people with similar sets of skills. Bessen, *How Computer Automation Affects Occupations*, *supra* note 41, at 9-10 (defining an occupation as a bundle of tasks that can be performed by people with similar skills and observing that tasks can be transferred from one occupation to another). *See also* CLAUDIA GOLDIN & LAWRENCE KATZ, THE RACE BETWEEN EDUCATION AND TECHNOLOGY 176-179 (2008) (discussing availability of new jobs as a result of inventions that permitted automation of some types of work like cash registers and tractors).

[53] *See* Vincent Van Roy, Daniel Vertesy & Marco Vivarelli, *Innovation and Employment in Patenting Firms: Empirical Evidence from Europe*, IZA DP No. 9147, June 2015, at 3 ("There is less debate about the positive employment effect of product innovations.").

[54] ENRICO MORETTI, THE NEW GEOGRAPHY OF JOBS 55-63 (2012) (discussing the "multiplier effect" associated with technology sector jobs).

[55] *See, e.g.*, David Autor and Anna Salomons, *Does Productivity Growth Threaten Employment?,* June 19, 2017, at 5 ("These spillovers are sufficiently large that they more than offset employment losses in industries making rapid productivity gains.").

[56] *See, e.g.*, BESSEN, LEARNING BY DOING, *supra* note 16, at 107-109 (discussing anticipated impact of ATM machines on bank tellers).

[57] *See, e.g.*, Bessen, *Don't Blame Technology for Persistent Unemployment*, SLATE, Sep. 30, 2013 (arguing that even if an innovation reduces jobs in one industry, it can offset these losses by generating "job growth in different occupations or industry segments"). *See also, e.g.,* Claire Cain Miller, *The Long-Term Jobs Killer Is Not China. It's*

for people to perform tasks that the tractor could do more efficiently, but also created demand for people with the skills necessary to manufacture, maintain, and operate tractors.[58] As I discuss in the next part, the job generation argument gets harder to make the better machines get at performing human tasks without assistance. For instance, Oracle's Automated Database can, says Oracle founder Larry Ellison, "automatically provision, patch, tune and back-up itself, *with no human intervention*."[59] But in theory, any new invention creates at least the possibility for new human tasks.

2. Demand-Boosting

The second mechanism of technological employment is what I call "demand-boosting."[60] Demand-boosting predicts that hiring in a given occupation or industry will *increase* as a result of labor saving innovations that permit more output at lower cost. As prices fall, consumption and demand increase, and demand for workers rises accordingly.[61] Demand-boosting usually occurs in conjunction with job generation. The idea is that both mechanisms occur at once. Demand for a company's output rises in response to increasing productivity and falling prices, *and* new or substitute jobs then emerge that need to be filled in order to meet that new demand.[62]

Automation, THE NEW YORK TIMES, Dec. 21, 2016, https://www.nytimes.com/2016/12/21/upshot/the-long-term-jobs-killer-is-not-china-its-automation.html ("Over time, automation has generally had a happy ending: As it has displaced jobs, it has created new ones.").

[58] *See* Derek Thompson, *How the Tractor (Yes, the Tractor) Explains the Middle Class Crisis*, March 13, 2012, *The Atlantic*, https://www.theatlantic.com/business/archive/2012/03/how-the-tractor-yes-the-tractor-explains-the-middle-class-crisis/254270/

[59] https://www.theregister.co.uk/2017/10/02/oracle_openworld_2017_larry_ellison_keynote_day_one/, emphasis added.

[60] GREENHALGH & ROGERS, *supra* note 33, at 268-69. Another term sometimes used is the "compensation theory." Van Roy et al, *supra* note 53, at 2 ("[T]he so-called 'compensation theory'… puts forward the view that process innovations lead to more efficient production and thus, assuming competitive markets, increasing demand and hence employment.").

[61] Bessen, *AI And Jobs: The Role Of Demand*, Boston University School of Law, Law & Economics Paper No. 17-46, at 2-3, forthcoming chapter in ECONOMICS OF ARTIFICIAL INTELLIGENCE (eds. Agrawal, Gans, and Goldfarb, 2018) "(If demand increases sufficiently, employment will grow even though the labor required per unit of output declines.").

[62] *See* discussion in Bessen, *How Computer Automation Affects Occupations*, *supra* note 41, at 3.

Several commentators cite the demand boosting theory in order to overcome fears that automation threatens the future of human work.[63] But does it really work? To test the theory, economist James Bessen performed a case study of the automated teller machine (ATM).[64] Adopted in the 1970s and 80s, we might think ATM's would eliminate the jobs of bank tellers. But Bessen found that, even though the ATM "took over cash handling tasks" and reduced work for human tellers, "the number of fulltime equivalent bank tellers has *grown* since ATMs were widely deployed during the late 1990s and early 2000s."[65] Bessen's explanation is that "the ATM allowed banks to operate branch offices at lower cost", which lowered the prices of, and increased demand for, banking services. This in turn "prompted [banks] to open many more branches" to meet the new demand, and led to hiring of bank tellers along with other related professionals, like people to install and fix ATM machines. This demand-boosting effect, Bessen concludes, "off[set] the erstwhile loss in teller jobs."[66]

C. Technological *Un*employment

Now for the dark side. Technological unemployment is defined as job loss brought about by technological change.[67] As by now is clear, the formula is not as simple as "automation destroys jobs." To the contrary, innovation *also* brings technological employment, explaining why, historically, innovation created more jobs than it destroyed.[68]

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[63] *See, e.g.*, Jerry Kaplan, *Don't Fear The Robots*, THE WALL STREET JOURNAL, Saturday/Sunday, July 22-23, 2017, at C3; Michael Jones, Yes, *The Robots Will Steal Our Jobs. And That's Fine. Those Jobs Will Be Replaced With New Ones*, THE WASHINGTON POST, February 17, 2016.
[64] Bessen, *How Computer Automation Affects Occupations, supra* note 41, at 1-4.
[65] *Id*. at 6 ("Indeed, since 2000, the number of fulltime equivalent bank tellers has increased … substantially faster than the entire labor force…").
[66] *Id*. *See also* BESSEN, LEARNING BY DOING, *supra* note 16, at 105-109.
[67] *See* definition in Mokyr et al, note 22 *supra*.
[68] *See, e.g.*, Autor & Salomons, *supra* note 55, at 1 ("[O]ver the 35+ years of data that we study, we find that productivity growth has been employment-augmenting rather than employment-reducing; that is, it has *not* threatened employment.").

However, prominent commentators, including "establishment" economists like former Treasury Secretary Lawrence Summers[69], have begun to cast doubt on whether what happened in the past will hold true in the future.[70] There are five distinct reasons to be worried that technological unemployment will begin to outpace technological employment.

1. The Increasing Quality And Pace Of Automation

For technological employment via job generation and demand-boosting to work, there must be tasks for humans to do. But if machines can do everything, it doesn't matter how many new tasks are generated or how much demand rises. Machines, not humans, would be the workforce of the future.

Commentators in the fields of economics, public policy, and journalism opine that machines are increasingly encroaching on human skills.[71] Robots (machines that resemble humans) are now capable of performing a range of tasks, from to driving a vehicle[72], to food

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[69] Lawrence H. Summers, *Keynote Address: Reflections on the Productivity Slowdown, Harvard University, Peterson Institute for International Economics*, Washington, DC November 16, 2015, https://piie.com/sites/default/files/publications/papers/transcript-20151116keynote.pdf, at 16-17. *See also* Eduardo Porter, *Contemplating The End of the Human Workhorse*, THE NEW YORK TIMES, Wednesday, June 8, 2016, at B1, B6 (discussing current debates among economists regarding 'end of work').

[70] For just a sampling of recent media articles expressing anxiety about technological unemployment, see, e.g., Nida Najar, *Tech Jobs Cut in India. A Reason? Technology*, THE NEW YORK TIMES, Monday, June 26, 2017, at B2; Rachel Abrams & Robert Gebeloff, *Another Blow For a Battered Work Force: E-Commerce Causes Retail Jobs to Dry Up in Old Steel Towns*, THE NEW YORK TIMES, Monday, June 26, 2017, A1; *Smarter Machines Cause Mass Unemployment*, THE ECONOMIST, http://www.economist.com/news/special-report/21700758-will-smarter-machines-cause-mass-unemployment-automation-and-anxiety; Robert C. Allen, *Lessons From History For the Future of Work*, NATURE 321-324, Oct. 19, 2017. *See also, e.g.,* BRYNJOLFSSON & MCAFEE, *supra* note 19, at 1-11; FORD, *supra* note 22, at xii.

[71] *See* BRYNJOLFSSON & MCAFEE, *supra* note 19, at 9 ("The pace and scale of this encroachment into human skills is relatively recent and has profound economic implications."); BRYNJOLFSSON & MCAFEE, THE SECOND MACHINE AGE 11 (2014) ("…computers, robots, and other digital technologies are acquiring ["ordinary" human skills and abilities] at an extraordinary rate."). *See also* ALEC ROSS, INDUSTRIES OF THE FUTURE 27-28 (2017) ("[T]he current moment in the field of robotics is very much like where the world stood with the Internet 20 years ago. …"). *See also, e.g.,* Steve Lohr, *A.I. May Underwhelm, but Before Long It May Overtake Expectations*, THE WALL STREET JOURNAL, Friday, December 1, 2017, at B3 ("[AI] It can probably do less right now than you think. But it will eventually do more than you probably think, in more places than you probably think, and will probably evolve faster than powerful technologies have in the past."). *See also* WEST, *supra* note 25, at 2-4 (discussing technology's growing capabilities in various fields).

[72] Part III.C

preparation[73], to milling steel[74], to testing electronics.[75] According to the Brookings Institute, there will be an estimated 1.9 million robots in commercial as of 2017, and robotics is expected to rise from a $15 billion sector now to $67 billion by 2025.[76]

And then there are the automation technologies that do not resemble humans at all. Drones, also called "unmanned aerial vehicles,"[77] can now perform a wide range of jobs formerly or still performed by humans: package delivery[78], going to war[79], crop-dusting[80], disaster aide,[81] and insurance claims inspection.[82] According to World Economic Forum, commercial drone sales are expected to rise from $2.5 million in 2016 to $7 million in 2020.[83]

The most influential form of automation comes simply from implementing algorithms on general purpose computers.[84] Quantifying algorithms' use in the economy is virtually impossible because they are used everywhere, with little transparency as to their function and capabilities.[85]

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[73] *See* Melia Robinson, *This robot-powered restaurant could put fast food workers out of a job*, BUSINESS INSIDER, June 30, 2016, http://www.businessinsider.com/momentum-machines-is-hiring-2016-6

[74] *See* Thomas Biesheuvel, *500,000 Tons of Steel. 14 Jobs. A mill in Austria shows how automation in steelmaking augues less employment—but better conditions*, BLOOMBERG BUSINESSWEEK, June 26, 2017, at 16 (describing a nearly deserted steel mill except for "three technicians who sit high above the line, monitoring output on a bank of flatscreens.").

[75] T-Mobile's custom-built phone-testing robot "Tappy" was part of a trade secret dispute when workers at Huawei stole Tappy's mechanical finger. *See, e.g., T-Mobile v. Huawei*, 2017 WL 951065 (W.D. Wash. Mar. 10, 2017).

[76] WEST, *supra* note 25, at 2.

[77] *Id.* at 6. On drones and privacy issues, see Margot Kaminski, *Drone Federalism,* 4 CAL. L. REV. CIRCUIT 57 (2013).

[78] Elizabeth Weizse, *Amazon delivered its first customer package by drone*, USA TODAY, Dec. 14,2016, https://www.usatoday.com/story/tech/news/2016/12/14/amazon-delivered-its-first-customer-package-drone/95401366/

[79] John Yoo, *Embracing the Machines: Rationalist War and New Weapons Technologies*, 105, CALIF. L. REV. 101 (2017); *but see* Rebecca Crootof, *The Killer Robots Are Here: Legal and Policy Implications*, 36 CARDOZO L. REV. 1837 (2015) (exploring legal implications of autonomous weapons systems including unclear liability).

[80] *See* marketing of "Spraying Drone" at http://sprayingdrone.com

[81] Ambulance drones are used to rapidly deliver defibrillators to people in cardiac arrest. *Drones To The Rescue*, THE NEW YORK TIMES, June 19, 2017, https://www.nytimes.com/2017/06/19/health/drones-by-air.html

[82] Nicole Freidman, *Drones Speed Up Insurance Claims*, THE WALL STREET JOURNAL, Saturday/Sunday, August 5-6, 2017, at B1.

[83] World Economic Forum, Future of Drones and Tomorrow's Airspace, https://www.weforum.org/projects/civil-drones-for-tomorrow-s-commerce

[84] WEST, *supra* note 25, at 4.

[85] *See* FRANK PASQUALE, THE BLACK BOX SOCIETY (2013).

But, if they work as advertised, computer algorithms now permit the near-total automation of a variety of tasks, such as internet searching,[86] data collection and analysis,[87] stock picking,[88] and designing investment strategies.[89] One program, called "Woebot" provides mental therapy (albeit probably not very well).[90]

The more disturbing piece of this story is the accelerating pace of improvements.[91] A major driver of this uptick is said to be "machine learning."[92] Machine learning permits automating complex, labor-intensive processes, from analyzing vast amounts of data to detecting skin cancer to detecting credit card fraud—without significant human involvement and with greater speed and accuracy than humans could ever achieve.[93] Progress in machine learning, Erik Brynjolfsson and Tom Mitchell write, permits "automating automation" itself.[94]

Even the act of inventing is no longer off limits.[95] IP-generating companies like Google are a big part of today's technological employment story.[96] But if machines can take on the role of inventing, these drivers of high-wage employment would go away.

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[86] Barry Schwartz, *How Google uses machine learning in its search algorithms*, SEARCH ENGINE LAND, October 18, 2016 (discussing Google's use of search algorithms to improve internet searching, both with and without human assistance), available at https://searchengineland.com/google-uses-machine-learning-search-algorithms-261158
[87] The Oracle autonomous database, mentioned above, is a compelling example. https://www.oracle.com/database/autonomous-database/feature.htmland
[88] Bailey McCann, *The Artificial-Intelligent Investor*, THE WALL STREET JOURNAL, Monday, November 6, 2017, at R13.
[89] *See* Hugh Son, *Robot Advisers Can Be Conflicted, Too*, BLOOMBERG BUSINESSWEEK, July 31, 2017, at 28-29.
[90] *See* Megan Molteni, *The Chatbot Therapist Will See You Now*, WIRED, June 7, 2017.
[91] *See, e.g.*, Tim Higgins, *Driverless Cars Pick Up Speed,* THE WALL STREET JOURNAL, January 9, 2018, at B4.
[92] Erik Brynjolfsson & Tom Mitchell, *What can machine learning do? Workforce implications*, 358 SCIENCE 1530, 1530 (2017).
[93] *Id*. at 1531.
[94] *Id*. *See also* Carnegie Mellon University News, *Machine Learning Will Change Jobs*, December 21, *2017,* https://www.cmu.edu/news/stories/archives/2017/december/machine-learning-study.html
[95] *See* Ryan Abbott, *I Think, Therefore I Invent: Creative Computers and the Future of Patent Law*, 1079 B. C. Law Rev. 1083–1091 (2016) (describing instances of computer-generated inventions). *See also* Camilla A. Hrdy, *Do Machines, And Women, Need A Different Obviousness Standard?* WRITTEN DESCRIPTION, November 12, 2017.
[96] Google is considered the top place to work in the country. It hires around 72,053 employees. *See Google: #1 on 100 Best Companies to Work For in 2017*, FORTUNE, http://fortune.com/best-companies/google/

Several empirical studies confirm that these technological improvements will impact the workforce. Scholars at the Oxford Martin School at University of Oxford estimate that *47 percent* of U.S. occupations "are potentially automatable over some unspecified number of years, perhaps a decade or two."[97] The Oxford Martin study finds jobs that are *least* likely to be automated include (to name a random sampling in the top twenty) recreational therapists, mental health and substance abuse workers, dietitians and nutritionists, physicians and surgeons, elementary school teachers, computer systems analysts, and anthropologists.[98] Those most likely to be automated include*, inter alia*, cashiers, order clerks, insurance claims processing clerks, library technicians (who shelve and organize books), tax preparers, cargo and freight agents, watch repairers, mathematical technicians, title examiners, and telemarketers.[99]

A McKinsey Global Institute report provides a more conservative assessment, predicting that although few entire occupations will be replaced in the near future[100], automation will "affect almost all occupations, not just factory workers and clerks, but also landscape gardeners and dental lab technicians, fashion designers, insurance sales representatives, and CEOs, to a greater or lesser degree[.]"[101] The report concludes, strikingly, that "as a rule of thumb, about *60*

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[97] Frey & Osborne, *supra* note 24, at 38, http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf *See also* TECHNOLOGY AT WORK V2.0: THE FUTURE IS NOT WHAT IT USED TO BE, CITI GPS: GLOBAL PERSPECTIVES & SOLUTIONS, January 2016, http://www.oxfordmartin.ox.ac.uk/downloads/reports/Citi_GPS_Technology_Work_2.pdf *See also* Sarah Nassauer, *Retailers Are Checking Out Automation,* THE WALL STREET JOURNAL, Thursday, July 20, 2017, at B3 (discussing results of Citi/Oxford study).

[98] Frey & Osborne, *supra* note 24, at 57.

[99] *Id*. at 71-72. *See also* Mark Whitehouse & Dorothy Gambrell, *How Screwed Is Your Job?,* BLOOMBERG BUSINESSWEEK, June 26, 2017, at 52-53 (summarizing Frey and Osborne data).

[100] MCKINSEY GLOBAL INSTITUTE, *supra* note 44, at 1 ("Given currently demonstrated technologies, very few occupations—less than 5 percent—are candidates for full automation today, meaning that every activity constituting these occupations is automated").

[101] *Id*. at 32.

percent of all occupations have at least 30 percent of activities that are technically automatable."[102]

"Technically automatable" is not the same as "will be automated." A variety of factors go into a business's decision to automate, besides just technological feasibility. The McKinsey report identifies *five* distinct factors that influence a business's decision to automate a particular task: (1) technical feasibility, (2) commercial feasibility, (3) supply and cost of human labor alternatives[103], (4) performance and cost benefits associated with using machines, and (5) regulatory hurdles or social inhibitions.[104] Thus, just because a labor displacing solution is technically possible does not mean businesses will choose to adopt it. Countervailing considerations, including availability of cheap human labor, reluctance to fire people, or concerns about reputational harm can sway businesses in the other direction.[105]

2. Limits To Demand As A Driver Of Technological Employment

Technological employment via demand-boosting relies on the idea that more productivity leads to lower prices leads to more consumption leads to more hiring. But the demand-boosting mechanism has inherent limits.[106] First, consumers' demand for products and services itself has limits. As Professor Bessen has discussed, the degree to which automation will boost employment depends on *how much a decrease in price actually enhances consumers' demand*

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[102] *Id*. (emphasis added).
[103] *Id*. at 10 (noting that an important factor is [t]he quality (for instance, skills), quantity, as well as supply, demand, and costs of human labor as an alternative affect which activities will be automated.").
[104] *Id*. at 10-12.
[105] *See id* at 10-11. The farming industry provides a compelling example of this fact. For some crops, the availability of cheap labor, not technological feasibility, is the major determinant of whether growers use machines at harvest or people. *See, e.g.,* Binyamin Applebaum, *With Fewer Immigrants, More Jobs? Not So, Economists Say*, THE NEW YORK TIMES, Friday, August 4, 2017, at A1.
[106] Jeremy Rifkin is quite skeptical of the "demand-boosting" argument, derisively calling it the "trickle down technology argument." RIFKIN, THE END OF WORK, *supra* note 22, at 15 ("The conventional economic wisdom is that new technologies boost productivity, lower the costs of production, and increase the supply of cheap goods, which, in turn, stimulates purchasing power, expands markets, and generates more jobs.").

for an output. While this mechanism works when consumers respond to decreases in price by buying more of the output (i.e. prices for the output are elastic), it does not work as well in more "satiated" markets like food or clothing, where decreasing the price doesn't lead people to buy more because they already have enough. In some industries, there could be a point at which demand and hiring begin to flatten out, despite falling prices due to automation.[107]

Another, closely related downward push on demand-boosting comes from the fact that "robots don't consume." Demand-boosting arguments implicitly rely on human consumers to drive demand for products and services. But if the quantity of human jobs that becomes automated continues to increase, more and more workers will be *robots*, not humans. Thus, there will be fewer and fewer humans with disposable income to spend and drive demand and further hiring.[108]

A final barrier to demand-boosting is that not all markets will see a decrease in prices just because technology becomes more efficient. A crucial assumption behind the notion that productivity lowers prices and leads to more buying and more hiring, is that markets are competitive, not monopolistic.[109] If barriers to entry—such as, for example, intellectual property—prevent competition from driving down prices and increasing output, this would

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[107] Bessen, *AI And Jobs: The Role Of Demand*, *supra* note 61, at 14-15; *see also id* at 7. *See also* Brynjolfsson & Mitchell, *supra* note 92, at 1533 (noting that "automation's impact on employment depends in part on the price elasticity of demand."); Autor, *supra* note 26, at 7 (discussing the limits to demand as the driver of employment).
[108] FORD, *supra* note 22, at 197; *see also* RIFKIN, THE END OF WORK, *supra* note 22, at 15-20 (making a similar argument); Brynjolfsson & Mitchell, *supra* note 92, at 1534 ("Automation may change the total income for some individuals or the broader population [and thus] change demand for some types of goods and the derived demand for the tasks needed to produce those goods.").
[109] *See, e.g.*, Bessen, *AI And Jobs: The Role Of Demand*, *supra* note 61, at 7 ("If we assume that rapid productivity growth generated rapid price declines *in competitive product markets*, then these price declines would be a major source of demand growth.") (emphasis added).

hinder demand-boosting still further.[110] Imagine that during the Industrial Revolution, when automated looms lowered costs and increased demand for items like clothing, intellectual property had permitted companies to keep prices high and to restrict output? Maybe the clothing industry would not have expanded as much, and hiring wouldn't have risen.[111]

3. Decreasing Quality of Remaining Human Work

Some commentators are skeptical of these fears. They contend the state of technology is not there yet, and that we should simply have faith that innovation will create new jobs we cannot yet imagine. [112] I am not less optimistic than these commentators about innovation's ability to create new jobs—to the contrary. But technological unemployment is not just about technology's impact on the overall quantity of jobs. It's about technology's impact on the *quality* of jobs in terms of wages and satisfaction.

Technological change can either "augment" or "diminish" human work.[113] Augmentation is, on its own, a very good thing. Workers become more productive (less input needed per output), and their performance is enhanced, sometimes to superhuman levels.[114] Several major

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[110] If commentators like Mark Lemley are correct that intellectual property will serve to artificially preserve monopolies as the costs of production fall, *see* Lemley, *IP in a World Without Scarcity*, *supra* note 6, at 497-499, this would keep prices high, restrict output, and hinder demand-boosting.

[111] For what actually happened, see BESSEN, LEARNING BY DOING, *supra* note 16, at 96-97 ("With progressively lower costs, prices fell, consumers demanded more cotton cloth per capita, and there was more demand for weavers.").

[112] *See, e.g.,* Lemley, *IP In A World Without Scarcity, supra* note 6, at 512-515 (opining that, even in a world where people are no longer needed to produce goods and services, people will have new jobs to do); Daniel Hemel, *Bringing the Basic Income Back to Earth*, THE NEW RAMBLER REV. (Sept. 19, 2016), at 8 ("…[A]dvances in artificial intelligence will lead to some job losses in the coming years[]…But these advances will also lead to new jobs …"). *See also* Kaplan, *supra*, at C3 (casting doubt on the ability of machines to perform many essential tasks in today's economy).

[113] *See, e.g.,* Brynjolfsson & Mitchell, *supra* note 92, at 1531 (noting that machine learning can make certain jobs less valuable and others more valuable as it "augment[s] human capabilities").

[114] The notion that technology will augment some professions, but not others, is the thesis of several recent books. *See, e.g.,* THOMAS DAVENPORT & JULIA KIRBY, ONLY HUMANS NEED APPLY: WINNERS AND LOSERS IN THE AGE OF SMART MACHINES (2016); *see also* Jeanne Meister, *Future Of Work: Three Ways To Prepare For The Impact Of Intelligent Technologies In Your Workplace*, FORBES, July 6, 2016.

professions being augmented by machines. These include, to name just a few, mechanical engineers, pharmacists, chief executive officers, and microbiologists—all of whom stand to benefit from technologies that compliment, rather than replace, their skill sets.[115] One extreme example are the "quants" who are "taking over the investment world" because they are able to use electronic trading algorithms to achieve much higher returns than ordinary traders and analysts.[116] Another example are certain doctors, who use artificial intelligence to search patient records, do research, make more accurate diagnoses, or perform surgery.[117] Some lawyers, too, benefit immensely from technology that can perform time-consuming document editing or case law research.[118] Why use a paralegal, or a first-year associate for that matter, when a machine can do it at lower cost and with less fuss.

Diminution, on the other hand, occurs when technology substantially reduces demand for workers' skills, and reduces their wages according. Even when technology does not wipe out someone's profession, it can turn them into, basically, an automaton, there mainly to "fill in gaps" left over by machines.[119] The manufacturing sector provides some depressing examples.

A recent *New Yorker* article, for instance, describes in detail the workplace a large manufacturer of office furniture that began to introduce computerized work stations and

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[115] Frey & Osborne, *supra* note 24, at 57-58.
[116] Gregory Zuckerman & Bradley Hope, *The Quants Run Wall Street Now*, THE WALL STREET JOURNAL, May 21, 2017, https://www.wsj.com/articles/the-quants-run-wall-street-now-1495389108
[117] Tom Sullivan, Cognitive computing will democratize medicine, IBM Watson officials say, HelthCareITNews, April 27, 2017 ("Artificial intelligence tools will augment physicians' jobs …"). *See also* Tim O'Reilly, *Don't replace people. Augment them*, MEDIUM, July 17, 2016 ("My eyes were fixed by an augmented surgeon able to do something that had been previously impossible.").
[118] *See* Karen Turner, *Meet Ross, The Newly Hired Legal Robot,* THE WASHINGTON POST, Meet Ross, May 16, 2016; *see also* http://www.rossintelligence.com
[119] *See, e.g.,* Brynjolfsson & Mitchell, *supra* note 92, at 1531. *See also* FORD, *supra* note 22, at 3 (describing various modern jobs that involve "filling the gaps between the machines", such as factory workers performing minor tasks at the end of an automated production process.)

computer-assisted arms.[120] Sometimes called "meat robots" by their own peers, employees now "follow a strict automated protocol," for which they "need little training."[121] "Even the drill [used to affix parts of furniture being assembled] [is] attached to a computer-assisted arm; the worker just [has] to move it to the right position and let the machine do its magic. A decade ago, the article concludes, "industrial robots assisted workers in their tasks. Now workers—those who remain—assist the robots in theirs."[122]

Diminution can happen to high-skill jobs as well as low skill jobs. For example, translating languages was once the sole domain of skilled human translators.[123] But thanks to improving translation technologies like Google Translate, "[i]t is much easier for machines (and humans) to translate between closely related languages."[124] Humans are not fully replaced because some translations are too complex or context-specific for machines to do alone[125], but for many purposes, "Google Translate is faster, cheaper, and often as good as a human interpreter."[126] Human translators are there merely for "clean-up" of work done by machine translation systems.[127]

4. Rising Inequality In Who Has What Jobs

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[120] Sheelah Kolhatkar, *Dark Factory*, THE NEW YORKER, Oct. 23, 2017, at 70.
[121] *Id*. at 71.
[122] *Id*.
[123] *Translation platforms cannot replace humans: But they are still astonishingly useful,* THE ECONOMIST, April 29, 2017, https://www.economist.com/news/books-and-arts/21721357-they-are-still-astonishingly-useful-translation-platforms-cannot-replace-humans.
[124] *Id*.
[125] *Id*. ("Literature requires far too supple an understanding of the author's intentions and culture for machines to do the job. And for critical work—technical, financial or legal, say—small mistakes (of which even the best systems still produce plenty) are unacceptable[.]").
[126] *Id*.
[127] *Why translators have the blues: A profession under pressure*, THE ECONOMIST, May 27, 2017, https://www.economist.com/news/books-and-arts/21722609-profession-under-pressure-why-translators-have-blues

One of the most disturbing pieces of modern technological unemployment is that the impact of technology drastically different for different members of society, generating both "winners" and "losers."[128] The main disparity comes from the thesis that technological change is "skill-biased."[129] "The central idea," Claudia Goldin and Lawrence Katz wrote in 2008 in their influential book, "is that certain technologies are difficult for workers and consumers to master, at least initially." "[E]mployees who are slow to grasp new skills will not be promoted and might see their earnings reduced. Those who are quicker will be rewarded."[130] The upshot is that "low skill" workers, with lower levels of education and experience, are left behind or made obsolete by machines, but "high skill" workers, with higher levels of education and experience, are rewarded.[131]

In their recent book, *Race Against the Machine,* economists Erik Brynjolfsson and Andrew McAfee show that this thesis is supported by historical data on the correlation between wages and education level. "Over the past 40 years," they write, "weekly wages for those with a high school degree have fallen and wages for those with a high school degree and some college have stagnated. On the other hand, college-educated workers have seen significant gains, with the biggest going to those who have completed graduate training."[132] They link this unequal distribution of gains mainly to machines and automation, rather than to others trends such as globalization.[133]

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[128] See BRYNJOLFSSON & MCAFEE, *supra* note 19, at 39 ("Even when technological progress increases productivity and overall wealth, it can also affect the division of rewards, potentially making some people worse off than they were before the innovations."); *id*. at 39-47 (discussing various "winners and losers" ushered in by advances in technology).
[129] *Id*. *See also* Autor & Solomons, *supra* note 55, at 4; GREENHALGH & ROGERS, *supra* note 33, at 268.
[130] GOLDIN & KATZ, *supra* note 52, at 90. Frey and Osborne discuss Goldin's and Katz's large body work in Frey & Osborne, *supra* note 24, at 9-12.
[131] GOLDIN & KATZ, *supra* note 52, at 94-99.
[132] BRYNJOLFSSON & MCAFEE, *supra* note 19, at 39-40.
[133] *Id*. at 39-42, 4-9.

5. The Inability of Education To Keep Pace

The fact that technology favors higher skilled workers would not in itself be a problem if everyone had the skills necessary to be a winner. However, according to Goldin and Katz, education in the United States has not kept pace with technological advancement, leaving a gap between the demand for educated workers and the supply.[134] They call this the "race between technology and education."[135] The result of technology winning the race is a "skills gap": higher demand for people with a certain skill set than there is supply.[136]

In theory, education could resolve the skills gap and alleviate inequality by bringing the unskilled to the level of the skilled. However, if improvements in automation continue at the same rate, there may not be enough jobs to go around *even assuming perfect education*.[137] Ford depicts the historic job market like a pyramid, with many, many low skill jobs at the bottom, and only a few high skill jobs at the top.[138] "It's becoming increasingly clear," Ford contends, that "robots, machine learning algorithms, and other forms of automation are gradually going to consume much of the base of the jobs skills pyramid."[139] Even by investing in "still more education and training", Ford writes, it is unlikely that we can "cram everyone into that shrinking region at the very top."[140]

III. Intellectual Property's Impact on Technological Un/employment

[134] GOLDIN & KATZ, *supra* note 52, at 7-8, 99-102.
[135] *Id*. at 7-8.
[136] *See, e.g.*, Kristin Majcher, *The Hunt for Qualified Workers*, MIT TECHNOLOGY REVIEW, September 16, 2014. *But see* Andrew Weaver, *The Myth Of The Skills Gaps*, MIT TECHNOLOGY REVIEW, August 25, 2017 (arguing that "persistent hiring problems are less widespread than many pundits and industry representatives claim.").
[137] FORD, *supra* note 22, at 252 ("The numbers simply don't work.").
[138] *Id*. at 252-253.
[139] *Id*. at 252.
[140] *Id*. at 253.

The consensus of the work discussed above has been that innovation both eliminates *and* creates employment. Moreover, innovation significantly affects the quality and distribution of remaining human work.[141] This part shows that intellectual property plays a role in generating technological un/employment and may contribute to these trends.

The reader might initially think the presence or absence of intellectual property makes no difference for employment at all. This is because modern intellectual property rights only provide a right to exclude others from using the covered innovation. [142] Intellectual property covering a particular technology does not give a company the right or permission to use it, let alone guarantee that they will do so and be successful.[143] On the flip side, absent intellectual property rights, companies are still free to adopt innovations like drones or self-driving cars, so long as they do not run afoul of health and safety or other regulations.[144]

This intuition is wrong.

A. Privilege Regimes

The easiest way to see why is to go back in time. Unlike today, historically, there was absolutely no question that intellectual property rights could influence employment. In fifteenth century Venice and sixteenth century Great Britain, where modern patent regimes evolved[145],

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[141] *See* Part II.
[142] 35 U.S.C. § 154(a)(1) ("Every patent shall contain…a grant to the patentee, his heirs or assigns, of the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States or importing the invention into the United States…"). *See also* 17 U.S.C. § 106 ("[T]he owner of copyright under this title has the exclusive rights to do and to authorize any of the following…")
[143] *See* Ted Sichelman, *Commercializing Patents,* 62 STAN. L. REV. 341, 341 (2010) (noting that few patents are ever commercialized).
[144] Various regulations external to intellectual property regulate the use of emerging technologies. *See, e.g.,* Carla Reyes, *Moving Beyond Bitcoin to an Endogenous Theory of Decentralized Ledger Technology Regulation: An Initial Proposal*, 61 VILL. L. REV. 191 (2016) (discussing ways to regulate Bitcoin and other payments systems that operate using "distributed ledger technology").
[145] See ROBERT MERGES & JOHN DUFFY, PATENT LAW AND POLICY: CASES AND MATERIALS 3-5 (5th ed. 2011). *See* also Camilla A. Hrdy, *State Patent Laws In The Age of Laissez Faire,* 28 BERKELEY TECH. L. J. 45, 60-65 (2013).

patents conferred the "privilege" to practice an invention in the jurisdiction, without which the inventor could not use his invention in the realm.[146] Also unlike today, privilege-granting regimes made the decision whether to confer a patent based on a variety of factors besides novelty or disclosure of new information—including the invention's likely "impact on local labor, commerce, and prices."[147] As Professor Herbert Hovenkamp puts it, like early corporate charters, "patents were granted selectively to private developers who promised to furnish the state with something that would contribute economic growth or infrastructure."[148]

Therefore, if an inventor came to the sovereign seeking a patent to use the technology in the region, and that technology was likely to have a negative impact on the work force, it was, so far as I can tell, far less likely the sovereign would grant that patent. For example, Professor Mario Biagioli has recounted the famous inventor Galileo's efforts to obtain a privilege to operate his new water pump in Venice in 1594 based on its assessment of the pump's utility in providing an efficient way to pump water in "[t]erminally swampy" Venice.[149] However, one wonders whether Venetian officials would have granted Galileo the privilege to operate his water pump if Galileo had instead insisted that his water pump's main advantage would be to reduce employment for Venetian workers in the irrigation industry.

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[146] *See* Hrdy, *State Patent Laws in the Age of Laissez Faire*, *supra* note 145, at 58. *C.f.* Adam Mossoff, *Who Cares What Thomas Jefferson Thought About Patents? Reevaluating the Patent "Privilege" in Historical Context,* 92 CORNELL L. REV. 953 (2007) (casting doubt on the notion that early American patent rights were seen as "privileges" in the modern sense of the term).

[147] *See* Mario Biagioli, *Patent Republic: Representing Inventions, Constructing Rights and Authors*, 73 SOCIAL RESEARCH 1129, 1134 (2006). *See also* Oren Bracha, *The Commodification of Patents, 1600-1836*, 38 Loyola of Los Angeles L. Rev, 177, 186-187 (2004).

[148] Herbert Hovenkamp, *The Emergence of Classical American Patent Law*, 58 ARIZ. L. REV. 263, 267 (2016); *see also* Hrdy, *State Patent Laws In The Age of Laissez Faire, supra* note 145, at 60-65, 95-96, 100-104 (discussing consideration of social utility in state patent laws and earlier privilege regimes).

[149] Biagioli, *supra* note 147, at 1132-34.

There are indeed documented instances of privilege-granting regimes denying patents for labor displacing inventions. The introduction mentioned William Lee's unsuccessful attempt to achieve a patent for his knitting machine in England and France, which the Queen of England predicted would bring her subject to "ruin by depriving them of employment[.]"[150] Another example comes from Venice, courtesy of Professor Stefania Fusco. The petitioner, Maria Bessea Brancaleoni, sought a patent for "a machine that could be used to either to spin and [sic] wind several kinds of materials." The officials reviewing her petition stated that the invention was "ingenious and beautiful and could easily accomplish" what Brancaleoni had promised. However, they warned the Signoria (the issuing authority) to be careful, because "if the device proved to be effective (as was likely to be the case) it would be to the detriment of the poor, because this machine would cause unemployment among poor [women]."[151]

These examples demonstrate that in both England and Venice, at least some patents were reviewed specifically for their predicted impact on labor and were potentially denied if found to be to the detriment of workers.

This changed in early American patent law. As Biagioli and others have observed, the first U.S. Patent Act of 1790 shifted the focus of patents from generating local utility in the socioeconomic sense to disclosing new information.[152] Nonetheless, in the first few decades, employment remained a factor that might be raised in discussions surrounding patentability, for instance, in assessing whether a patent met the Patent Act's "utility" requirement.[153] Professor

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[150] *See* citation in note 1.
[151] This example is courtesy of Professor Stefania Fusco. Professor Fusco's original translation is on file with the author.
[152] *See* Biagioli, supra, at 1138. *See also* Hrdy, *State Patents As A Solution To Underinvestment In Innovation*, 62 U. KAN. L. REV. 487, 493-95, 511-512 (2014).
[153] *See* Oren Bracha, *Owning Ideas: A History of Anglo-American Intellectual Property*, 99-100 (June 2005) (Ph.D. dissertation, Harvard Law School (discussing assessment of social utility in early nineteenth century patent law).

Oren Bracha gives the example of Eli Whitney's patent for his cotton gin, challenged in *Whitney v. Carter* (1810).[154] When the cotton gin's utility was questioned, Whitney's counsel responded by cataloguing the public benefits conferred by the cotton gin, including that the cotton gin provided "a lucrative employment" for "[i]ndividuals who were depressed with poverty" and "sunk in ideleness[.]"[155] This example shows not only that inventions' impact on employment was a valid consideration within the U.S. patent system, but also that inventions were perceived to lead to technological *em*ployment as well as unemployment.

B. Modern Intellectual Property

Modern intellectual property rights in the United States are not what they were in early privilege regimes. The Patent Act of 2011, which is in this respect representative of modern American intellectual property regimes, gives innovators only the "*right to exclude others*" from making, using, selling, or importing the covered innovation for the lifetime of the patent—not the right or permission to practice the covered invention.[156] Thus, denying intellectual property rights for a labor displacing innovation would not create a ban on using or adopting the technology; it would just mean the innovator does not get the benefit of exclusivity. What is more, today, neither the Patent Office nor courts scrutinize the moral or economic implications of inventions when deciding whether or not to grant or uphold intellectual property rights.[157]

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[154] *See* 29 F. Cas. 1070 (C.C.D. Ga. 1810) (No.17,583), discussed in Bracha, *supra* note 153, at 230-231.
[155] *Whitney*, 29 F.Cas. at 1072. *See also* Bracha, *supra* note 153, at 231.
[156] 35 U.S.C. § 154(a) (2011); *see also Kewanee v. Bicron*, 416 U.S 470, 480 (1974) ("The patent laws promote [the Progress of Science and useful arts] by offering a right of exclusion for a limited period as an incentive to inventors to risk the often enormous costs in terms of time, research, and development.").
[157] An exception is Justice Joseph Story's so-called "moral utility" requirement, under which an invention cannot be "injurious to the morals, the health, or the good order of society." *Bedford v. Hunt*, 3 F. Cas. 37, 37 (C.C.D. Mass. 1817). However, the moral utility doctrine has been largely rejected by modern courts. *See* Sean B. Seymore, *Making Patents Useful*, 98 MINN. L. REV. 1046, 1047-1059 (2016).

However, standard intellectual property theory suggests modern intellectual property rights still have an impact on both the magnitude and the pace of technology's replacement of human labor. There are four major intellectual property regimes: patents[158], copyrights[159], trade secrets[160], and trademarks[161]. The reason the government creates intellectual property is to help innovators internalize the uncompensated benefits their innovations generate for others (called positive externalities or spillovers), so that they will innovate more than they otherwise would and get us closer to the optimal level of innovation.[162] This right to exclude is thought to perform several important functions, of which two are particularly relevant in this context.

First, the right to exclude acts as an incentive to invent and commercialize new or fairly new innovations by generally making it easier for companies to appropriate returns from innovation by restricting competition.[163] The chance to obtain intellectual property is not

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[158] Patent Act, 35 U.S.C. §§ 101, 102, 103, 112 (2011).
[159] 17 U.S.C. §§ 101, 102, 106 (1976).
[160] Defend Trade Secrets Act, 18 U.S.C. §§ 1831-1839 (2016).
[161] Lanham Act, 15 U.S.C. §§ 1127, 1114, 1125 (1946).
[162] R. Polk Wagner, *Information Wants to Be Free: Intellectual Property and the Mythologies of Control*, 103 COLUM. L. REV. 995 (2003) (asserting that intellectual property serves to preserve incentives to generate new information in the face of inevitable spillovers).
[163] *See* GREENHALGH & ROGERS, *supra* note 33, at 272 (observing that intellectual property rights allow firms to achieve "excess profits that cannot easily be competed away by other firms in the short run.").

For discussion of patents' effects on incentives to invent and commercialize, see Camilla A. Hrdy, *Commercialization Awards,* 2015 WIS. L. REV. 13, 27-39 (2015); *see also* Robert P. Merges, *Uncertainty and the Standard of Patentability*, 7 HIGH TECH. L. J. 1, 2–3 (1992).

With respect to copyrights, although most copyright subject matter—books, articles, movies, music—seems divorced from the types of innovation under discussion, an important subset of copyright subject matter has been integral to automation: software. Despite early objections, copyright law protects computer code as "literary works" and also protects some functional aspects of software. *See generally* Pamela Samuelson, *The Uneasy Case for Software Copyrights Revisited*, 79 GEO. WA. L. REV. 1746, 1782 (2011).

Trade secret law only provides a right to exclude others who obtain the innovation by improper means or in breach of a duty of confidentiality. *Kewanee*, 416 U.S. at 490. But the principle by which trade secrets operate is the same: the right to exclude gives an incentive to innovate, as well as more freedom to exchange information. *Id*. at 493 ("[Trade secret] encourages the development and exploitation of those items of lesser or different invention than might be accorded protection under the patent laws [and] promotes the sharing of knowledge.").

necessarily a "but for" cause of why an innovation is invented and adopted, but is viewed as one of several more-or-less important factors that go into companies' decisions about whether to invent, develop, and commercialize innovative products and services.[164] Second, the race for priority over a legal right to exclude—particularly in patent law where one inventor achieves universal priority—is believed to accelerate the pace at which creation and deployment of innovations occurs.[165]

The upshot is that, when presented with the decision of whether to innovate or not innovate, the potential innovator is theoretically more likely to choose to innovate due to the option for intellectual property protection, and is likely to do so faster than in a world without intellectual property.

C. Intellectual Property's Impact on Technological Un/employment

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Trademark law's primary goal is said to be to protect consumers from confusion as to the source of goods and services, and only secondarily to give sellers an incentive to invest in product "quality." Robert Bone, *Hunting Goodwill: A History of the Concept of Goodwill in Trademark Law*, 86 B.U. L. REV. 547 (2006); *see also* Mark McKenna, *The Normative Foundations of Trademark Law*, 82 NOTRE DAME L. REV. 1839, 1844-49 (2007). However, trademarks may provide a not-insignificant incentive to innovate, in specific, because they help innovators prevent others from passing off their own offerings as those of the true innovator. *See, e.g.,* GREENHALGH & ROGERS, *supra* note 33, at 40 ("The signaling argument for trademarks is linked to the basic justification for IPRs: firms would be reluctant to invest in new product innovation if the new product could not be distinguished from innovators.") *See also* William M. Landes and Richard A. Posner, *Trademark Law: An Economic Perspective,* 30 J. LAW & ECON. 265. 265-309 (1987) (discussing trademarks as an incentive to invest in product quality).

[164] Whether intellectual property rights *work* to promote innovation is beyond my scope. For survey evidence regarding the perceived importance of patents and trade secrets as innovation incentives, see, e.g., Richard C. Levin, Alvin K. Klevorick, Richard R. Nelson, Sidney G. Winter, Richard Gilbert and Zvi Griliches, *Appropriating the Returns from Industrial Research and Development*, 3 BROOKINGS PAPERS ON ECONOMIC ACTIVITY 783, 783-831 (1987). For a recent attempt to use surveys to help answer whether intellectual property promotes innovation/creativity, see Christopher Buccafusco, Zachary Burns, Jeanne Fromer, & Christopher Sprigman, *Experimental Tests of Intellectual Property Laws' Creativity Thresholds,* 93 TEX. L. REV. 1921 (2014). For extensive discussion of link between patents and innovation, see Ouellette, *Patent Experimentalism, supra* note 4, at 75-87.

[165] *See, e.g.,* Michael Abramowicz & John F. Duffy, *The Inducement Standard of Patentability*, 120 YALE L.J. 1590, 1599 (2010); *see also* Hrdy, *Commercialization Awards, supra* note 163, at 32-33 (discussing theories under which patents accelerate the pace of innovation).

For various reasons, the impact of modern intellectual property rights on employment has not been as widely studied by economists as we might think.[166] However, pursuant to standard intellectual property theory, intellectual property rights should be expected to have two major effects on the process of technological un/employment[167]: the Incentive Effect and the Distribution Effect.

1. The Incentive Effect

The Incentive Effect predicts that the incentives generated by intellectual property's right-to-exclude magnify and accelerate the pace of technological un/employment. The Incentive Effect works as follows. The chance to obtain an exclusive right increases the incentive to invent and commercialize any given innovation. Within the entire universe of innovation, at least some will be labor saving innovations. At least some of these labor saving innovations will end up being labor displacing—meaning they eliminate or significantly reduce the amount of labor required to complete a task that would otherwise be performed by a paid human worker.[168] Therefore, the existence of effective intellectual property laws should make it more likely that any given labor displacing innovation will be invented, commercialized, and adopted in industry.[169]

The Incentive Effect generates a testable hypothesis. Call the entire universe of innovation I, and call the labor saving subset of all innovation, I_L. The Incentive Effect predicts

[166] Economists' work usually seeks to answer a different question: *innovation's* impact on employment. They view intellectual property as mere proxies for innovation itself. *See, e.g.,* Van Roy et al, *supra* note 53, at 1 (finding that higher levels of innovation, as measured by forward-weighted patent citations, had a positive impact on employment at firms in high-tech manufacturing sectors).
[167] Again, by technological un/employment I mean the simultaneous creation and elimination of jobs due to advances in technology via the mechanisms discussed in Part II.
[168] *See* definition in Part II.A.
[169] Obviously, intellectual property is not the only factor influencing invention and adoption of labor saving developments. *See* Part II.C.1.., discussing five factors that go into the decision of whether to automate.

that intellectual property rights should on aggregate increase the overall size of I_L by providing the opportunity to exclude others from using the protected innovation. Thus, the size of I_L in the presence of intellectual property rights, call it I_L^{IP}, should be greater than the size of I_L in the absence of IP, call it I_L^0.

The Incentive Effect: $I_L^{IP} > I_L^0$

It is important to emphasize that I am not arguing that intellectual property rights enlarge *only* the size of I_L. Rather, intellectual property rights enlarge the size of the entire universe of I, *including* I_L. In other words, I do not necessarily claim there is something about the inherent nature of intellectual property's incentive mechanism—for instance, the fact that intellectual property relies on a right to exclude[170]—which leads businesses to prefer labor saving innovations.[171] To illustrate the point by way of example, the presence of intellectual property does not necessarily mean Google is more likely to invent a new kind of automated car as opposed to a new kind of human-operated car. But the presence of intellectual property does mean Google is more likely to invent all types of new cars, *including* fully automated cars.

If the Incentive Effect ($I_L^{IP} > I_L^0$) holds true, intellectual property rights increase the size of the universe of innovations that are labor displacing. Proving the Incentive Effect is not as difficult as it might at first appear. *If* readers are willing to assume intellectual property has a

[170] Some have argued, for instance, that patents, which provide a right to exclude in exchange for disclosure, may lead innovators to prefer certain types of inventions that are easier to exclude and more difficult to keep secret. *See, e.g.,* Amy Kapczynski & Talha Syed, *The Continuum of Excludability and the Limits of Patents*, 122 YALE L.J. 1900, 1905 (2013).

[171] That said, when assessing damages in patent cases, courts have held damages may include the profits the infringer would have expected to obtain from savings on labor. This could mean patentees have an incentive, beyond the strong incentives they already have, to invest specifically in inventions that save on labor costs, knowing they can recover damages based on future infringers' savings on labor. *See, e.g. Doten v. City of Boston,* 138 F. 406, 406–07 (1st Cir. 1905); *Trio Process Corp. v. L. Goldstein's Sons, Inc*., 612 F.2d 1353, 1355-1357 (3d Cir. 1980).

positive net impact on innovation in the long run, then it is necessarily true that intellectual property also has a positive net impact on innovation that is labor saving in the long run.[172]

One way to disprove the hypothesis would be if there were zero or very few intellectual property rights obtained for labor saving inventions. This would suggest intellectual property is not significant in the mix of factors affecting the decision to invent labor saving solutions to problems. However, the patent record reveals that companies regularly sought to protect labor saving innovations through the patent system. There are many famous labor saving patents from the Industrial Revolution, such as several early patents on the steamboat, famous for outpacing boats operated "by any other power"[173], and the cotton harvester, advertised as "having a large capacity for work."[174] The automated teller machine (ATM), whose impact on bank teller jobs I discussed in Part II, was needless to say covered by patents lauding its cost cutting potential.[175] A search for the term "labor saving" in Google Patents reveals over 80,000 results, such as labor saving long arm gardening shears[176], a labor saving materials dispenser[177], and a labor saving consolidated checkout system.[178] The term "automation" yields over 300,000 results,

[172] In the short run, intellectual property rights would actually do the opposite: slow down adoption of labor saving technologies for as long as they are protected by an exclusive right. *See* Robert Merges & Richard Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839, 868 (1990) (discussing classic studies showing a "tradeoff between increased inventive effort resulting from longer anticipated patent life and greater deadweight costs associated with longer monopoly."). Here I am assuming intellectual property scopes and term lengths are appropriately tailored so as to limit needless monopoly costs as well as negative impacts on cumulative innovation. *C.f. id*. at 873-874.
[173] *See* Hrdy, *State Patents in the Age of Laissez Faire, supra* note 145, at 78, 105 (John Fitch's 1791 patent).
[174] U.S. Patent No. 526209A, for a "Cotton-Harvester," was obtained by Ely Whitney in 1894. Its stated objective was to produce a "simple and durable apparatus" for harvesting cotton, "capable of operation by unskilledlabor", and "having a large capacity for work."
[175] For instance, the objective of U.S. Patent No. 3,761,682, for a "Credit card automatic currency dispenser," was "[t]o provide the consumer with a source of ready cash without the expense of branch banking" and "to make cash available to bank customers on a 24 hour basis."
[176] U.S. Patent No. 7530172B1.
[177] U.S. Patent No. 5592760A.
[178] U.S. Patent No. 5497853A.

including several recent patents involving "sales force automation"[179] and "home automation system[s]."[180] The term "autonomous vehicle" alone yields over 40,000 results, several of which are owned by Uber Technologies.[181]

To illustrate how labor saving patents are presented, take NCR Corp's patent for a labor saving consolidated checkout system—the self-service checkout terminals we can now use at the grocery store and the pharmacy.[182] Noting that "the largest expenditures" in the retail industry besides "the cost of the goods sold" are "the cost of labor expended," the patent then discusses at length the invention's goal to "reduce labor costs" associated with grocery and supermarket transactions[183] by "reducing the number of occasions in which an employee of the retailer must intervene in the customer's transaction relative to self-service checkout terminals which have heretofore been designed."[184] In other words, the invention's objective is to reduce the amount of labor required to perform the task to as close to zero as possible.

The fact that a large number of labor saving inventions have been patented does not tell us whether the opportunity to obtain patents influenced whether or when they were invented. However, if we saw few labor saving inventions in the patent record, this would support the opposite conclusion—that patents are not causally linked to technology's impact on employment. This is not the case. If these patents are having their desired effect on the amount and pace of innovation, they also must be having a magnifying effect on technological un/employment.

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[179] U.S. Patent No. 7340410B1.
[180] U.S. Patent No. 6473661B1.
[181] U.S. Patent No's 9557183, 9603158, 9616896, 9672446, 9432929.
[182] U.S. Patent No. 6522772B. The National Cash Registry Company was founded in 1894 by John H. Patterson, "maker of the first mechanical cash registers." NCR Corp. has since developed many machines to facilitate consumer transactions, including cash registers, ATMs, and self-service kiosks. *See* https://www.ncr.com/company/company-overview/history-timeline Patterson's first patent for a cash register has a grant date of 1889. *See* U.S. Patent No. CA32621A.
[183] U.S. Patent No. 6522772B1, 11, LL 14-19.
[184] U.S. Patent No. 6522772B1, 3, LL 30-34.

2. The Distribution Effect

The Distribution Effect is an outgrowth of the Incentive Effect. The Distribution Effect has two parts. First, intellectual property increases returns for the owners of intellectual property by giving them a right to exclude, and thereby increases demand and wages for people who possess the skills necessary to generate intellectual property ("IP-generators"). Second, because at least some of this same intellectual property involves labor displacing innovations, this contributes to lower demand and wages for people whose core skills are more easily replaced by machines. The upshot is that intellectual property magnifies the division between the owners and generators of intellectual property, and the workers whom their innovations replace.

A core hypothesis generated by the Distribution Effect is that demand and wages for IP-generators, called W^{IP}, should be exponentially higher than for other people who are not capable of generating intellectual property and/or who are more easily replaced by machines, called W^{0}.[185]

Distribution Effect: $W^{IP} >> W^{0}$

The upshot of this hypothesis is that intellectual property rights exacerbate the growing inequality between high-skill and low-skill workers, discussed above in Part II.C.4.

Proving the Distribution Effect is difficult, in large part because it is so difficult to isolate intellectual property's impact on employment and wages as opposed to *innovation's* impact.[186]

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[185] For purposes of simplicity, I divide workers two groups—"IP-generators" (who generate valuable intellectual property and are not easily replaced by machines) and "non-IP-generators" (who do not generate valuable intellectual property and whose skills are more easily replaced by machines). This assumes IP-generators are less likely to be replaced by machines than non-IP-generators—which is not necessarily true. Yet other commentators on this topic make similarly simplistic distinctions between "high-skill" and "low-skill" workers. *See, e.g.,* GOLDIN & KATZ, *supra* note 52, at 95-96. *See also* discussion of machines as IP-generators in note 95 *supra*.

[186] The recent USPTO report stresses that this connection is tenuous. USPTO REPORT, *supra* note 3, at i ("… our methodology does not permit us to attribute [differences in economic indicators such as employment, wages, and value added] to IP alone...").

But, taken as a whole, the evidence supports that intellectual property contributes to comparatively higher wages for IP-generators. It is worth going through some of the evidence.

First, as already mentioned, data from the last several decades shows a correlation between technological advance, on the one hand, and increased wages for "high-skill" as compared to "low-skill" workers.[187] Second, evidence shows wages in geographic regions with high levels of innovation and higher levels of patenting per entity—"brain hubs" like Silicon Valley, California—tend to be higher than wages in other regions.[188] Lastly, several studies purport to find that employees within firms or industries that own intellectual property have comparatively higher wages than workers in other industries.[189] To give just one example, the recent USPTO report mentioned in the introduction found, using U.S. Census Bureau and USPTO data, that wages in "IP-intensive" industries—in which companies own more intellectual property per size—tend to be 46% higher than in other industries that are not classified as IP-intensive.[190]

There are several mechanisms by which intellectual property might enhance wages for IP-generators. First, firms may share some of the rents from intellectual property with employees whose skills are necessary to obtain those rents.[191] Second, firms may pay IP-generating employees more in order to keep them from working for competitors and from sharing their

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[187] *See, e.g.* BRYNJOLFSSON & MCAFEE, *supra* note 19, at 39.
[188] I review the connection between innovation, patenting, and wages in Hrdy, *Patent Nationally, Innovate Locally*, *supra* note 31, at 1317-22. *See also* MORETTI, *supra* note 54, at 82-86, 72-97.
[189] *See* GREENHALGH & ROGERS, *supra* note 33, at 277 (discussing studies finding the innovation rents variable is "a significant determinant of higher wages", with as much as 20-30% of rents generated through innovation going to workers).
[190] USPTO REPORT, *supra* note 3, at ii, 19 ("Private wage and salary workers in IP-intensive industries continue to earn significantly more than those in non-IP-intensive industries. In 2014, the average weekly wage of $1,312 was 46 percent higher (up from 42 percent in 2010) than for workers in non-IP-intensive industries[.]").
[191] *See* GREENHALGH & ROGERS, *supra* note 33, at 277.

secrets.[192] Third, employees may be able to more easily signal their abilities to the job market if they can obtain intellectual property.[193]

To be clear, we do not know that intellectual property rights, in specific, are causing these higher wages. It is just as likely to be that people who generate IP have more education and skill than other people. But I merely suggest the possibility that another reason they are paid so well is that these people are capable of generating intellectual property that will give their employers a legal right to exclude others.[194]

3. The Case Of Self-Driving Cars

Leaving aside aggregate data, the most compelling evidence for the impact of intellectual property on technological un/employment is a contemporary case study: autonomous vehicles, also known as self-driving cars. Corporations and the U.S. government are pouring billions of dollars into self-driving car research.[195] Start-ups can raise millions of those dollars to develop self-driving vehicle technology.[196] Salaries for experts in this field, such as roboticists and engineers, are startlingly high.[197]

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[192] Jonathan M. Barnett & Ted Sichelman, *Revisiting Labor Mobility in Innovation Markets*, working paper (2016); Andrea Contigiani, Iwan Barankay, & David Hsu, *Trade Secrets and innovation: Evidence from the "Inevitable Disclosure" Doctrine*, (January 1, 2018), https://ssrn.com/abstract=3092880

[193] For instance, it is theorized that inventors of high-quality patents can obtain higher wages when they are able to signal their skills to other firms. Contigiani et al, *supra* note 192, at 8-9 (assuming that "high-skill inventors" with the ability to produce "high-quality patents" receive a wage premium).

[194] *See* Part III.B.

[195] Bill Vlasicjan, *U.S. Proposes Spending $4 Billion on Self-Driving Cars*, THE NEW YORK TIMES, January 14, 2016; *see also Toyota spending $1B on self-driving car research,* REUTERS, Friday, November 6, 2015.

[196] Max Chafkin & Josh Eidelson, *These Truckers Work Alongside the Coders Who Are Trying to Eliminate Their Jobs*, BLOOMBERG BUSINESSWEEK, June 26, 2017, at 62. *See also* Liza Lin, *China Self-Drive Firm Gets Daimler Funding*, THE WALL STREET JOURNAL, Tuesday July 25, 2017, at B2.

[197] *See, e.g.,* Johana Buiyan, *Ex-Googler Sebastian Thrun says the going rate for self-driving talent is $10 million per person: Now he wants to train more engineers for the fast-growing industry, since there are simply not enough*, ROCODE, September 2016; *see also* Cade Metz, *N.F.L. Salaries for A.I. Talent,* THE NEW YORK TIMES, Monday, October 23, 2017, at B1.

Why is there so much money pouring into self-driving cars? The fundamental reason is surely that self-driving cars can bring tremendous value to businesses, which can use them to reduce costs and improve speed, safety, and accuracy.[198] Companies cannot develop the product or compete with others in the industry unless they have top talent; so they buy or start new companies, and lure workers with the prospect of huge salaries.[199] But another reason could be the expectation that, at the end of the road, these workers will generate valuable intellectual property, including trade secrets as well as patents, that can be used to exclude competitors or licensed to others for high fees.[200] The ability to generate intellectual property is obviously not the only reason companies are investing in self-driving cars or in IP-generating workers.[201] But absent the chance for exclusive rights, self-driving cars might not be quite such a profitable industry, and these people might not be quite so well paid.

Meanwhile, the very same intellectual property that allows owners and IP-generators to achieve vast profits in the emerging industry simultaneously threatens the jobs and earning power of truck drivers and other people who drive people and things from place to place for a living.[202] Even now, the wage differential is striking. While base pay for engineers in the self-

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[198] *See, e.g.,* Rogers, *supra* note 12, at 100-101 (discussing the temptation for Uber to switch to autonomous vehicles); *see, e.g.,* Laura Stevens & Tim Higgins, *Amazon Forms Team to Focus on Driverless Technology*, THE WALL STREET JOURNAL, April 24, 2017 (discussing ways Amazon may incorporate self-driving cars into its package delivery in order to cut costs and improve delivery service).

[199] For instance, Anthony Levandowski sold Otto to Uber for $700 million. Robotocists from Carnegie Mellon came on board, lured away from academia with huge salaries. *See* Johana Buiyan, *Inside Uber's self-driving car mess*, RECODE, March 24, 2017.

[200] *See Waymo LLC v. Uber Technologies, Inc.,* No. C 17-00393 WHA, 2017 WL 2123560 (N.D. Cal. May 15, 2017) (bringing claims against Uber for theft of trade secrets under state and federal law). *C.f.* John Allison, Mark Lemley, Kimberly Moore, & Derek Trunkey, *Valuable Patents*, 92 GEO. L. J. 435 (2004) (noting that the decision to litigate patents may be representative of their perceived value).

[201] *See* Parts II.C.1 (on the fundamentals affecting the decision to automate) and II.C.5 (on the skills gap).

[202] *See* Chafkin & Eidelson, *supra* note 196, at 62.

driving vehicle field is well over $200,000 per year, trucker drivers' median pay is around $40,000 per year and will presumably fall as autonomous trucks are adopted.[203]

This difference might not be problematic if the numbers were different—if there were more jobs available for people to be engineers working on autonomous vehicles than there were for people to be truck drivers. But at least currently, companies developing autonomous vehicles hire comparatively few human workers in relation to their net worth.[204] The American Trucking Association reports that there are "approximately 3.5 million" professional truck drivers in the United States.[205] Even if the United States could successfully retrain former drivers to be engineers, there would not be enough jobs to go around.[206]

IV. The Case For A "Pro-Employment" Innovation Policy

Part III argued that intellectual property facilitates and accelerates the pace of technological un/employment and exacerbates inequality between IP-generators and owners of intellectual property, and everyone else. If accurate, this thesis contradicts the conventional view that intellectual property rights like patents "spur innovation" *and* "create jobs."[207]

This raises a normative issue. Should government adopt policies to alleviate unemployment brought about by technological change? For instance, should government do anything about the truck drivers who lose their jobs when self-driving cars take off?

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[203] *Id*. *See also* Alan Ohnsman, *Autonomous Car Race Creates $400k Engineering Jobs For Top Silicon Valley Talent*, FORBES, March 27, 2017.
[204] *See* WEST, *supra* note 25, at 6 (noting that "[m]any of the large tech firms have achieved broad economic scale without a large number of employees."). *See also* Chafkin & Eidelson, *supra* note 196, at 62 (noting that Otto "had fewer than 100 employees when Uber Technologies Inc. acquired it for $700 million.").
[205] The total number of people employed in the industry, including those in positions that do not entail driving, "exceeds 8.7 million." http://www.alltrucking.com/faq/truck-drivers-in-the-usa/ *See also* Ben Leubsdorf, *Self-Driving Cars Could Transform Jobs Held by 1 in 9 U.S. Workers*, THE WALL STREET JOURNAL, August 14, 2017 (noting Commerce Department economists predict the approximately 3.8 million people who drive taxis, trucks, and other vehicles for a living may either be displaced or see their wages fall drastically).
[206] *See* Part II.C.1-5.
[207] *See* quotes in note 5 *supra*.

Some might say "do nothing." Innovation increases productivity and gives us a better lifestyle, and is good for the economy in the long run.[208] The fact that innovation has negative as well as positive effects on society is the price we pay for progress. However, my review of the research discussed in Parts II and III convinces me technological un/employment is a growing problem, in particular because of its adverse impacts on the quality and distribution of work, and that intellectual property exacerbates this problem. In this part, I argue there are several theoretical justifications for using policy to intervene. I then explain how policymakers should go about deciding which policy mechanisms to use.

But first I must recognize some threshold objections.

A. Threshold Objections

i. The Hayekian Objection[209]

The first objection is that, all else being equal, free markets should be preferred over government for allocating resources, and that government attempts to interfere will leave jurisdictions worse off.[210] In designing innovation policy, government relies on intellectual property as opposed to direct government financing ("innovation finance") because free markets

[208] *See, e.g.,* JOSH LERNER, THE ARCHITECTURE OF INNOVATION: THE ECONOMICS OF CREATIVE ORGANIZATIONS 16 (2012) ("Innumerable studies have documented the strong connection between new discoveries and economic prosperity across nations and over time.").

[209] Friedrich Hayek was an Austrian economist famous for objecting to John Maynard Keynes' view that government should subsidize demand in order to stimulate spending and employment. *See, e.g.,* F.A. Hayek, *The Use of Knowledge in Society*, 35 AM. ECON. REV. 519 (1945). *See also* NICHOLAS WAPSHOTT, KEYNES HAYEK: THE CLASH THAT DEFINED MODERN ECONOMICS (2012). Professor Amy Kapczynski has observed the linkage between IP theory and the view that government lacks knowledge and ability to provide information goods. *See, e.g.,* Amy Kapczynski, *Intellectual Property's Leviathan.* 77 LAW AND CONTEMPORARY PROBLEMS 131, 134 (2014) ("[T]he conventional theory [of IP law] … implicitly invokes a Hayekian hypothesis about information asymmetries. …") (citing, e.g., Harold Demsetz, *Information and Efficiency: Another Viewpoint*, 12 J.L. & ECON. 1 (1969)).

[210] *See, e.g.,* Robert Cooter, *Innovation, Information, and the Poverty of Nations*, 33 FL. STATE U. L. REV. 373, 378-379 (2005) (arguing that government "manipulations" of the market in the form of taxes, subsidies, and regulations amount to "industrial policy" or "technology policy," in which government unwisely seeks to guide market decisions).

are better than government at allocating resources across society.[211] The intellectual property mechanism takes advantage of the superior knowledge possessed by the private sector, and avoids government interference with the natural forces of supply and demand.[212] It also avoids the potential for capture of government by powerful interest groups.[213] In other words, government relies on intellectual property precisely in order to follow the will of the market and to prevent external political goals from influencing which innovations are pursued.[214]

On this view, if government were now to adopt policy solutions like tax law in order to alleviate a particularly irksome negative consequence of its "market-set" innovation policy—that is, pervasive technological un/employment resulting from the private sector's impulse to increase efficiency and cut costs—this would disrupt the entire system, exposing the market to government corruption and ineptitude.

ii. The "Productivity Is Everything" Objection[215]

The second objection is that a policy geared towards reducing the amount of labor saving innovations used in an economy is anti-innovation and anti-growth.[216] Even assuming government could accurately identify technologies that are likely to eliminate significant segments of the workforce[217], government's actions would surely have a negative long-term effect on the economy. Not only would it become more difficult to start a business in the

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[211] Innovation finance refers to direct public financing for innovation, such as research grants, tax incentives, or public venture capital, in lieu of intellectual property rights. *See* Hrdy, *Patent Nationally, Innovate Locally*, *supra* note 31, at 1304.
[212] Kapczynski, *Intellectual Property's Leviathan, supra* note 209, at 134.
[213] *Id.* at 134 ("[T]he state [in the dominant account of IP law] is also imagined to be uniquely vulnerable to capture...").
[214] *See* Daniel Hemel & Lisa Ouellette, *Beyond the Patents–Prizes Debate*, 92 TEX. L. REV. 303, 327 (2013) (discussing the distinction between "market-set" and "government-set" innovation incentives).
[215] *See, e.g.*, Daniel Hemel, *Should Robots Be Subsidized? Probably*, MEDIUM, Aug. 17, 2017 (quoting Paul Krugman, *The Age of Diminishing Expectations* (1994)).
[216] *See id.*
[217] I discuss this challenge below in Part IV.C.1.

jurisdiction[218], but markets might begin to direct resources towards solutions that are *less efficient*, costing more per unit of output. For example, businesses might begin to use humans instead of robots even when robots are far cheaper or better suited to the task. Research firms might begin to invest in comparatively inefficient technological solutions like multi-human-driven motor vehicles or avoid solutions that utilize robotic arms—all in order to obtain some government subsidy or avoid running afoul of some new tax or regulation. Meanwhile, workers would have significantly reduced incentives to educate themselves appropriately. If job-displacing technologies were disfavored, workers might not work as hard to train for the industries of the future, secure in the sense that the government would not let them be automated out of work. We would, in other words, lose an important signal from the market about which industries and jobs people should train for.[219]

This might not be so terrible if government actually succeeds in halting automation in its tracks. Businesses would just be less efficient than in an alternative, labor saving universe. But innovation does not happen in a vacuum. We live in a world of fierce global competition. Any nation that adopts, say, a flat-out ban on a labor displacing technology like self-driving cars—which as I discuss below may happen—would face competition from neighbors that *do not* invoke such a ban. This country would fall behind others and see its economy falter.[220]

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[218] Cooter, for instance, argues that one reason for the comparative poverty of certain nations is that the state places "heavy regulatory burdens" on entrepreneurs seeking to create new companies and therefore hinders economic growth. Cooter, *Innovation, Information, and the Poverty of Nations, supra* note 210, at 387-388.

[219] *See* Weaver, *The Myth Of The Skills Gaps*, *supra*, at 1 (arguing that, when it comes to predicting which skills will be needed in the economy, "there is no substitute for coordination between the supply side of the labor market (workers and their skill investments) and the demand side (employers and their skill requirements).").

[220] To give a historic analogy, economics writer Mark Levinson argues France's policies to create jobs in the 1970s, including subsidizing industries most likely to hire large numbers of workers, left France unable to "adapt to a world of rapid technological change and intense global competition." MARC LEVINSON, AN EXTRAORDINARY TIME: THE END OF THE POSTWAR BOOM AND THE RETURN OF THE ORDINARY ECONOMY (2016). *See also* Liz Alderman, *Newfound Freedom…to Fire*, THE NEW YORK TIMES, at B1 (discussing recent regulatory changes in France making it easier to hire and fire workers in Franc in order to revive growth).

Given these concerns, surely no country would adopt a policy that seeks to reduce, rather than increase, the amount of labor saving inventions in the marketplace, regardless of whether they displace human jobs.

B. Justifications For Intervention

While sympathetic to these objections, I believe there are several justifications for adopting policies to curb the amount and pace of labor displacing innovation.[221]

1. Correcting Externalities

The first justification is that labor displacing innovations generate "negative externalities: for workers whose occupations and wages are affected.[222] Even the staunchest libertarians perceive externalities as a justification for intervention in markets. The idea is that the market is not an effective mechanism for dealing with the problem because it is "external" to the market; it is "not fully factored into a person's decision to engage in the activity." [223] A classic example of a negative externality is pollution released by companies into the environment. Companies' profits do not take into account the harm the pollution causes to the earth or to others. Taxation is often posited as a mechanism for correcting negative externalities. Taxes force companies to

[221] These justifications are directed at proponents of the dominant intellectual property paradigm described above as well, as to skeptics of government intervention in markets. *C.f.* Miranda Perry Fleischer & Daniel Hemel, *Atlas Nods: The Uneasy Libertarian Case for a Basic Income*, 2017 WIS. L. REV. 101, 131 (2017) (defending a "universal basic income" against objections from libertarians). *See also* N. GREGORY MANKIW, PRINCIPLES OF MICROECONOMICS, 11–13 (6th ed. 2012) (discussing common "market failures" that might warrant government intervention in markets).

[222] I define negative externality in this context as a cost conveyed to others (mainly, workers) that is not represented in market prices. *See* Robert Cooter, *Liability Externalities and Mandatory Choices: Should Doctors Pay Less?* 1 J. TORT LAW 1, 7 (2006); *see also* Brett M. Frischmann & Mark A. Lemley, *Spillovers*, 107 COLUM. L. REV. 257, 262 (2007) ("[P]ositive (or negative) externalities are benefits (costs) realized by one person as a result of another person's activity without payment (compensation). Externalities generally are not fully factored into a person's decision to engage in the activity."). *C.f.* MANKIW, supra, at 10 ("An externality is the impact of one person's actions on the wellbeing of a bystander.").

[223] Frischmann & Lemley, *supra* note 222, at 262.

"internalize" the costs of their actions, leading them to avoid creating negative externalities when possible in order to avoid incurring the tax. [224]

Some commentators have suggested that labor saving technology, in particular automation, generates negative externalities for others in the form of reduced employment prospects.[225] The idea is that when companies adopt labor displacing technologies, they profit from reduced labor costs and improved performance, but do fully internalize the costs this imposes on workers who lose their jobs. Thus, automation should be taxed for the same reason pollution is taxed—to force companies to internalize the costs their actions create for displaced workers.[226]

Some may object to this conceptualization. A true externality, like pollution, is a negative effect of a market transaction on bystanders w*ho are not participating in the transaction*.[227] The inanimate environment, for instance, cannot pay to prevent itself from being polluted. People living downstream from a polluting factory can only reasonably be compensated using legal

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[224] Cooter, *Liability Externalities and Mandatory Choices, supra* note 222, at 1.

[225] As one economist puts the argument,

> [T]echnology is creating new jobs but it is also destroying some old ones even faster. *In economics, negative consequences not directly accounted for in a transaction, but borne by other third parties (society, future generations, the ecology, and so forth), are known as negative externalities*.

Ernest Chi-Hin Ng, "Taxing the Robots and Other Externalities", *Buddhistdoor Global*, 2017-03-17 (emphasis added). *See also* Daron Acemoglu & Pascual Restrepo, *The Race Between Machine and Man: Implications of Technology for Growth*, FACTOR SHARES AND EMPLOYMENT 30 (2016) ("[Automation] reduces employment…and this has first-order effect on workers. … [*I]innovators do not internalize this externality*.") (emphasis added); *see also* Loren Nerhus, *Automation and the Labor Force,* MAJOR THEMES IN ECONOMICS 65, 66 (2014) ("[Improvements in technology] make work less taxing, living conditions more comfortable, and health care more extensive. Even though everyone in society benefits from improvements in technology, *it does create negative externalities for some segments in the short run*.") (emphasis added).

[226] Acemoglu and Restrepo, for example, theorize that "the social planner *will need to impose a tax on automation* … in order to combat the tendency of the decentralized equilibrium to automate excessively." Acemoglu & Restrepo, *supra* note 225, at 30 (emphasis added). *See also* Ng, *supra*, at 1 ("Some of these negative externalities can be addressed through taxation and/or surcharges.").

[227] *See* Frischmann & Lemley, *supra* note 222, at 262 ("Technological externalities are direct benefits (or costs) realized by third parties—*agents who are not participating in the relevant market and thus have not transacted with the provider of the benefits or costs*.").

mechanisms like tort law.[228] But in this case, workers participate in the transaction to the extent they control the wages they receive from employers. Unemployment, on this view, is not an "externality." It is just a negative consequence for workers who cannot accept wages low enough to prevent themselves from being replaced by machines.[229] Workers could prevent the harm if they could accept lower wages. If they cannot, they are simply priced out of the labor market.[230]

But this objection misunderstands the mechanism by which labor displacing innovations create negative externalities for workers. The negative externality here is *not* the one-off job loss that happens when a company adopts a labor displacing innovation. It is the economy-wide impact of a new technology that suddenly make peoples' skills obsolete. The driving force behind this externality is the fact that innovations themselves are "public goods" that can eventually be copied and used by other businesses across the economy.[231]

To make this more concrete, take the following example. Automation Co. produces widgets and hires one thousand workers (widget-makers). Automation Co. invents a new labor saving device that permits it to hire only one worker, whose main responsibility is supervising and maintaining the device. Eventually, other widget manufacturers across the world copy Automation Co.'s technology and choose to replace their widget-makers. Obviously, the nine

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[228] *See* Cooter, *Liability Externalities and Mandatory Choices, supra* note 222, at 7 ("When markets fail, liability law often improves the situation by making injurers compensate victims.").

[229] In other words, job loss is just a "pecuniary" externality: a wealth transfer between private parties. *See* Frischmann & Lemley, *supra* note 222, at 262-263 ("[E]conomists don't much care about pecuniary externalities, reasoning that wealth transfers 'within' the market—that is, externalities mediated by the price mechanism—result in offsetting private costs and benefits.").

[230] R. H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1, 15 (1960); *see also* MANKIW, *supra*, at 210–12. One minor response is that transaction costs prevent workers from bargaining to retain their jobs. Workers who are willing to accept lower wages in order to stay employed may lack the bargaining power or organizational capacity to ask for what would otherwise be in their self-interest. *See* Brishen Rogers, *Passion and Reason in Labor Law*, 47 HARV. C.R.-C.L. L. REV. 313 (2012). This response is limited, however, to situations where more bargaining *could* feasibly result in employees retaining jobs. If machines can do the job better and more cheaply, even if there are zero transaction costs, workers will be priced out of the job market.

[231] Frischmann & Lemley, *supra* note 222, at 272-273 ("Ideas can be freely copied by others in the absence of a legal rule restricting that copying without depriving their creators of the use of the ideas.").

hundred and ninety-nine employees fired by Automation Co. experience a direct negative consequence. But the bigger picture "externality" in this scenario is the entire workforce of widget-makers who no longer have relevant skills for the workforce. The cost for widget-makers—losing a viable means of making a living—are completely "external" to Automation Co.'s initial decision to invent and adopt the labor saving device.[232]

Labor displacing innovations also create external costs for people who are not born yet. Future generations are innocent bystanders with respect to the technologies invented today.[233] Imagine the labor saving innovations developed by companies like Automation Co. eventually mean humans are no longer needed to perform 90% of the processes that go into production. A baby born in 2048 must live with the new jobless world brought about by this technological revolution. I don't see this as distinguishable from the environmental pollution example.

But surely, we cannot conceptualize every negative consequence over which people have no control as an "externality" warranting regulation.[234] Suddenly discovering one's skills are obsolete is not an externality. It is just tough luck that you gauged the market incorrectly. Being born in 2048 with nothing to do for pay is not an externality. It is just the reality of the future. The basic point is: how can we distinguish the prospect of machines taking our (humanity's) jobs away, from good old-fashioned creative destruction?[235] Imagine Automation Co. were actually

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[232] This example is intentionally adapted from Frischmann and Lemley's example. See Frischmann & Lemley, *supra* note 222, at 300.
[233] *See* note directly *supra*. In this conceptualization, unemployment is a "temporal" negative externality of certain innovations—an unanticipated consequence for future generations that was not addressed by any of the actors initially responsible. Frischmann & Lemley, *supra* note 222, at 260 (noting that some externalities are temporal). *See also* quotation from Ernest Chi-Hin Ng in the note directly above.
[234] *C.f.* Richard Epstein, *The Ubiquity of the Benefit Principle*, 67 SO. CAL. L. REV. 1369, 1376-1377 (1994) ("Every transaction has innumerable consequences—positive and negative—with respect to the fortunes and satisfactions both of the individual actor, the actor's trading partners, and of many other individuals.").
[235] *C.f., e.g.,* John Komlos, *Disruptive Innovation: The Dark Side*, MILKEN INSTITUTE REVIEW, January 20, 2015 ("The destructive component of innovation, whether organizational or technological, can be viewed as a negative

Green Co., an innovative business in the energy sector experimenting with wind turbines in lieu of coal power. Once Green Co.'s wind turbines are copied and adopted across the economy, coal miners in Appalachia now have irrelevant skills and no viable way to make a living.[236] How are the widget-makers in the first example distinguishable from the coal miners?

The answer is that there is something inherently different about using a *machine* rather than a human being to perform work. In ordinary "creative destruction" circumstances, companies that invent and adopt new technology must consider whether they can find workers with the requisite skills to operate the new technology. Availability of workers and skills are crucial factors. Workers, in turn, are part of the transaction just by virtue of being in the labor market. The coal miners above, for instance, have at least the theoretical opportunity to work in the wind power industry, and indeed might initially be a scarce commodity in the technology's early days.[237] However, when the innovation is one that permits complete automation, availability of workers and skills need not be considered. The impact of the innovation on workers is "external" to the market and not "fully factored into" companies' decisions to generate or adopt the innovation.[238]

To be fair, most instances of automation today involve partial rather than complete automation.[239] Thus, the availability of workers, both as alternatives to machines and as compliments to them, is still a crucial factor in companies' decisions about whether to automate.

'externality' – a cost borne by third parties in the way that the consequences of pollution spewed by a factory are borne by its neighbors rather than by its owners or customers.").

[236] ECOWATCH, Oct. 24, 2017, https://www.ecowatch.com/coal-jobs-technology-2492852723.html ("[C]oal jobs are in a terminal decline and whatever cynics claim, it's not some cabal of heartless environmentalists to blame. It's the power industry itself, driven by advances in technology and simple market forces.").

[237] *See, e.g.,* BESSEN, LEARNING BY DOING, *supra* note 16, at 102 (noting that workers who have the skills to work with a new technology are often in "short supply").

[238] Frischmann & Lemley, *supra* note 222, at 262.

[239] *See* Bessen, *How Computer Automation Affects Occupations, supra* note 41, at 4-5-7.

Humans can still compete with machines as workers in many (probably most) industries. But I think this is the best explanation for how to think of technological unemployment as generating "externalities." It is not just that companies adopt machines that take away some people's jobs—it is that companies invent new technology that, when widely adopted, makes human skills irrelevant and pushes them out of the labor market.[240]

2. Effectuating Redistribution

Some may be more moved by appeals to distributive justice than by discussion of externalities.[241] As discussed in Part II.C.4, the impact of labor saving innovations on employment is highly uneven across society. Even when "technological progress increases productivity and overall wealth," it can also affect the division of rewards, potentially making some people worse off than they were before the innovations."[242] Given the data suggesting that technology has exacerbated inequality, there is a strong argument that interventions are necessary to help those who are disproportionately harmed.

It is perhaps not surprising then that several commentators, including in the private sector, have suggested turning to "Keynesian policies"—i.e. government spending supported by taxation in order to help those whose jobs are displaced by automation.[243] Several famous company executives have chimed in. For instance, Tesla's CEO Elon Musk has stated his view that "[artificial intelligence] is the biggest risk that we face as a civilization", and speculated that policymakers should try to slow down development and potentially even give people a

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[240] *See* Acemoglu & Restrepo, *supra* note 225, at 30.
[241] *See, e.g.,* Justin Hughes & Robert P. Merges, *Copyright and Distributive Justice*, 92 NOTRE DAME L. REV. 513, 518 (2017). *See also* MANKIW, supra, at 11–13 (listing alleviating inequality as a potential basis for government intervention in the free market).
[242] BRYNJOLFSSON & MCAFEE, *supra* note 19, at 39.
[243] *See, e.g*, Jonathan Taplin, *Can the Tech Giants Be Stopped?,* THE WALL STREET JOURNAL, Saturday/Sunday, July 15-16, at C2.

"universal basic income" (UBI) to help them get along without paid work.[244] I suspect the motivation behind such views is less about correcting externalities than it is about correcting inequality.

Of course, not everyone will agree that redistribution alone is a solid basis for adopting a policy that risks slowing down innovation and hindering productivity. Anti-state libertarians, in particular, may chafe at this idea.[245] That said, Professors Miranda Fleischer and Daniel Hemel have argued that even libertarians might agree with some amount of redistribution.[246] One justification they give is that redistribution itself may be a "public good" (a nonrival, nonexcludable resource) that generates positive externalities for others.[247] They observe that poverty and unemployment can contribute to societal ills that affect everyone, such as crime.[248] The idea is that when people have fewer opportunities for legally earning an income, they turn to crime.[249] Notably, utilizing automation in business in lieu of employing people, may exacerbate this connection because fewer human employees typically means less security and fewer "eyes on the street."[250] A similar argument could be made here. If we adopt policies to help people

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[244] *See, e.g.,* Tim Higgins, *Tesla Boss Warns on Artificial Intelligence*, THE WALL STREET JOURNAL, Monday July 17, 2017, B1; Catherine Clifford, *Elon Musk: Robots Will Take Your Jobs, Government Will Have To Pay Your Wage*, CNBC.COM, Nov. 4, 2016.
[245] Fleischer & Hemel, *supra* note 221, at 104 ("[L]ibertarianism is—or at least is generally thought to be—inhospitable to redistribution.").
[246] *Id*. at 105.
[247] *Id*. at 134-138.
[248] *Id*. at 135. *See also id*. at 134-135 (discussing the views of Mark Pauly and others such as Milton Friedman that poverty relief can be conceptualized as a public good to alleviate, for instance, crime and even the distressing sight of poverty itself).
[249] *See* Matthew D. Melick, *The Relationship between Crime and Unemployment*, 11 THE PARK PLACE ECONOMIST 30, 30-31 (2003) (identifying "two major schools of thought regarding the unemployment-crime relationship," one focusing on the "supply of offenders," which may rise as employment opportunities decrease, the other focusing on the "supply of victims," which may actually fall since people have less to steal). *See also* Hemel & Fleischer, *supra* note 221, at 135-136 (discussing the linkage between poverty and crime as a potential justification for poverty alleviation).
[250] To give one anecdote, Wal-Mart stores have apparently developed a serious crime problem in the past decade, ever since they began reducing the number of human employees manning Wal-Mart stores. In contrast, Target stores have not experienced this problem, in part because they hire more staff. *See* Shannon Pettypiece and David

achieve meaningful employment, we may reduce poverty and the ills it brings like crime. (In other words, to appease libertarians, the redistribution justification can be reframed as being about correcting externalities.)

3. A Correction To State Intervention

A final justification for intervention is that intellectual property itself can be seen as a form of government interference in the free market.[251] On this view, intellectual property's negative impacts on some employment are not altogether distinct from other constraints imposed by the state that arguably lead companies to shed jobs, such as minimum wage laws.[252] If intellectual property is viewed as a form of government intervention that results in some degree of technological un/employment, then policies to alleviate certain negative effects on the work force can be seen as corrections that guide us back to where we would have been without intellectual property. This is especially true since, as explained, government's decision to rely on intellectual property in lieu of innovation finance[253] is a deliberate decision to follow the "pull" of market forces rather than political desires.[254] Whereas in Queen Elizabeth's time, intellectual property 'as regulation' was aligned with what benefited the Queen's subjects, today intellectual property 'as regulation' represents government magnification of the needs of the market—

Voreacos, *Walmart's Out-of-Control Crime Problem Is Driving Police Crazy*, BLOOMBERG BUSINESSWEEK, August 17, 2016, https://www.bloomberg.com/features/2016-walmart-crime/

[251] *See* Mark Lemley, *The Regulatory Turn in IP Law*, 36 HARV. J. L. & PUB. POLICY (2012) (suggesting that intellectual property law has come more and more to resemble government-directed regulation). *C.f.* Adam Mossoff, *Who Cares What Thomas Jefferson Thought About Patents? Reevaluating the Patent 'Privilege' in Historical Context*, 92 CORNELL L. REV. 953, 1009 (2007) (arguing that "natural rights philosophy played an important role, albeit hardly single-handedly, in defining and protecting patents as privileges in the early American republic.").

[252] C.f. Hemel & Fleischer, *supra* note 221, at 124 ("Some individuals might be unable to access the labor market *due to constraints imposed by the state*, such as the minimum wage or licensing laws.") (emphases added).

[253] Hrdy, *Patent Nationally, Innovate Locally*, *supra* note 31, at 1302.

[254] *See, e.g.,* Brett Frischman, *The Pull of Patents*, 77 FORDHAM L. REV. 2143, 2159 (2009) (symposium essay discussing how patent incentives can aggravate the market's "pull" on the direction of university research by biasing companies in favor of research with market potential).

including the market's need to cut costs by generating labor saving innovations. On this view of intellectual property, even anti-state libertarians should be more likely to condone some form of counter-corrective, if not necessarily full-on regulation or taxation.[255]

C. Crafting A Policy To Address Technological Un/employment

Assume we accept one or more of the above justifications for policy interventions. The next question is how to regulate technological un/employment in a way that doesn't make the problem worse or cause different, worse problems. Without advocating a single solution at this time, below I simply identify five threshold determinations that must be considered in crafting a policy.

1. Determining whether an innovation warrants regulation

The threshold issue for courts and regulators is how to identify an innovation that warrants regulation. In Part II.A., I defined labor displacing innovations as a subset of labor saving innovations: innovations that eliminate or significantly reduce the labor required to complete a task that would otherwise be performed by paid human workers. Sometimes it is easy to identify labor displacing innovations because the inventors advertise them that way. Think of Oracle's "self-driving" database, Courts or regulators would not have difficulty classifying this invention as a labor displacing innovation, given that the invention's express purpose as marketed to users is to eliminate the labor costs involved in database manipulation.

But most innovations would presumably have less obvious impacts on the work force. Indeed, inventions can have a multitude of possible uses, only some of which may have negative impacts on employment. For example, Kraft Food's patented method for making rindless block

[255] *But see* Hemel & Fleischer, *supra* note 221, at 124 (suggesting that "the fact that the state itself stands in the way of full employment would likely not convince a minimal-state libertarian to expand the state further by taxing for redistributive purposes.").

Swiss cheese (the "Stine process") had a long list of benefits, mostly related to the shape and size of the cheese produced by the process.[256] But it also happened to fit more easily into "labor saving trucks", permitting a reduction in labor costs.[257] It would have been difficult to predict this impact ex ante.

I do think courts and regulators can make these types of determinations, so long as they have sufficient data and a clear legal standard. Intellectual property doctrine provides a framework for classifying the impacts of "dual use" technologies, such as copying devices, which enable unauthorized copying of copyrighted materials (a bad thing), but also enable other benefits, like time-shifting. In these cases, courts ask whether the technology is "capable of substantial noninfringing uses."[258] In this context, courts or regulators can ask whether an innovation that has some labor displacing uses is also "capable of substantial non-labor displacing uses." To determine whether a technology has sufficient "non-labor-displacing uses" to outweigh adverse impacts on some peoples' jobs will still obviously require assessing significant evidence of actual and predicted impacts. At the least, this type of legal standard could serve as a starting point for making the difficult decision of whether or not to regulate.

2. Whether to target the point-of-invention or the point-of-adoption

The second question to consider is *when* to regulate within the innovation lifecycle. As described by Professor Brett Frischmann, there are two temporal targets for innovation policy.[259]

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[256] Kraft Foods Co. v. Walther Dairy Prod., 118 F. Supp. 1, 20 (W.D. Wis. 1954), aff'd, 234 F.2d 279 (7th Cir. 1956).
[257] *Id*. (noting that one benefit of the Stine process was that "[l]abor saving devices such as lift trucks [could] be used for handling the cheese made by the Stine process, which are not feasible with the large wheel Swiss.").
[258] Dontan Oliar, *The Copyright-Innovation Tradeoff: Property Rules, Liability Rules, and Intentional Infliction of Harm*, 64 STAN. L. REV. 951, 958 (2012) (quoting *Sony Corp. of Am. V. Universal Studios Inc*., 464 U.S. 417, 442 (1984)).
[259] *See* Brett Frischmann, *Innovation and Institutions: Rethinking The Economics Of U.S. Science and Technology Policy*, 24 VT. L. REV. 347, 356-357 (2000).

A policy can target ex ante investment decisions, which are made when inventors "decide how to allocate resources among prospective inventive prospects," or ex post investment decisions, which are made after the results of the invention have been developed.[260] Intellectual property rights, research grants, and R&D tax incentives, all target the ex ante decision point—whether and what to invent.[261] But many taxes and regulations target the ex post decision—whether and how to adopt an invention once it's been invented.

In this context, government would have to decide whether to use policy to affect the incentives of inventors, or of adopters. In some situations, this might mean regulating totally different entities. Inventors of improvements in automation are likely to be research firms, universities, or independent inventors, while adopters can be anything from large financial firms to pharmacy chains to mom-and-pop restaurants.[262] In other cases, the decision-maker may be the same entity. For instance, Uber is both an inventor self-driving car improvements and has plans to adopt it in the Uber ride-sharing business.

In some ways, the distinction is very important. Regulating at the point of invention would presumably make it less likely companies would invent labor displacing innovations in the first place. In contrast, regulating at the point of adoption would permit invention, but put strings on whether those inventions can be adopted in the marketplace. However, the distinction may not make much difference. Most regulations would presumably end up affecting both decisions to invent and decisions to adopt. For example, banning drones that can deliver

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[260] *Id.* at 356.
[261] *Id.* at 357.
[262] In these situations, adopters would have to purchase particular embodiments of labor displacing technologies through distributors, or they be asked to obtain a license to the underlying intellectual property. Either way IP owners would be profiting due to possession of an exclusive right. *See* Robert Merges, *A Transactional View of Property Rights*, 20 BERKELEY TECH. L.J. 1477 (2005) (viewing a key function of patents as facilitating disclosure and transfer of information related to innovations from creators to the most effective developers).

packages would deter their adoption in the marketplace, but would also affect decisions to invent in this field.[263] Likewise, taxing patents on drones that can deliver packages would affect both the decision to invent such technology, and the decision of whether to adopt it, since the tax would likely be passed on to businesses to some degree. In other words, because of the feedback loop between decisions to invent and decisions to adopt, whether government regulates at the point of invention or at the point of adoption should not strictly matter when it comes to affecting incentives.

There is, however, a very practical reason why the distinction does matter. In Part II.A., I defined labor displacing innovations as those that cause a significant reduction in the amount of paid human labor required to complete a task. This classification will become more and more difficult to make the earlier the government attempts to interfere. When government chooses to regulate at the point of invention, government must determine ex ante which innovations are likely to impact labor in the future, and how. When regulating the point-of-adoption, government already has a good idea about whether a labor displacing device has been used in the market and has or will realistically lead to significant firing of workers. The latter is probably much easier to administer than the former.

3. Which type of regulatory mechanism to use

We now come to the question of precisely which mechanism to use. Just because intellectual property law may be part of the problem does not mean it is part of the solution.

[263] The market for the technology would exert a "pull" on the direction of invention. *C.f.* Peter Lee, *The Push And Pull Of Patents,* 77 FORDHAM L. REV. 2225 (2009).

There are a multitude of regulatory mechanisms available for alleviating technological un/employment.[264]

a. Regulatory bans

The simplest option is to simply adopt a total ban a certain labor displacing technology.[265] Some nations might try this option in the coming years.[266] The effect of a ban is what it sounds like: no more of the banned technology within the jurisdiction. Advantages of a ban include that it is comparatively easy to administer and, on the surface, cheap. Government pays nothing directly, other than the cost of enforcement. Private actors also pay nothing directly—though their bottom line may suffer.[267]

But bans are highly vulnerable to the Hayekian objection.[268] With a regulatory ban, government's lack of knowledge is front and center because government must know at the outset which particular innovations to ban. Moreover, because a ban halts the prohibited technology in its tracks, it has a high likelihood of negatively impacting businesses' productivity, and of

[264] In general, government can use a "stick"—a negative incentive to deter people from acting in a certain way—or a "carrot"—a positive incentive to encourage people to act in a certain way. I mainly discuss sticks. *See* Ian Ayers & Amy Kapczynski, *Innovation Sticks: The Limited Case for Penalizing Failures to Innovate*, 81 U. CHI. L. REV. 1781, 1783 (2015).

[265] The Environmental Protection Agency (EPA) regularly bans or limits use of certain toxic chemicals. Rebecca Harrington, *The EPA Has Only Banned These Nine Chemicals—Out of Thousands*, BUSINESS INSIDER, February 10, 2016, http://www.businessinsider.com/epa-only-restricts-9-chemicals-2016-2

[266] For example, India's transportation minister recently floated the idea of banning driverless cars in the country, stating that "[w]e will not allow driverless cars in India. We don't need it[]…Each car gives a job to a driver. Driverless cars will take away those jobs[]…" Transport Minister Nitin Gadkari was quoted as telling reporters: *See* http://money.cnn.com/2017/07/25/technology/india-driverless-cars-jobs/index.html

[267] *C.f.* Robert P. Merges, *The Economic Impact of Intellectual Property Rights: An Overview and Guide*, 19 J. CULTURAL ECON. 103, 110–11 (1995) ("[Patents] something of a free lunch in the eyes of government: a valuable benefit for which business constituents will be grateful, but which also has a zero impact on the federal budget deficit."). *See also* Ayers & Kapczynski, *supra* note 264, at 1786 ("[I]f a government has a choice between a threat or a payment to induce innovation, ceteris paribus, the threat will be cheaper.").

[268] *See* Part IV.A.1. *See also, e.g.*, Cooter, *supra* note 210, at 378-379.

putting the jurisdiction at an economic disadvantage.[269] In other words, the concerns highlighted in Part IV.A are in fullest force.

b. Intellectual Property

Intellectual property law itself provides another avenue for effectuating some of the same goals as a ban. If we accept the premise of Part III that intellectual property increases the returns from inventing labor displacing innovations, then by the same token denying intellectual property for labor displacing innovations would decrease returns from doing so, and theoretically reduce incentives to invent, commercialize, and adopt them in the first place.

The most feasible way to institute this mechanism is through the patent system because this is the only intellectual property regime in which prior application is required to receive protection.[270] Like Queen Elizabeth, government, through the USPTO, could begin to deny patents for technologies that promise to eliminate significant numbers of jobs. For example, if NCR Corp. applies for a patent for a "labor saving consolidated checkout system" whose express goal is to "reduce labor costs" associated with the retail grocery or supermarket industry[271], this would be denied.

While a "job saving patent bar" could achieve the desired effect of dampening incentives to generate labor displacing inventions, the idea faces significant challenges. The first problem is simply that the patent office lacks legal authority to conduct these denials. The obvious legal means to accomplish this type of subject matter bar would be the utility requirement of Section 101 of the Patent Act.[272] However, as presently interpreted by the USPTO and the courts, the

[269] *See* Part IV.A.2. *See also* Hemel, *Should Robots Be Subsidized*, *supra* note 215, at 1.
[270] See 35 U.S.C. § 101.
[271] U.S. Patent No. 6522772B, 11, L14-19.
[272] 35 U.S.C. § 101.

utility requirement does not scrutinize the moral or economic implications of inventions.[273] Thus, in order to overcome long-accepted doctrine and case law from the Federal Circuit[274], a statutory amendment from Congress would almost certainly be required. I have no doubt Congress could use its power under the Intellectual Property Clause or the Commerce Clause to require scrutiny of patents for workforce impacts—though as I'm about to explain, it is not clear that Congress should do so.

The second problem has to do with government capacity. Patent examiners would need to be able to accurately discern which inventions will threaten the workforce. But the patent office is seen as having very limited information about issues external to patent law.[275] Patent examiners are often engineers and experts in technology and the mysteries of claim drafting. They seem unlikely candidates to become experts on labor markets. To mitigate this problem, examiners might only be charged with flagging *potential* labor displacing inventions. They could then require patentees themselves to submit an impact statement delineating how the invention is likely to impact the labor market. This would permit the examiner to draw on private knowledge in making its decisions. Alternatively, the examiner could put the patent's prosecution on hold, and forward the application and impact statement to a separate agency within the Department of Commerce, such as the Small Business Administration (SBA).

A final objection is that an intellectual property subject matter bar seems a highly round-about way to affect incentives. As explained, denying an intellectual property right does not deny

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[273] Seymore, *supra*, at 1047.
[274] *Id*. at 1059.
[275] *See* Robert Merges, *Intellectual Property In Higher Life Forms: The Patent System And Controversial Technology*, 47, MD. L. REV. 1051, 1062-68 (1988) (noting that the patent system is not seen as the proper governmental institution in which to make speculative judgments regarding the "potential negative consequences" of new technology).

the right to use the technology. It just denies the exclusive right to do so. Government might be better off just banning problem technologies outright. On the other hand, we might actually *like* the fact that a labor displacing bar would merely blunt incentives, not ban innovations outright. As explained in Part IV.B., a major concern people will likely have with regulating labor displacing technology is that this would distort market signals about where to invest inventive energy, and make the businesses less productive. Denying intellectual property rights could represent a compromise option in comparison to a total ban.

That said, if all we are trying to do is dampen incentives to adopt labor displacing innovations, we would probably be better off using the tax system.[276] This is especially true if we wish to provide aide to displaced workers. A major downside of the intellectual property bar, as compared to a tax, is that it would not directly provide any financial aide to displaced workers.[277] They might be left with the worst of both worlds. Subject matter bars would not actually prevent companies from automating; and they would not redistribute any of the profits. In sum, even if subject matter bars are somewhat effectual in deterring automation of work, they would be only a partial solution for workers.

c. Tax

Tax represents a natural alternative to the above options. Government would impose a tax (a required payment of cash into the public fisc) upon companies that decide to invent or adopt technologies that have an adverse impact on jobs. The tax can be imposed on two discrete

[276] *C.f.* Hemel & Ouellette, *supra* note 213, at 303 (noting that tax incentives have many of the same advantages as intellectual property rights as innovation incentives).
[277] A ban on IP for labor displacing innovations might lower prices for downstream consumers, who might also be workers. Hemel & Ouellette, *supra* note 213, at 371 ("[P]atent rights operate as shadow taxes that enable patentees to charge prices above marginal cost.").

groups: the businesses that implement robots or other labor displacing innovations, or the owners of intellectual property rights in those labor displacing innovations.

i. Robot Tax

The most oft-discussed tax proposal along these lines is the so-called "robot tax."[278] In an interview, Bill Gates discussed two version of this tax. The first version would tax business profits derived from adopting robots (and presumably other types of labor displacing innovations) in lieu of humans. This tax would thus be proportionate to the labor costs saved.[279] The second version would tax the owners of the robots at the same rate the robots would have been taxed if they were human workers.[280]

The robot tax has several features that make it a potentially attractive policy solution. First, a tax forces companies to internalize the costs of automating labor. Thus, a tax would at least marginally discourage companies from replacing humans with technology.[281] Second, unlike a ban, the tax would not interfere significantly with the impact of market forces on technology development.[282] Companies would still be permitted to proceed with their plans.

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[278] For critique of a robot tax from the "productivity is everything" perspective, see Hemel, *Should Robots Be Subsidized?, supra*, at 1 ("The concern that motivates most of these robot tax proposals… is that robots will replace human labor as an input into the production process, leading to higher unemployment and economic inequality.").

[279] "Certainly there will be taxes that relate to automation[,]" Gates predicted. "There are many ways to take that extra productivity and generate more taxes. … Some of it can come on the profits that are generated by the labor saving efficiency there." *See* "The robot that takes your job should pay taxes, says Bill Gates", QUARTZ, February 17, 2017, https://qz.com/911968/bill-gates-the-robot-that-takes-your-job-should-pay-taxes/

[280] Gates explained this version of the "robot tax" idea as follows:

> Right now, the human worker who does, say, $50,000 worth of work in a factory, that income is taxed and you get income tax, social security tax, all those things. If a robot comes in to do the same thing, you'd think that we'd tax the robot at a similar level.

Id.

[281] Above I debated whether this is technically a "negative externality." Part IV.B.1.

[282] *See* Frischmann, *Innovation and Institutions*, *supra* note 259, at 382 ("…[T]ax incentives have the potential to improve market-based efficiency by providing indirect subsidies that align private firms' incentives in a socially desirable fashion."); *see also* Hemel & Ouellette, *supra* note 213, at 328 ("[T]ax incentives, like patents, rely on potential innovators—rather than government officials—to decide (1) which inventions are worth pursuing and (2)

They would simply be penalized for doing so. This helps respond to both the Hayekian objection and the "productivity is everything objection."[283] Third, a tax is imposed relatively late in a technology's lifecycle, at the point-of-adoption rather than the point of invention. Lastly—and most significantly when compared with the intellectual property solution—a tax would permit government to collect revenues to potentially be redistributed via the tax system to those who are harmed by labor displacing innovation.

ii. A Tax On Labor Displacing Intellectual Property

A distinct option is to tax the owners of intellectual property covering labor displacing innovations.[284] One version of this is a "job displacing patent tax". This would be similar to the job displacing patent bar described above, except the penalty of patenting a labor displacing invention would be a tax, not a denial of the patent. Also, the tax could be implemented at the point-of-adoption rather than during the patent application stage. This would allow time to see whether the invention is actually adopted in the workforce and used to eliminate large numbers of workers—alleviating the administrative difficulty in point-of-invention regulation.[285] Lastly, the main agency responsible would be the Internal Revenue Service (IRS), not the USPTO. This would assuage some of the concerns discussed above about the USPTO's institutional capacity.

The assumed effect of a job displacing patent tax would be a marginal reduction in patenting of labor displacing inventions, and a new stream of revenues from companies that

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which R&D projects are most likely to yield the inventions in question. Like patents, tax incentives cause innovators to pursue inventions that will succeed in the market[]…").

[283] *C.f.* Hemel, *Should Robots Be Subsidized?, supra* note 215, at 1.

[284] For example, Professor Robert Reich speculates a universal basic income (UBI) might be "financed out of the profits going to …labor replacing innovations, or perhaps even a revenue stream off of the underlying intellectual property." Robert Reich, *Why We'll Need a Universal Basic Income*, September 29, 2016, http://robertreich.org/post/151111696805 *See also* ROBERT MERGES, JUSTIFYING INTELLECTUAL PROPERTY 132-133 (2011) (discussing limited taxation of IP owners as a way to force innovators who benefit from IP to give back to society).

[285] *See* Part IV.C.2.

choose to patent labor displacing inventions anyway.[286] Even if the reader does not buy that automation generates negative externalities for workers,[287] she might see significant merit in the idea of a labor displacing intellectual property tax from a fairness perspective. If we are worried about a future in which a lot of people don't have jobs, while others profit off the inventions that now perform those jobs, then it seems fair to give some of those profits back to the people who are harmed. This may seem even more fair than instituting a robot tax on businesses that adopt robots. Those businesses may be operating with small margins; and unlike intellectual property owners, they are not benefitting from increased profits due to an exclusive right. That said, as explained above, the tax on intellectual property owners might ultimately be passed on to adopting businesses anyway.

4. What to do with the money

Once the policymaker decides to pursue a tax and redistribution strategy, a separate question is what to do with the proceeds. One possibility is to institute a "universal basic income" (UBI). A UBI is a guaranteed minimum income in the form of cash paid out to everyone on a periodic basis, irrespective of whether they are employed or what their income is.[288] Several influential thinkers have spoken of a UBI as a potential panacea for a jobless future.[289] The UBI has usually been proposed as a traditional progressive tax, transferring wealth

[286] *See* Part III.C.1. One complication is that some inventors might choose secrecy rather than patenting to avoid incurring the tax. A way to prevent this type of distortion would be to tax income from licensing of intellectual property, including trade secrets, rather than patents themselves.
[287] See Part IV.B.1.
[288] *See generally* Fleischer & Hemel, *supra* note 221, at 104-107.
[289] Examples include Elon Musk and Robert Reich, discussed herein. *See also id.* at 110, n. 31 (noting fears about automation are a reason for more attention to adopting a UBI).

from rich to poor.[290] But a UBI could also be used in association with a tax on innovators. For example, both the robot tax and the job displacing patent tax could be used to fund a UBI.[291]

But the redistribution would not have to come in the form of cash.[292] Indeed, some people believe guaranteed subsistence payments would have perverse effects on peoples' incentives to work, and would exacerbate rather than help the under-employment problem.[293] Some people see this as a positive. It could be *good*, Professor Reich suggests, if people could "have more free time to do what they want instead of what they have to do to earn a living."[294]

Another commonly discussed option is to use the tax proceeds for education and skills training in order to help prepare workers to take on new jobs in the wake of technological shifts.[295] For example, when self-driving cars become the norm, people who drive for a living could be taught how to perform other tasks such as maintaining or coordinating the vehicles. Rather than asking government to control skills training, companies in the private sector such could be given subsidies or tax credits to reach out to workers and train them. That said, for skills training to work, government would need to provide more support for K-12 education as well.

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[290] As Professors Fleischer and Hemel explain, a UBI would presumably be drawn from richer people, who would pay more in taxes, and then 'redistributed' to the less wealthy, who would pay less in taxes but receive the same UBI. *Id*. at 104 ("[The UBI is,] at its core, a program of income redistribution.").
[291] *See* discussion of Reich's proposal in note 284 *supra*.
[292] Some might prefer the cash option for a variety of reasons. *See* Fleischer & Hemel, *supra* note 221, at 144 ("Libertarians will generally prefer cash transfer schemes rather than in-kind programs on the grounds that cash transfers promote recipients' autonomy and self-ownership, whereas in-kind transfers exemplify the type of paternalism that libertarianism abhors.").
[293] Dan Nidess, Why a universal basic income would be a calamity, THE WALL STREET JOURNAL, Aug. 11, 2017, at A22 (speculating that "millions of Americans" would "become dependent on the government and the taxpaying elite."). *See also* Fleischer & Hemel, *supra* note 221, at 158 ("[An] objection to a UBI is that recipients will reduce work effort or drop out of the labor force altogether.").
[294] Reich, *supra* note 293, at 1.
[295] Citi/Oxford report, *supra*, at 115-124 (discussing how the education sector can respond to the challenge of skills training). *See also* BESSEN, LEARNING BY DOING, *supra* note 16, at 19-20 (arguing technology policy should include more focus on skills training to help workers adapt to new technologies); *id*. at 133 ("The real problem is that new technology-related skills are difficult to acquire and most workers cannot yet gain much benefit from the new skills they do acquire.").

This would not ensure anyone who wants a job can get one—and it would not help anyone if machines can do all possible jobs—but it would at least give workers more of an opportunity to participate in an economy of pervasive automation of tasks.[296]

5. Which level of government should be responsible?

A final issue to consider is the question of governmental allocation: which part of the United States government should be responsible for crafting and administering a policy to address technological un/employment? The topic is beyond my current scope. But I have previously argued that some kinds of innovation policy are better effectuated by at the state and local level.[297] Local governments often have superior incentives to act on behalf of constituents, and superior information about local conditions, such as availability and make-up of the workforce.[298] This would also permit tailoring of policies to different regions. For example, a state robot tax could be instituted in Alabama, but not in California. Proceeds could be used to train workers in the region.[299]

On the other hand, a better option might be to institute such taxes at the federal level, because this would permit a geographic redistribution.[300] For example, under a job displacing patent tax, innovators in Silicon Valley, who own more patents than anywhere else in the

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[296] *See, e.g.,* Claire Cain Miller & Jess Bidgood, *Preparing Young Children For The Automated Economy,* THE NEW YORK TIMES, Tuesday, August 1, 2017, at A15 ("Jobs are likely to be very different [in the automated economy], but we don't know which will still exist, which will be done by machines and which new ones will be created. To prepare, children need to start as early as preschool, educators say.").
[297] Hrdy, *Patent Nationally, Innovate Locally*, *supra* note 31, at 1302.
[298] *Id*. at 1334-1340.
[299] If states decide to tax intellectual property rights, there could be some interesting preemption issues. For instance, if a state imposed an 80% tax on certain patents, this would likely be preempted by the Intellectual Property Clause and the Patent Act. Hrdy, *The Reemergence of State Anti-Patent Law,* 89 U. COLO. L. REV. 101, 154-155 (2018). *See also* MERGES, JUSTIFYING INTELLECTUAL PROPERTY, *supra* note 284, at 133 ("[A]t some point, tax rates climb so high that, in principle anyway, the state may be seen to overstep the proper bounds of its authority.").
[300] *See* Hrdy, *Cluster Competition*, 20 LEWIS & CLARK L. REV. 3 (2016) (arguing that the federal government can use federal funding for emerging innovation clusters to "effectuate a geographic redistribution of resources from richer to poorer states.").

country, would pay taxes; and the proceeds would be used to train workers in other parts of the country, who are being displaced by those inventions at higher rates. Even if the tax is instituted at the federal level, administration of benefits programs should arguably done at the local level, especially if the proceeds are used for education and skills training. Indeed, state and local governments already administer a wide range of job creation programs, including skills training, many of them specifically directed at developing a suitable workforce for companies in the technology sector.[301]

V. Conclusion

The major focus of IP scholarship has been on whether intellectual property promotes innovation.[302] But this article shows that if intellectual property is successful in promoting innovation, then by necessity intellectual property also facilitates and accelerates the pace of technological un/employment: the simultaneous elimination and creation of jobs brought about by technological change.

The article generates two testable hypotheses regarding intellectual property's role. First, the Incentive Effect theorizes that intellectual property protection magnifies incentives to invent and commercialize labor displacing technologies, and thus marginally increases the size of the universe of labor displacing innovation, as well as the pace at which these innovations come into existence. [303] Second, the Distribution Effect theorizes that intellectual property, by design, increases returns for intellectual property owners and, accordingly, increases demand and wages for highly skilled employees who are necessary to generate intellectual property. But at the same time, intellectual property makes it marginally more likely that innovations will be developed

[301] Hrdy, *Patent Nationally, Innovate Locally*, *supra* note 31, at 1362-72.
[302] *See, e.g.,* MERGES, JUSTIFYING INTELLECTUAL PROPERTY, *supra* note 284, at 1-11.
[303] *See* Part III.C.1.

that displace other workers. The upshot is that intellectual property magnifies the unequal division of returns between IP owners and IP-generators, and everyone else. [304]

To be clear, innovation is a very good thing. Innovation has been shown to be essential to the economic prosperity of nations. And labor saving innovation is arguably one of the most important subsets of innovation in this regard precisely because it increases productivity.[305] Moreover, the entire point of this article's title, *technological un/employment*, is that innovation, and I argue intellectual property itself, tends to create new jobs—sometimes very good ones—even as it destroys or diminishes others.[306]

But like other commentators, I am not certain innovation is on net going to create more jobs than it displaces in the near future. I am also disturbed by the declining quality and distribution of available jobs, and the failure of education and skills training opportunities to keep pace.[307] That said, if people like Mr. Gates are serious about taxing companies that use robots, they should make their proposals more precise, and be clear about the underlying goals. I do believe some form of policy is necessary to address this situation, and that such intervention can be justified based on ideas about externalities, as well as distributive justice.[308] At minimum, the policymaker must consider the following issues: (1) how to identify a "labor displacing" innovation that warrants regulation; (2) whether to regulate innovation decisions at the point-of-invention or at the point-of-adoption; (3) which type of regulatory mechanism to use (ban, tax, intellectual property); (4) what to do with the money, and (5) which level of government should be responsible.

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[304] *See* Part III.C.2.
[305] LERNER, *supra*, at 16. *See also* Hemel, *Should Robots Be Subsidized? Probably*, *supra* note 215, at 1.
[306] *See* Part II.B.
[307] *See* Part II.C.
[308] See Part IV.B.

Most importantly, policymakers must not forget why we have intellectual property and innovation policy in the first place—to preserve markets' incentives to innovate. Government cannot stop the tide of market inclinations to automate work. At most, government should try to marginally alter incentives, and focus on alleviating the negative impacts on some members of society through means such as investment in education and skills training, whether funded by rich people or by innovators themselves. Indeed, slowing things down is arguably government's very role in this type of circumstance.[309]

[309] KARL POLANYI, THE GREAT TRANSFORMATION 39 (1944, Beacon Press 2d ed.). ("Why should the ultimate victory of a trend be taken as a proof of the ineffectiveness of the [government's] efforts to slow down its progress? And why should the purpose of [government's] measures not be seen precisely in that which they achieved, i.e., in the slowing down of the rate of change?").