# DON'T FEAR THE ROBOTS:

## Why Automation Doesn't Mean the End of Work

A JOINT REPORT FROM:

ROOSEVELT INSTITUTE
REIMAGINE THE RULES

THE SAMUEL DUBOIS COOK CENTER ON SOCIAL EQUITY
AT DUKE UNIVERSITY

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# Acknowledgments

*The author thanks Dean Baker, Josh Bivens, Lenore Palladino, Frank Pasquale, and Todd Tucker for their comments and insight. Roosevelt staff Nell Abernathy, Kendra Bozarth, Jessica Forden, Rakeen Mabud, and Marshall Steinbaum all contributed to the report.*

***This report was made possible with the generous support of the Robert Wood Johnson Foundation. The contents of this publication are solely the responsibility of the author.***

# / Executive Summary

The narrative that large-scale automation will imminently lead to mass unemployment and economic insecurity has become prevalent in the media. As the story goes, we are on the cusp of a major technological change that will drastically alter the nature of work, leave masses unemployed, and exacerbate already high levels of economic inequality.

In this paper, we argue that this narrative detracts from the bigger underlying problems with the rules of our economy and the distributional consequences of increased automation under current institutional arrangements.

First, we find that there is little evidence to suggest that the U.S. economy is approaching massive technological change: productivity levels are remarkably low and capital investment is significantly slower than would be expected under impending technological upheaval. Second, historical evidence suggests that even if we were on the verge of rapid technological change, mass unemployment would not be inevitable. In the past, the long-term effects of technological advancement on employment have been positive. Technology has allowed workers to do their jobs better and faster, which in turn, increased output and raised living standards.

As with any major structural shift in the economy, technological change has the potential to create job loss in the short term but does not necessarily lead to net job destruction in the long term. The amount of work available is not a fixed quantity, and technology can complement labor, instead of substitute for it, making workers more productive rather than simply replacing them. The job gains from technology often outpace the job losses over time and allow workers to focus on better, high-productivity jobs.

However, we should not trivialize the costs of this kind of economic transition for workers in the short term, nor can we ignore the structural disadvantages in today's economy that define economic outcomes. Workers are right to be concerned about the negative effects of technological change because the historical link between labor productivity and wages, which grew side-by-side for most of the 20th century, is broken. In the past, productivity growth from technological innovation led to shared prosperity for workers, including higher wages and better living standards. When that link broke, it changed how the economic pie was divided.

In order to fix this broken link, we propose a few policy changes that would ensure that economic growth from technological change benefits everyone:

- Full employment: The U.S. government should recommit to pursuing full employment. Implementing full employment would create a significantly tighter labor market, which would both encourage technological advance and nullify the potential negative effects of technology on workers.

- Revised intellectual property law: Intellectual property law is a primary reason why technological advances currently exacerbate inequality. While a first step would be reducing the lengths of patents and copyright protections, more substantial measures should also be pursued.

- Public guidance in technological development: Government has a sizeable role in leading the direction of innovation through funding research and establishing research agencies. The government should focus on tech innovations that complement workers.

- Work sharing: The U.S. should adopt work sharing in two ways. First, in reducing the overall hours typically worked by individuals; and second, by temporarily reducing working hours during economic downturns, rather than laying off workers.

- Free higher education and vocational training: Education and training are vital components in advancing society and maintaining a productive workforce. More accessible options should be made available to the public.

While these are not a comprehensive list of potential policy changes, they provide a starting point to for moving toward an economy where all workers share the gains from technological advancement.

# / Introduction

A narrative of imminent mass unemployment and economic insecurity due to rising automation, also known as "the robot revolution," is gripping policymakers, workers, and the media (Cixin 2016). Conflicting reports hype up the supposed inevitability of a large-scale displacement of workers by the robots. A 2013 paper by researchers at Oxford University warns that 47 percent of jobs in the U.S. are at risk of being automated, while a 2017 McKinsey Global Institute report claims that one third of American workers will be displaced from their current occupations by impending automation (Frey and Osborne 2013; Manyika et al. 2017). Other reports offer a tammer outlook, with a recent Organisation for Economic Co-operation and Development (OECD) report (2018) finding that only 9 percent of jobs in the U.S. are "highly automatable." Such wide-varying claims are stoking fears about the future of work and the continued erosion of secure and stable employment.

What is left out of the story is the fact that automation, on net, has provided far more jobs than it has destroyed. To be sure, technological change has destroyed jobs and occupations, but it has also created far more new jobs. As a recent Deloitte report, aptly titled "Technology and People: The Great Job-Creating Machine," argues "the last 200 years demonstrates that when a machine replaces a human, the result, paradoxically, is faster growth and, in time, rising employment" (Stewart et al. 2015).

While the lackluster recovery has largely left workers behind, futurists are pointing to an even more troubling phenomenon on the horizon. The story goes like this: "[W]e're living in a time of astonishing progress with digital technologies," and as these technologies, including the rise of artificial intelligence (AI) and the infamous robots advance, are honed, they will become cheaper and more widely accessible (Brynjolfsson and McAfee 2014).

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In time, they will be broadly adopted into the production process as these technologies will slowly learn to do many of the jobs currently done by humans—from driving our cars and trucks to taking and making our order at the local fast food joint. The result according to the robot enthusiasts? Large swaths of the population will be unemployed and empty handed, while the few superstar workers who program the new technologies will thrive. This will further divide the U.S. along economic lines, causing deeper rifts in an already troublingly divided society.

The traditional story of androids overthrowing human labor does highlight that not everyone will be affected equally by the supposed impending mass technological unemployment. Futurists and economists have claimed that the rise of the robots will likely displace "low-skilled" workers in far greater numbers than "high-skilled" workers, thus further exacerbating our already deeply unequal labor market and society.[1] Further, these technologies can be used to discipline labor, as workers who demand higher wages or better benefits can simply be replaced by R2D2000. If large disruptions in the labor market occurred, they may lead to large-scale unemployment, suppressed wages, and declining labor force participation rates. At the same time, the winners from the robot revolution, those who own the intellectual property (IP) and the workers who are essential to run such technologies, will likely see massive windfalls. In the end, "technological progress is going to leave behind some people, perhaps even a lot of people, as it races ahead" (Brynjolfsson and McAfee 2014).[2]

This debate has played itself out throughout history—multiple times. In 1961, *Time Magazine* ran "The Automation Jobless," which stated a familiar story: "What worries many job experts more is that automation may prevent the economy from creating enough new jobs. Today's new industries have comparatively few jobs for the unskilled or semiskilled, just the class of workers whose jobs are being eliminated by automation." Yet automation did not stunt new job creation. In 1961, the economy supported about 53 million nonfarm jobs, while the economy today supports over 148 million (BLS 2018).

Economists have long argued that technological change, which can be seen in the productivity growth numbers published by the Bureau of Labor Statistics (BLS), is how the economy improves average living standards (BLS 2018a). Historically, labor productivity, which is a measure of the amount of goods and services that the average worker produces in an hour of work, has been one of the best indicators to track growth in average living standards. This is because technological change leads to a rise in labor productivity, which in turn grows the economy and has historically increased wages, decreased prices of consumer goods, and lead to higher amounts of leisure for workers. In the current case, we can think of robots, AI, etc. as the next wave of technological change.

Of course, the reality of technological change is not so simple. Technology has, on balance, been a tremendous boon to the economy and our society—despite the fact that there are some substantial costs associated with technology. Real workers will lose jobs. Communities will be devastated without adequate transition policies in place. But when technology replaces workers, it is not always bad. Throughout history, technology, machines, and the automation process have increasingly taken over routine, mechanical, and dangerous work. In turn, technology has released human resources to conduct activities beyond those that are required for mere subsistence. Further, workers are also consumers. Technological advances frequently result in lower prices, improving the living standards of households; but if the household's worker(s) are out of a job, lower prices will not make up for lost employment and income. Of course in a high pressure labor market, workers should be able to find alternative employment—but we know that is not so simple.

1 This is the skill-biased technical change story, which does not necessarily depend on a speedup of productivity, but rather on the relative displacement of "low-skilled" workers.
2 For another critique of Brynjolfsson and McAfee, see "A Silicon Valley Catechism" by Frank Pasquale in *Issues in Science and Technology*.

But while technological change in aggregate increases living standards and has the potential to improve job quality, we must ask "for whom?" The job of policymakers is to handle these challenges in a socially desirable way, ensuring that the overall gains from technology are shared, and the potential losers, such as the people displaced by technological advances, are compensated, transitioned to new jobs, and included in the ensuing growth.[3]

Interestingly, stories of automation vary substantially across countries. In the U.S. a PEW Foundation survey of experts found that 48 percent of them thought robots and other new technologies would displace significant numbers of workers, including both high- and low-income workers, with many experts noting "permanent unemployment" was a very real possibility (Smith and Anderson 2014). Further, over two thirds of Americans think technology will perform the majority of work currently done by human workers within 50 years, stoking further fears of unemployment (Smith 2016). Yet this is not the case in many countries with stronger labor market institutions that ensure workers have a say in the direction of change within firms and sectors and have maintained the historic link between technological change and rising real wages for the majority of workers. For instance, in Sweden, 80 percent of people have a positive view of robots and AI. Rather than worrying about job displacement, they embrace it. As Sweden's Minister for Employment and Integration Ylva Johansson told *The New York Times*, "The jobs disappear, and then we train people for new jobs. We won't protect jobs. But we will protect workers" (Goodman 2017). After all, increased use of technology, which leads to high labor productivity, is a significant part of how high-income countries stay competitive in an increasingly global economy.

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Workers in the U.S. seem to be skeptic of potential technological change, perhaps because the link between economic growth and broad-based wage gains is broken in this country. If the rules of the economy are not changed to rebalance worker power, future technological developments will likely further exacerbate inequality and displace workers in our already deeply divided country. However, little work has challenged the impending doom narrative and sought to find another path forward. After all, automation has historically been a job creator, a critical way the U.S. remains competitive in an increasingly global economy, and a primary driver of rising living standards.

Inequality, including worker displacement from employment, is one of the main concerns posed by the proliferation of new technology. In this paper, we argue that the relationship between automation, inequality, and unemployment is important, but that this relationship is dictated by the institutional arrangements that govern the economy rather than being predetermined by some natural law of economics. The rules of the economy decide who wins and who loses from automation. Historically, we have seen times where automation has led to widespread shared prosperity and near-full employment;[4] we have also seen that throughout most of history, automation has improved long-run living standards, but sometimes at tremendous short-term costs to workers and communities.

3 For an excellent brief history on automation and its effects on employment, see Akst (2013).
4 This is primarily a white male phenomena. For instance, black workers have never seen levels of unemployment anywhere near what one could deem to be "full employment."

The are several questions that we will address in this paper. In the first section, we ask if technological change has lead to broad-based increases in average living standards and employment in the past. Through a historical overview of this relationship, we argue that technological change has resulted in an *increase* in the numbers of jobs in the economy while simultaneously *raising* living standards.

***The rules of the economy decide who wins and who loses from automation.***

Next, we ask if rapid structural change in the economy via large-scale, labor-displacing automation (i.e., rapid productivity growth) is here or on the horizon. While this is a contentious question, we find that the evidence shows no recent or impending significant uptick in automation; however, we delve into potential reasons why automation may not be showing up in the data yet. While there have been impressive improvements in technology recently, we have three conclusions from this section: 1) automation is an ongoing process that will continue; 2) economists are worried about productivity numbers, noting that the economy is growing too slow and lacks sufficient technological advances to support robust growth; and 3) we conclude that there is no evidence to support the story proclaiming that rapid automation will occur in the very-near future.[5]

In the second section, we address the current narrative which posits that automation will lead to mass *permanent* unemployment (i.e., the destruction of work). First, we unpack the important distinction between the destruction of jobs and the permanent destruction of work as it relates to automation. There will unquestionably be new technological advances that lead to sizable displacements of workers in certain occupations, industries, and firms, but the labor market is dynamic. This is a feature, not a bug, if we have the institutions right. During times of economic transitions, such as those arising from technological change, economies are frequently slow to react; the economy can take significant, and painful, time to adjust for and absorb displaced workers. But transitions do not last forever. Rather than automation leading to permanent unemployment, we argue that automation has historically created far more jobs than it has destroyed, and that this process will continue. Nevertheless, the troubling findings for workers and our communities is that if we have significant increases in technological change in the future, the adjustment period can be difficult without the right institutions in place. Such transitions, if left to the market, can result in sizable amounts of *temporary* technological unemployment.

The remainder of this section looks at various forms of automation and the potential effects on the labor market. While techno-enthusiasts generally claim automation will displace workers, we argue that automation can also complement workers—resulting in higher rates of both employment and wages. When technology is a substitute for workers, it can be used to discipline workers, tipping the already skewed balance of power more towards the bosses and business owners. On the other hand, when technology complements workers, workers are more likely to share in the benefits through increased wages, improved working conditions, higher rates of employment, and rising living standards.

Finally, in the third section, we discuss policy recommendations to rebuild the bridge between productivity growth and rising living standards for workers across the wage distribution. Importantly, we work to reframe the debate to ask how policymakers can change the rules of the game to ensure that any future automation will work for all. Based on our finding that the historic link between automation and rising wages for most workers has weakened in the U.S., this section considers policies to rebuild that bridge. Specifically, we focus on reducing inequality and securing a permanent full-employment economy. This builds on our findings that public policies largely govern what types of technologies are pursued and how the benefits and costs from the creation and implementation of those technologies are distributed.

5 It is worth noting that it may be nearly impossible to predict what technological changes will occur in the next 5, 10, or 20 years. For more on this view, see Dan Gardner's and Phil Tetlock's *Superforecasters*.

# SECTION ONE

## Automation: Past and Present

Technological change is an integral part of economic growth. A historical overview of technological change demonstrates that the social costs of such change—including the dislocation of workers, stemming from past technological advances—underscore the need to prepare for the inevitable adjustments to the production process and labor market that lie ahead. While technological change is forever on the horizon, we will spend the bulk of this report concerned with *who* will reap the rewards from new technology, and *how* those rewards can be used to foster full employment and the rise of real wages across the economy. First, we discuss the relationship between technology and living standards, then the following sub-section will address the question of employment.

What is technological change? Technological change includes new methods of production, new designs of goods and services, and the rise of entirely new goods and services. Thus, automation and robots are one narrow part of technological change, though we will use these terms interchangeably in this paper. Technological change is exemplified by inventions and innovations, such as the automation of cars, the reorganization of the work process (think about the profound changes brought about by the assembly line), the introduction of artificial intelligence (AI) and intelligence augmentation (IA), the development and improvement of antiretroviral therapy, etc. Sometimes these come in the form of eye-popping changes, like the advent of the self-driving car. In other instances, some of the most revolutionary technologies are easy for most people to look right past—such as the shipping container which helped revolutionized global trade.

In general, technological change, or **automation**, reflects the ability to get more output from the same amount of inputs. For instance, we produce far more cars today per worker thanks to the assembly line and partial mechanization of the production process than we did when Ford first started producing automobiles. In terms of measuring technological change, either the rate of change or the economic effects, there is no direct method or number economists can point to. Thus, economists commonly rely on **labor productivity**, which is a measure of the amount of goods and services that the average worker produces in an hour of work, to measure technological change. A worker today, for instance, is roughly three times more productive, meaning they can on average produce three times as much stuff per hour, than a worker in 1960.

Figure 1 depicts Real Gross Domestic Product from 1947-2017. This is simply representing labor productivity times employment. The takeaway from this graph is that the U.S. economy today is eight times larger than it was around 1950. This arises from significant increases in labor productivity, which is largely due to technological change, and the number of workers and jobs in the economy, both of which have risen significantly during this time period.

FIGURE 1

## Real Gross Domestic Product

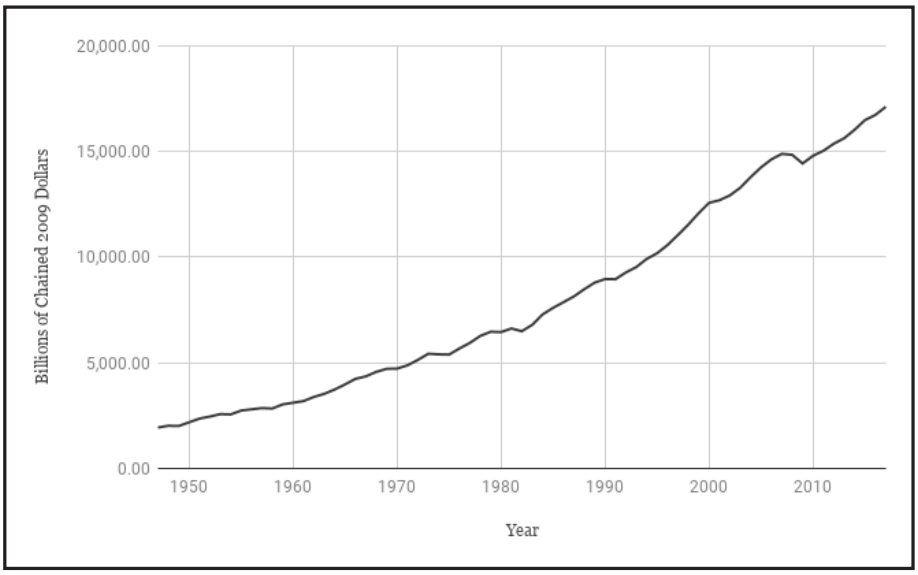


**Figure 1 Source:** St. Louis Fed, FRED Economic Data: https://fred.stlouisfed.org/graph/?graph_id=467375.

The benefits of technological progress are numerous, with rising living standards atop the list. By and large, economists agree that the level of productivity is the single largest determinant of a country's average living standards, with more rapid productivity growth, much of which occurs from technological advance, leading to more rapid increases in average living standards. For the bulk of modern history, we have witnessed technological developments improve wages and living standards. This can be easily observed by viewing the link between labor productivity and wages, which grew near hand-in-hand for a great deal of the 20th century, a point we will return to below (Bivens and Mishel 2015).

Increasing wages is one major benefit to technological advances, but there are others.[6] Technology has allowed for better working conditions, the elimination of many menial jobs, the shortening of work hours and increase in leisure time, and the growing abundance of basic goods, such as food, housing, and clothing. Not only has technology improved our lives, but it has also played a major role in the sizable increase in average life expectancies. For instance, the average person in 1900 lived to only 47, compared to an average life expectancy of 79 years today.[7] Further, technological change has significantly reduced morbidity and mortality rates on the job, helping to improve workplace safety and mechanizing jobs that used to result in high rates of injury and death (OSHA 2011).

Technological change has also helped reduce the burden of care work for large segments of the population. While technology has by no means brought about gender parity in work, major changes have nevertheless been made that have reduced hours worked in the household for many traditional caregivers. Consumer durables, like the washing machine, microwave oven, and personal computer, have, to some degree, served as "engines of liberation" for women in particular (Greenwood et al. 2005).[8] For instance, Bureau of Economic Analysis (BEA) estimates show that hours spent on home production has declined from 40 hours per week in 1965 for women to 26 hours per week for women in 2010 (Bridgman et al. 2012).[9]

6 While wages may have increased at the median, we now know that workers in the bottom half of the income distribution have not seen a raise in a generation despite significant advances in technology and aggregate income growth (Piketty et al. 2018).
7 Recent evidence highlights that average life expectancy is on the decline, with inequality being one of the primary contributors (Case and Deaton 2017).
8 See Hans Rosling discuss the transformative nature of the washing machine here: https://www.youtube.com/watch?v=BZoKfap4g4w&feature=youtu.be
9 In 1965, women spent nearly three times more hours per week than men doing household work. In 2010, women spent roughly one and a half times more hours per week than men doing household work.

While historically there has been a robust link between technological advances and workers' living standards, times have changed. Research from the Economic Policy Institute has shown a divergence between technological advances and wage gains for average workers in the United States. Since the 1970s, wages for non-supervisory workers (i.e., not the managers) have largely been stagnant, yet productivity continues to rise. This can be observed in Figure 2 below. First, we see that wage growth and productivity increases were rising in tandem, as discussed above. But things changed in the 1970s: Technological advances continued to grow the economy, but the benefits from making the economic pie larger were no longer being shared with the majority of working households. Thus, while technology has continued to benefit the economy at the aggregate level, how those benefits are distributed has changed.

***While technology has continued to benefit the economy at the aggregate level, how those benefits are distributed has changed.***

FIGURE 2

## Divergence Between Hourly Compensation and Net Productivity Growth

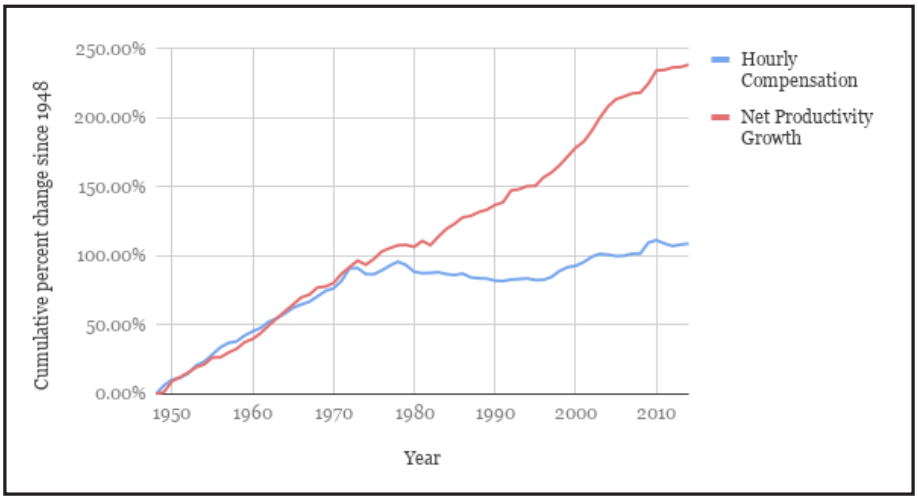


**Figure 2 Source:** Economic Policy Institute, Understanding the Historic Divergence Between Productivity and a Typical Worker's Pay: https://www.epi.org/publication/understanding-the-historic-divergence-between-productivity-and-a-typical-workers-pay-why-it-matters-and-why-its-real/#epi-toc-11.

*Note: Data are for average hourly compensation of production/nonsupervisory workers in the private sector and net productivity of the total economy.*

Researchers continue to debate the modern link between productivity and compensation,[10] but it is clear that there is no natural law within capitalism that governs who benefits and who loses from productivity increases. If the recent trends in Figure 2 continue, most working households will see marginal benefits and perhaps even further labor market displacement from technological change. If, in theory, we were in an economy where full employment was the norm, and the historic link between productivity growth and wage growth remained intact, there would be little concern about automation.[11] After all, as long as society has needs, there will be work.

10 See recent contributions by Anna Stansbury and Lawrence H. Summers (2017) and a reply from Lawrence Mishel and Josh Bivens (2017).
11 This is the case in many European Union (EU) countries, where strong unions and social policies to protect workers are in place (Goodman 2017). In these instances, automation is largely embraced as a way for high-income countries to stay competitive in an increasingly global economy.

The break in this relationship likely bears a significant part of the responsibility for the recent concerns around automation and its effects on the economic well-being of workers, especially those in the bottom half of the income distribution. Yet the idea that automation will exacerbate inequality is rarely challenged. With inequality near an all-time high, will automation deepen the problem? Or is it possible that getting the rules of the game right may allow for technological advances to raise all boats? Just because everyone *could* be better off from technological advances does not mean everyone *will* be better off. This depends critically on the laws and political economy that govern our institutional settings. After all, if unemployment and inequality do increase in the future, it will be the fault of economic policy choices, not the fault of technological change.

***Just because everyone could be better off from technological advances does not mean everyone will be better off. This depends critically on the laws and political economy that govern our institutional settings.***

Technology has, on balance, been a great blessing to our economy and society, but it can, and does, have drawbacks. How do we handle these drawbacks as a society? Specifically, how do we understand the link between a growing economic pie and the distribution of that pie, as well as consequences for the labor market? These are the challenging questions that economists, policymakers, advocacy organizations, and the general public should be concerned with in regards to automation. Our goal is to think about how policymakers can intervene to mitigate the costs and share the rewards from technological change.

In terms of its relationship with the aggregate economy, macroeconomic indicators clearly demonstrate that automation increases GDP (i.e., it enlarges the economic pie). But how that pie is distributed is of great consequences. Policymakers and economists have historically focused on economic growth, while relegating economic distribution to the back burner. This is a mistake. If we are to develop equitable policies to promote a strong labor market and the return of rising real wages in times of continued technological change, distribution should be *the* question.

We believe that the primary challenge posed by technological change will be inequality and unemployment. Let us first address the question of unemployment. As we will discuss in detail below, there is no evidence that automation destroys work—on the contrary, automation is associated with a steady *increase* in the number of jobs in the economy. But automation has been, and will likely continue to be, a major source of disruption in specific occupations and industries. Some occupations and industries have gone by the wayside, leaving workers in the lurch. To date, public policies have largely done a terrible job at transitional assistance as technology—or in recent times, globalization—displaces certain groups of workers. This is a matter of public policy, and it must change.

In terms of inequality, let us first hear from the late Stephen Hawking (2016):

> ***"If machines produce everything we need, the outcome will depend on how things are distributed. Everyone can enjoy a life of luxurious leisure if the machine-produced wealth is shared, or most people can end up miserably poor if the machine-owners successfully lobby against wealth redistribution. So far, the trend seems to be toward the second option, with technology driving ever-increasing inequality."***

Machines may one day produce everything we need. But that day is not here. Nevertheless, Hawking's insights are worth unpacking. The gains from technology can indeed lead to broad-based prosperity, but they need not. This is largely a matter of the distribution of property rights. If the benefits from technology were distributed in a more equitable manner, we would expect to see: 1) wages increasing with productivity; 2) shorter work hours; and/or 3) improved work conditions. Some combination thereof is most likely. A dive into history shows that all of these have happened in the past, contributing to the relatively high average living standards we see today in the U.S. Of course, when we look at averages in the data, the numbers can hide the fact that automation has allowed for the continuation of scarcity, i.e. poverty, by design. Recently, the story is more muddled. As we look across the past few decades, it is clear that technological change has not translated into broad-based wage gains for the majority of workers. This is the result of a relatively new institutional design. There is no natural law in economics that dictates who wins and who loses from automation—the outcome is determined by the institutional arrangements that govern our economy, institutions which are perpetually in motion.

What Hawking's quote fails to mention is how we got to this position in the first place. The ownership of the technology (machines, robots, you name it) is a result of government-granted property rights, which largely come in the form of patent and copyright protections.[12] As we will discuss below, the concern that automation will displace workers—causing significant economic and social damages to the workers, families, and communities that are affected—is not a new phenomenon. It is, however, one policymakers have not paid nearly enough attention to. If history is any guide, we should remain convinced that automation will indeed increase living standards and create more new jobs, but *for whom* is an open question.

## *Is the Era of Automation Upon Us?*

There is no doubt that the pace of technological change is uneven from decade to decade and century to century. For instance, in the postwar boom of 1947-1973, the economy grew at a trend rate of 2.7 percent per year. Today, the economy has been in the midst of a prolonged period of slow labor productivity growth—or, in other words, lackluster technological change—since 2005, with average labor productivity growth clocking in at a meager 1.2 percent per year on average from 2005-2017. Further, over the past two years, productivity growth has fallen even further, averaging under 1 percent.[13]

The economy has gone through periods of rapid technological change in the past, but are we in, or nearly approaching, an era of rapid technological change today?

In 1987, economist Robert Solow famously quipped that "we see the computer age everywhere, except in the productivity statistics." The computer age was in full swing in the late 1980s, yet the supposed revolutionary technological change was not bringing about large-scale gains in productivity growth. This left some policymakers puzzled. Today, we have a similar narrative on our hands. The tech enthusiasts cannot stop touting the supposed leaps and bounds being made in the tech world; yet, economists have consistently pointed out that the productivity numbers are barely budging.[14] How can we reconcile this productivity paradox?

In recent years, a number of books have stoked the public's fears of the robot revolution, crystallizing the naïve mass automation narrative that runs amok in the media today. Perhaps the most widely read recent work making the argument that rapid automation is on the horizon, and that it will result in massive technological unemployment, is made by Erik Brynjolfsson and Andrew McAfee in *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies* (2014).

12 For an excellent and thought-provoking extensive discussion on patents, copyrights, and inequality, see *Rigged* by Dean Baker (2009).
13 This is measured by the nonfarm private business labor productivity series compiled by the BLS.
14 Economist Dean Baker, in particular, has been relentless in combating the failure to recognize the productivity statistics.

In the book, the two main conclusions are that the economy is in the midst of "astonishing progress" in terms of technological advances, and that these "transformations" will be "profoundly beneficial." The book, like much of the narrative out of Silicon Valley and the tech world, stresses that while they believe these technologies will be transformative and beneficial, they will also likely exacerbate existing inequalities—a point we will return to later.

To anticipate technology skeptics, Brynjolfsson and McAfee provide a lengthy discussion, along with historical examples, in an attempt to explain away the "productivity paradox": the fact that the productivity statistics are at worrisome *low levels* in the economy at the same time that techno-enthusiasts are sounding the alarms that the robots are coming.[15]

**FIGURE 3**

## Labor Productivity

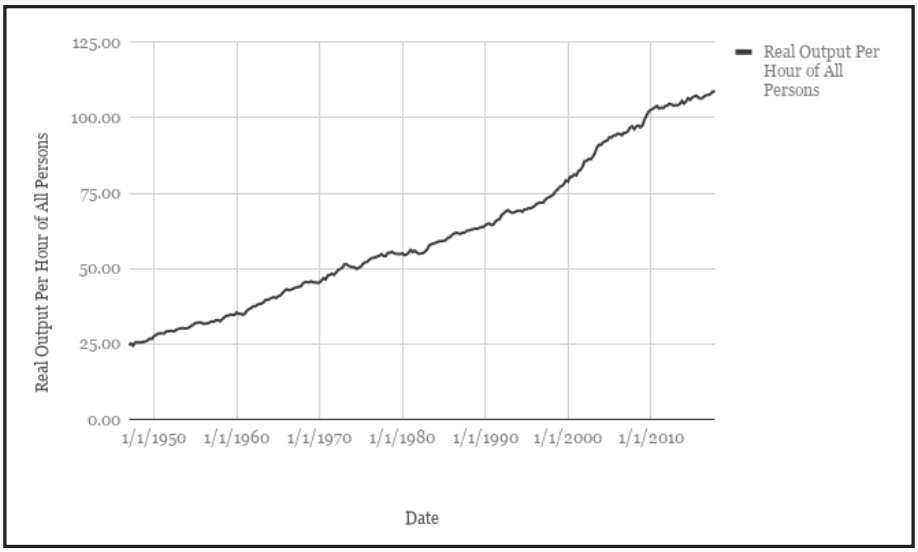


**Figure 3 Source:** St. Louis Fed, FRED Economic Data: https://fred.stlouisfed.org/series/OPHNFB.

*Note: Labor productivity is for the nonfarm business sector. The graph depicts the real output per hour of all persons.*

Skeptics, including us, of the current narrative around rapid technological gains have long pointed to one statistics: productivity growth in the economy. Or, more importantly, the lack thereof. As we see in Figure 3, the economy is in the midst of a remarkable collapse of productivity growth. This can be seen clearly when comparing recent growth (2005-present) to the mid 1990s, when productivity growth underwent a significant speedup. When the economy is undergoing rapid technological change, it necessitates rising labor productivity; yet the data show anything but.

Recognizing the continued discontinuity between the techno-optimist's story of rapid technological change despite the meager growth in productivity, automation enthusiasts have continued to come up with ways to explain the productivity paradox and argue that the robots are indeed marching on our jobs. In an attempt to explain the paradox, three common explanations are frequently put forward.

The first "explanation" is the mismeasurement hypothesis. A group of researchers have argued that we are simply mismeasuring output, productivity, and GDP in the standard statistics (Brynjolfsson and McAffee 2011, 2014; Mokyr 2014; Alloway 2015; Feldstein 2015).

15 Low levels of productivity gains are worrisome because they are a key input in obtaining economic growth. Additionally, they have historically been vital in raising living standards for the majority of workers.

This is probably the case to some degree, but the real question is if the statistics are wrong in a way that would miss this technological boom in particular. To this end, there are those that argue that *true* productivity growth since 2005, when most researchers mark the beginning of the productivity slowdown, has not slowed nearly as much as the official statistics show (ibid). Some even argue that despite the statistics, true productivity growth has actually been accelerating, but the standard statistics are simply terrible at capturing it.

While the theory may sound appealing to some, there have been a plethora of studies that have effectively debunked the idea that mismeasurement could account for a significant part of the story. For instance, prior research has documented that productivity slowdown across U.S. states, or internationally, are not related to variation in the intensity of information technology (IT) production across states or countries (Cardarelli and Lusinyan 2015; Syverson 2017). Nakamura and Soloveicik (2015) calculate the value of advertising-supported entertainment for internet consumers, finding that including free-to-consumer content would increase GDP growth by under 0.02 percent per year. Despite the research, this idea lives on, mainly because it is a convenient narrative that tells an audience what they want to hear.

The second idea that may explain part of the puzzle is that the technology that has been developed has not been shared across a large number of firms. This is because of the market power generated by the current structure of U.S. intellectual property law, a point we will return to (Steinbaum et al. 2018). We can think of this as poor dispersion of technology due to market concentration. In other words, mega-firms, such as Google, Apple, and Amazon, may indeed be innovative, but the lack of competition in our economy means that these firms hoard new technologies—ultimately limiting technological implementation across industries and inhibiting further technological developments that occur through technological dispersion. Further, when major advances in technology have indeed been implemented in the economy, they have been deployed for the purpose of rent-extraction rather than for productive means. For instance, the most profitable uses of AI thus far have been for targeting and pricing online ads and for automated trading of financial securities, both of which constitute rent-extraction activities and add little to the produce forces of the economy (Brynjolfsson et al. 2017).

***While the theory may sound appealing to some, there have been a plethora of studies that have effectively debunked the idea that mismeasurement could account for a significant part of the story.***

Finally, the most commonly cited explanation for the productivity paradox is that for new technologies to show up in the productivity statistics, other complementary innovations are needed. This story, based on the idea of "implementation lags," is a favorite of many technology enthusiasts, because it allows for both sides of the productivity paradox to hold true. In other words, rapid technological change is here, but it hasn't showed up in the statistics—yet. The basic argument is that people need to just wait a little longer. Those holding this position do not need to argue that the productivity statistics are simply wrong. Pointing to historical processes, ranging from the implementation of electricity to the widespread use of the personal computer, believers of the implementation lag theory say that in time, the productivity numbers will indeed reflect the technological boom the economy is currently experiencing.

Why may there be a sizable lag between innovation and adoptions and implementation? For instance, in the late 1890s and early 1900s, electrification was being introduced into the industrial process in the U.S. Yet, labor productivity barely budged. One could not simply take the old factory floor, the old workers, and the old work processes and add a major new technology—electricity—to the mix. The entire labor and production process had to be retooled from the ground up. Workers had to be re-trained and new workers had to be brought in. The factory, including the entire building itself had to be redesigned. The bosses had to be replaced. It takes time, as well as complementary innovations, to take advantage of the new technologies.[16]

## *The Reality of Automation in Today's Economy*

Each of these potential explanations has their supporters and critics, but we also have to be clear about the current facts. The U.S. is in a troubling era, but it is not because there is too much technology (i.e., too many robots). Rather it is because we are in the midst of an era of lackluster productivity growth, making it harder to raise wages and grow the economy (i.e., too few robots).

Beyond the productivity statistics, data on capital investment supports our finding that the economy is not undergoing, or on the verge of, a technological revolution. Analyzing data going back to 1947, Mishel and Shierholz (2017) have documented that capital investment in the 2007-2016 period is significantly slower over the past decade than we have seen in recent history. Further, capital investments in IT have also slowed, including marked declining rates of investment in both hardware and software compared to earlier decades.

Further evidence about the technological revolution can be found in labor market data. If the common narrative that the robots are replacing workers is right, we might suspect to see a high level of job separations, resulting from the supposed replacement of workers by robots or other technological advances.[17]

FIGURE 4

**Total Nonfarm Separations**

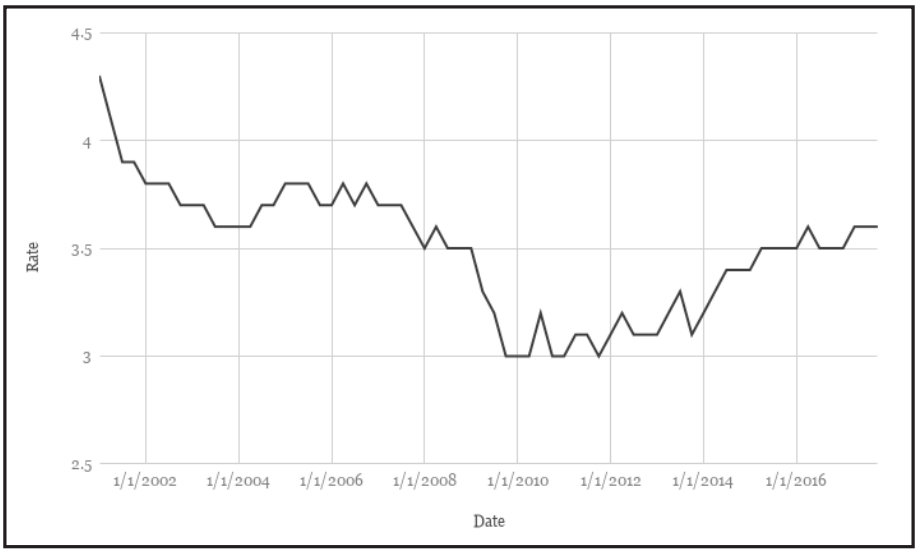


**Figure 4 Source:** St. Louis Fed, FRED Economic Data: https://fred.stlouisfed.org/series/JTSTSR#0 .

16 For a lengthy discussion of the prolonged process to electrify the industrial sector in the United States, see "The Dynamo and the Computer: An Historic Perspective on the Modern Productivity Paradox" (David 1990).
17 The next section addresses the relationship between automation and unemployment.

Figure 4 comes from the U.S. Bureau of Labor and Statistics' Job Opening and Labor Turnover Survey (JOLTS), which produces statistics on job openings and labor market turnover. The figure shows total separations between workers and employers (i.e., the churn of employment within the nonfarm economy). If robots, or other forms of technology, were rapidly displacing workers, we might expect a high rate of employment churn in the economy; yet the statistics do not support that story. This is confirmed by Atkinson and Wu (2017) whom perform a historic analysis of churn in the labor market, noting "levels of U.S. occupational churn are now at historic lows." Higher rates of labor market churn could signal two things: 1) it could be a sign of a strong labor market, as workers quit their current job in exchange for an upgrade; or 2) it may signal an event where workers are being laid off and are downgrading employment or becoming unemployed.

**FIGURE 5**

## Hires, Quits, and Layoffs

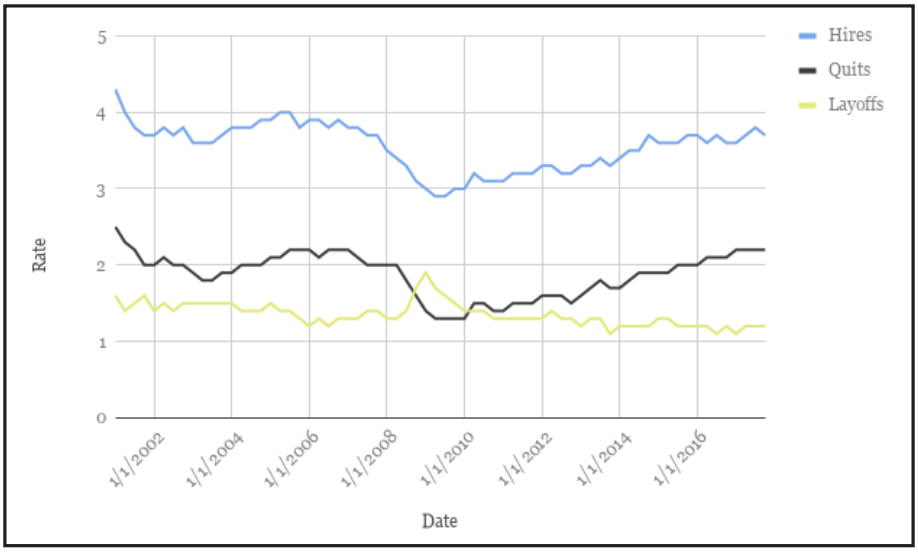


**Figure 5 Source:** St. Louis Fed, FRED Economic Data: https://fred.stlouisfed.org/graph/?graph_id=455586#0.

As we can see, employees quitting their current jobs significantly outpaces employees being laid off or discharged from their current employment. Additionally, the number of job openings are at their highest level since the government started tracking this statistic at the end of 2000.[18] The recent data is indicative of a strengthening labor market, one in which firms are both seeking new workers and retaining current workers.

While it is challenging to know what the future holds, the data are clear: We are not in the midst of a labor-displacing technological boom, nor are we on the verge of rapid technological change in the near future. Nevertheless, technology and the economy is perpetually in motion, and technological advances are vital to a healthy economy and rising living standards. If history is any guide, we should expect the economy to continue to go through times of technological change, where such change may have profound implications for employment, inequality, and standards of living. Thus, it is important to think through the potential ramification of technological change on future employment opportunities and to consider policies to ensure that technological change is not in conflict with full employment, increases in living standards for workers, and declining inequality. To this end, the next section will investigate the link between automation and future employment.

18 See https://fred.stlouisfed.org/series/JTSJOL

# *Lump-of-Labor Fallacy*

Many are concerned with the idea that automation will displace workers—and they are partially right, though the story is not so simple. There have been, and will continue to be, innovations that replace workers throughout the economy. But those workers are only permanently displaced if we think there is a *fixed amount of work* to be done in the economy. This idea, which gives rise to the notion that an increase in the amount each worker can produce actually reduces the total number of jobs an economy can support, is known as the "lump-of-labor fallacy."

Think about the personal secretary. The advent of the computer, combined with advances in software, have lead to the decline of this profession. This undoubtedly displaced hundreds of thousands of workers (Jacobs 2015). Do these workers permanently leave the labor market? Are those jobs gone forever, never to be replaced by other jobs? If we think there is only a fixed amount of work to be done in the economy, we would rightly want to bash these machines. After all, they will take all the work!

But that is not how the real economy functions. First, our economy is a dynamic one. Every month, new jobs are created as other jobs are destroyed. When we read the headline numbers from the U.S. Bureau of Labor and Statistics (BLS) on job creation every month, what we are seeing is the difference between jobs created and jobs destroyed. Luckily, the government tracks these numbers in the BLS Job Openings and Labor Turnover Survey (JOLTS). In 2017, the economy destroyed 62.6 million jobs—but it also created 64.7 million, meaning that the economy added 2.2 million net jobs (BLS 2018b). The economy will continue to destroy specific jobs, but that is not necessarily a bad thing for the overall economy.[19] On average, the economy destroys low-productivity jobs and replaces them with higher-productivity jobs—opening the door for higher wages and rising living standards.

Second, we do not know what the jobs of the future are. A generation ago, people would not have predicted that information technology (IT) jobs would be where they are today. It is clear from the media reports that the fear of destroying jobs sells. What is missed by this half-truth is the fact that technological developments also generate new jobs. As the recent Deloitte report argues, technology creates far more jobs than it destroys (Stewart et al. 2018).

Third, the fallacy misdirects public policies. Arguments are frequently made that we need to bring back our old jobs or rejuvenate declining industries like coal. Given the destruction of communities in the wake of increased trade and an economy transitioning away from coal and general manufacturing, such arguments are understandable. But policies directed to look backward instead of forward are misguided. While this does little to combat the economic despair caused by losing these jobs, the answer is in building public policies for the future. The fatalism perpetuated by the lump-of-labor fallacy, inciting fear that the economy cannot create new and better jobs, leads to a decline in public pressure on policymakers to help create an economy with full employment and rising wages. Policymakers must recognize and adapt to the fact that the economy is dynamic, but also that getting the policies right is essential to the creation of new and better jobs. After all, the level of unemployment and wages in our modern economy is largely dictated by policy choices.

***In sum, as long as there are unmet needs in society, there will be work to be done.***

19 To be sure, the personal consequences from losing a job can be catastrophic. For this reason, we discuss below why policymakers should improve social insurance programs, support policies to aid in rapidly transitioning workers to new jobs, and push for permanent full employment through direct government hiring.

# SECTION TWO

## Automation, Unemployment, and the Future of Work

***"The basic fact is that technology eliminates jobs, not work."***

*-Report on the National Commission on Technology, Automation, and Economic Progress, 1966*

Let us be clear: Technology destroys jobs. But it creates more new jobs than it destroys. The idea that developments in technology will replace a large segment of the workforce, adding them to the rolls of the "surplus population" is not a new one. In 1964, President Lyndon B. Johnson signed a bill to create the National Commission on Technology, Automation, and Economic Progress (Bowen 1966). The commission was to concern itself with the recent (early 1960s) rise of hysteria around robots taking all the jobs, rendering the human worker obsolete and unable to put bread on the table. Sound familiar? Specifically, the commission was to analyze the pace of technological change, the economic and employment needs of those potentially affected by automation, and the means by which technologies can be utilized to "yield general benefits" to society by meeting "unmet human and community needs." While the report rejected the argument that technology would result in permanent increases in unemployment, it recognized that the process of technological change was costly, and that technology was "a major factor in the displacement and temporary unemployment of particular workers." Today, during a time of growing inequality, job precariousness, and a broken link between productivity growth and rising real wages for workers, people are right to be concerned.

***We must separate the destruction of jobs and the destruction of work.***

In assessing the relationship between technological change and employment, we have a number of factors to consider. First, we must separate the *destruction of jobs* and the *destruction of work*. To do so, we make a distinction between the general level of unemployment and the displacement of particular workers in certain occupations or industries that may result from technological change. While there is substantial evidence that technology has destroyed, and will continue to destroy, specific jobs, there is no evidence that technological change will in any way result in the end of work. After all, as long as there remain socially desirable needs to be met, there will be work to be done.

## *The Destruction of Jobs*

In terms of the destruction of particular jobs, there is significant cause for concern given the weak protections for workers in the current labor market in the United States. **Technological unemployment** is the unemployment that results in workers who are forced out of a job due to technological change. As technological change progresses, there will inevitably be some technologies that displace workers, resulting in at least short-term technological unemployment.

We can think of plenty of examples where technology has led to large scale substitution for labor. The U.S. was founded as an agrarian society, with the vast majority of the labor force (over 80 percent) engaged in agriculture. As technology progressed, and the economy diversified, labor exited the agricultural sector—entering the industrial sector at rapid rates. This marked an era of structural transformation in the U.S. By 1900, the percentage of workers employed in agriculture was cut in half, to 40.2 percent (Lebergott 1966). Due to the rapid innovation in, and adoption of, technology in agriculture, the sector has been fundamentally transformed. Developments from the reaper and thresher, to the tractor, to modern irrigation, to herbicides and pesticides have allowed for massive increases in agricultural production while significantly reducing the amount of hands necessary to grow, harvest, and process those agricultural goods. Today, agricultural employment accounts for a mere 1.4 percent of U.S. employment (USDA 2017). However, as the economy transitioned from an agrarian economy to an industrial economy, there were very real transitional costs to workers, including the systematic displacement of family farmers and the widespread abuse of early factory labor (Ritchie and Ristau 1986).

Even in instances with strong unions, technological change can result in devastating consequences for workers. One of the most profound examples in modern history is the case of the shipping container. In *The Box*, Marc Levinson elaborates on the devastation to labor. Prior to the adoption of the modern shipping container, "[l]oading loose cargo on a medium-size cargo ship cost about $5.85 per ton in 1956" (2016). This labor accounted for nearly half of the total cost of shipping goods at the time. But with the introduction of the shipping container, experts estimated that loading and unloading ships outfitted to carry containers would cost only $0.16 cents per ton (p. 68). The automation of the ports was going to be devastating to labor, and in turn was fought by the unions. For instance, only three years after striking an agreement known as the Mechanization and Modernization Agreement, West Coast ports used 2.5 million fewer man-hours of labor, representing 8 percent of total labor in the first year of the agreement. In terms of the jobs decline, the numbers are staggering (ibid). In 1950, West Coast ports employed roughly 100,000 longshoremen. As of 2002, that number was down to 10,500 longshoremen, despite handling much more cargo than before (Greenhouse 2002).

In terms of the current concern, sometimes workers are literally being replaced by robots (Acemoglu and Restrepo 2017), but more likely it is workers being replaced by changes in the labor process and other forms of technological advances that are incorporated into the production process. In a well-functioning labor market, with significant job churn and full employment, there may be little cause for concern. Workers who are displaced from their job once the robots are introduced could simply walk to the business next door and obtain a new job, frequently at higher pay. Or, the worker may be re-trained and will now help operate the new machinery, again at higher pay. Such instances frequently involve government support for transition policies—policies which are currently weak or nonexistent in the U.S. This is one set of potential outcomes from automation, one we can think of as the high road, but without the right institutional setting we may end up on another path—the low road.

Despite a relatively low level of unemployment in the current economy, the economy is by no means at full employment. By **full employment**, we mean that everyone who seeks a job can find one.[20] Provided that the economy is not at, nor has it usually operated near, full employment, policymakers should think deeply about the ramifications of technological unemployment and policy solutions to address them.

Given the economic and political institutions that govern our current labor market, policymakers and workers should be concerned about technological unemployment. While the economy is not currently undergoing a rapid technological change, new technologies nevertheless will continue to destroy existing jobs—and even entire occupations. Technological unemployment is not a permanent phenomenon, but rather it is a negative byproduct of labor displacing technology and arises as a transitional phenomenon.

Getting the transitions right is a matter of great importance. Job displacement resulting from technological change can be costly, resulting in financial distress, long-term unemployment, downgrading of employment, community distress, and other social ills. Throughout history we have witnessed workers, who have repeatedly been threatened by technological change, resist. Most famously, there was the Luddite movement in 18th and 19th century England. This was a movement of textile workers who opposed the mechanization of their labor process—not for fear of mechanization itself, but for fear that it would result in large-scale labor displacement and redistribution upwards because of the existing property laws (Hobsbawm 1952). Of course, if gains from automation are not shared, resistance from workers is completely rational.

Whether or not we believe the headline numbers claiming a large segment of the U.S. workforce will be displaced by automation—and we shouldn't—additional attention should be paid to think about labor market transitions and how public policies can support a well-functioning dynamic labor market while sustaining both full employment and broad-based wage increases reflecting an equitable distribution from technological change.

***Given the economic and political institutions that govern our current labor market, policymakers and workers should be concerned about technological unemployment.***

## *The Destruction of Work*

The end of work is an entirely different matter. Economists have long disagreed about the future of work. For one, famed economist and Nobel Prize winner Wassily Leontief was convinced human labor, like horse labor after the widespread adoption of the automobile, would become obsolete (Leonteif 1983). While human labor has by no means become obsolete, Leonteif was not alone in this prediction. In 1930, economist John Maynard Keynes famously predicted that economic growth through technological change (i.e., productivity gains) would result in "three hour shifts or a fifteen hour work week" (Keynes 2010). He may have slightly underestimated our insatiability as consumers and capital's ability to keep the masses working.

20 From 1943-1945, the U.S. economy arguably operated near true full employment. The average unemployment rate during that time was 1.7 percent.

A brief look at the data suggests that the economy has continued to produce large numbers of jobs. Figure 6 shows total nonfarm payrolls from 1939 through 2017. During that 68-year span, the economy managed to produce a net increase of 118,854,00 jobs. That is, the economy sustained about five times more jobs in 2017 than it did in 1939. History is a guide, so there is no reason to expect the economy to stop producing jobs; rather we should expect a change in the type of jobs created in the future.

FIGURE 6

## Total Empoyment

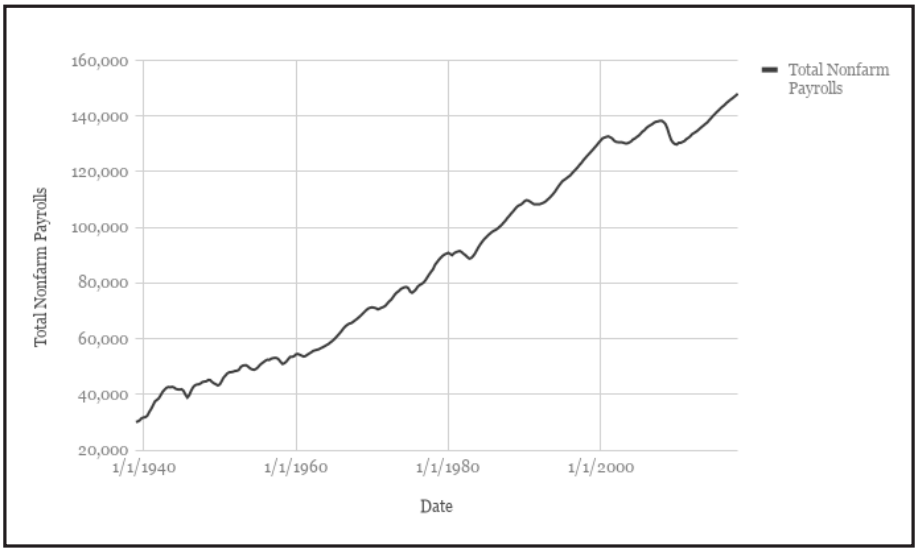


**Figure 6 Source:** St. Louis Fed, FRED Economic Data: https://fred.stlouisfed.org/series/PAYEMS#0.

It is important to point out that times of rapid automation should actually lead to a short-term employment boom, not bust. Despite the fact that we are not approaching a technological revolution, we should have consensus on the fact that we cannot have layoffs *ahead* of productivity gains (Mason 2013). If firms are working to adopt new technologies, they need old workers in place to maintain existing levels of output, plus additional new workers in place to implement the new technologies. The uptake of new technologies takes time, and thus should result in a short-term gain in employment rather than immediate layoffs. If the robots happen to ever actually arrive, that is one thing, but the robots cannot be responsible for current levels of economic inequality or job displacement.

As a final note, we must acknowledge that not all technological change is the same. The majority of the popular narrative on automation provides an oversimplified vision of technology as exclusively replacing labor. Some forms of technology complement labor, while other forms of technology are meant to substitute for—i.e., replace—labor.[21] Thus, it is not clear by any means that technology in and of itself will be detrimental to workers.

Automation need not destroy jobs; it can improve existing jobs and create new jobs. For instance, we can think of examples where improvements in technology have helped labor, enhancing workers' skills, increasing opportunities, reducing menial and dangerous work, and increasing productivity. Recent technological advances have led to sizable increases in knowledge- and care-intensive jobs.

21 Economists frequently refer to these two types of automation as labor-augmenting (complement) or labor-saving (substitute) following Hicks (1932).

Nursing, for instance, an occupation on the rise, is a dangerous occupation. Recent studies have found that 56 percent of nurses suffer from musculoskeletal pain related to their work within the past year (ANA 2011). Technology is changing this. Assistive patient handling equipment, such as the Robear, aids nurses and other workers in lifting and maneuvering patients, increasing workers ability to perform their job and avoid injury. Other examples of changes in technology that complement labor include: medical devices for surgeons, IT complementing workers that perform task-intensive jobs, IT and employment for bank tellers.[22]

***The majority of the popular narrative on automation provides an oversimplified vision of technology as exclusively replacing labor. Some forms of technology complement labor, while other forms of technology are meant to substitute for—i.e., replace—labor.***

Future technological change will both complement and substitute for labor. While commentators have continuously focused on automation as a means to displace workers, resulting in a bleak outlook for the future of work, much more attention should be directed at technologies that are complementing work. When technology complements workers, workers are more likely to share in the benefits through increased wages, improved working conditions, and more. Further, when technology and labor are complementary, output is raised in a fashion that is likely to lead to higher demand for workers, which is exactly how the reality of technological change has unraveled historically.

22 For a discussion of complementary automation in the legal professor, see "A Rule of Persons, Not Machines: The Limits of Legal Automation" by Frank A. Pasquale: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3135549.

# SECTION THREE

## Policy Recommendations

Fifty-four years ago, the report commissioned by President Johnson on technology and the economy claimed that the country's ability to meet society's needs—to provide quality food, shelter, water, health care, education, employment, etc.—no longer depended on technology. Rather, the era of continued scarcity in the U.S.—scarcity that causes poverty, homelessness, unemployment, and even death—was a matter of distribution, and therefore it was a political choice. Yet 54 years later, little has changed. Policymakers should consider policies that have the ability to address the two primary concerns with technological change: unemployment and inequality. In addressing these, we will also provide a brief discussion of policies that may lead to more fundamental change in the economy—policies that work towards ensuring the inevitable benefits of technological change are shared, while the costs are mitigated and shouldered by society rather than the individual via policy design.

***Policymakers should consider policies that have the ability to address the two primary concerns with technological change: unemployment and inequality.***

## *Meet the Full Employment Obligation of the U.S. Government*

The continued displacement of workers is the price we pay as a society for a dynamic economy. It is the role of policymakers to implement public policies to minimize the economic pains from such change, ensure full employment, and assist workers and communities in times of transition.

The government has a mandate to pursue "maximum employment" as outlined by the Employment Act of 1946 and the Full Employment and Balanced Growth Act of 1978 (commonly known as the Humphrey-Hawkins Act).[23] Despite this mandate, the government has repeatedly failed to maintain a full employment economy. Achieving maximum full employment, meaning that everyone who wants a job can find one, is a mandate that the government must take seriously. Such actions would create a significantly tighter labor market—both encouraging technological advance and ensuring the potential negative side effects of technology on workers is largely nullified.

A high-pressure labor market is vital to re-establish the link between productivity gains and rising real incomes. For example, low rates of unemployment allow workers, especially those at the middle and low end of the wage distribution, to acquire employment and achieve wage and income gains. Employment rates, however, are not the result of some "free market" but are largely governed by economic policies.

***Employment rates, however, are not the result of some "free market" but are largely governed by economic policies.***

Full employment should be pursued through monetary and fiscal policy. In terms of monetary policy to date, it is clear that the Federal Reserve (the Fed) has continuously ignored the full employment portion of their mandate, treating it secondary to their inflation target.[24]

23 The Humphrey-Hawkins Act established the modern dual mandate of the Federal Reserve.
24 The estimates for the "natural rate of unemployment," a political tool that has been thoroughly debunked as an effective measure of the economy's true potential full employment rate, has ranged from about 4.6-6.8 percent. Despite this, the economy is currently at 4.1 percent unemployment, and it shows no signs of significant inflation on the horizon.

Thus, actions by the Fed have been guided almost solely by the inflation target, treating what they call "full employment" as the level of employment that happens to coincide with their inflation target. In the least, the Fed must halt its actions to prematurely curtail a strengthening labor market. Further, the Fed must take its full employment mandate seriously and support a full employment economy, which will minimize potential negative effects of technology on workers by ensuring alternative employment opportunities are available. To add to their current toolkit, the Fed should take seriously the steps outlined by Mike Konczal and J.W. Mason in "A New Direction for the Federal Reserve: Expanding The Monetary Policy Toolkit" (2017).

Improving current monetary policy is critical for establishing and maintaining full employment, but it is not sufficient. In addition to monetary policy, permanent full employment necessitates both fiscal policy that is calculated to provide continued robust demand for labor, and a direct hiring program to *guarantee* that the economy is functioning at full employment.[25] In the current economy, a lack of effective demand is one of the largest hindrances to achieving full employment. Nevertheless, the government must intervene and place a true floor in the labor market. To address this, the government should enact a job guarantee program, which would provide non-poverty employment for workers and function as a route to permanent full employment. Such a program would ensure that workers displaced by the continued technological progress, or for other reasons, would be able to immediately obtain employment. For a detailed discussion of a job guarantee program, see "The Federal Job Guarantee - A Policy to Achieve Permanent Full Employment" (Paul et al. 2018).[26]

***It is the role of policymakers to implement public policies to minimize the economic pains from such change, ensure full employment, and assist workers and communities in times of transition.***

## *Revise Intellectual Property Law*

The primary reason that current advances in technology exacerbate inequality in the United States is intellectual property (IP) law, including patent and copyright protections. IP law exists, in theory, to provide a legal framework and institutional setting to encourage innovation and investment in research and development (R&D). However, IP law has evolved over time in the U.S. in a way that impedes innovation and exacerbates inequality—negatively affecting most Americans as both consumers and workers. For one, current IP law creates what economists refer to as "innovator rents." These are rents earned by firms due to state-sanctioned market power, granted by IP law, associated with innovations or technological capture.[27] Whether it be through patent or copyright protection, the government is granting individuals or corporations a monopoly over intellectual property for a set period of time. The idea is that the monopoly allows the firms to recoup the investment and make a reasonable profit on the innovation, but this story is just that: a story. In reality, the current structure of IP law hinders innovation and broadly shared productivity growth in the economy.

Since the mid 1970s, the U.S. government, through bipartisan support, has continuously strengthened intellectual property law. In some instances, this means the government extended the duration of the monopoly power granted to the individual or firm. In 1975, for instance copyright protections lasted for 58 years, while today they last for 95 (the two rulings that extended the law were applied retroactively, as well). Further, the government has bolstered these laws by including them in internal and bilateral trade agreements.[28]

25 Both of these policies were advocated for by the Blue Ribbon Commission established by LBJ on technology, as well.
26 This policy has been advocated for by a host of scholars, politicians, and activists historically, and it has started to gain significant momentum recently. While the LBJ commission recommended a similar job guarantee program, they went a step further, recommending that any displaced worker be provided a job *at least as good as* the one they lost.
27 Recently there has been an explosion of patent trolling. Patents, especially in the United States, are not a reliable indicator of innovation. The recent explosion in patent activity is largely attributable to rent-seeking behavior of firms (CBO, 2014).
28 See Baker (2016) for a lengthy discussion on IP law.

Rather than resulting in a boost to innovation, the evidence suggests that the strengthening of IP law has largely resulted in increased rent extraction in the economy, with no noticeable increase in R&D or productivity growth. On the contrary, there is growing agreement amongst economists that these rents, which are earned in excess of the cost of the innovation, slow both innovation and economic growth while simultaneously exacerbating existing inequalities (Boldrin and Levine 2013; Korinek and Nh 2017).

Many lawyers and economists have written extensively on ways to reform intellectual property law in the U.S. There is some bipartisan support for IP law reform, especially around the idea that the duration of patent and copyright protection should be reduced.[29] While reducing the duration of these monopolies would represent a step in the right direction, it would be far from sufficient to promote a more equitable economy where the majority of the innovator rents were no longer in play.[30] Bolder examples of IP reform exist. Such an example was articulated by Nobel laureate Ken Arrow, who argued that the optional solution would be for the public to fund innovations and then to make them freely available to all (1962). Others argue that IP law should be industry specific, with public financing for innovations in the medical sector while alternative regimes, such as R&D tax credits, could replace patents and individual tax credits modeled on the tax deduction for charitable giving could replace copyright protections (Baker 2016). Today, wide-ranging discussions on alternative ways of funding and stimulating innovation are happening.[31]

## *Implement Direct Technological Development to Benefit Society*

> ***"The state has not just fixed markets, but actively created them..."***
>
> *-Mariana Mazzucato, The Entrepreneurial State, 2011*

We should not overlook the fact that government has a sizable role to play in marshalling in the needed technologies of the future. That role is not limited to creating the conditions for technological development in the private market, but it also includes intentionally steering the direction of technological change. Through programs and agencies, such as the National Institute of Health, National Science Foundation, Small Business Innovation Research program, Defense Advanced Research Projects Agency, and others, the U.S. has continuously funded and directed technological developments.

***We should not overlook the fact that government has a sizable role to play in marshalling in the needed technologies of the future.***

But what new technologies are being supported, and why? Is the government focusing on technologies to meet general social needs? These are important questions. If society is concerned with future employment and shared prosperity, the type of technology being developed is of great importance. As discussed above, technology that complements workers tends to increase employment and wages,—leading to broad-based wage gains and economic growth. As Nobel Prize economist Joseph Stiglitz has discussed, there are ways to intervene and direct the technological development process that can lead to Pareto improvements,[32] for instance guiding technology to complement, rather than substitute for labor. Policymakers should be explicit about the goals of the government in guiding technological advances, with rising living standards, especially for those in the bottom half of the distribution, and labor augmenting technologies as central tenants.

29 *The Captured Economy* (2017), a new book by Brink Lindsey , former director of the Open Society Project at the libertarian think tank the Niskanen Center, and Steven M. Teles, a political scientist at John Hopkins and self-proclaimed liberal uses current patent law as one of their four examples on how and why the economy is currently rigged to favor those already at the top of the income and wealth distribution.

30 IP law reform has been complicated in recent decades as it has increasingly been included in trade agreements. Programs, such as tax credits for R&D, may be needed to encourage individuals and firms to opt-out of copyright and patent protection.

31 See Kapczynski (2012); Dosi and Stiglitz (2014); Baker et al. (2017); and Korinek and Ng (2017).

32 A Pareto improvement is a change in the allocation of resources that benefits at least one individual while making nobody worse off.

## *Utilize Work Sharing*

There are a number of routes to support full employment and to increase leisure for workers. **Work sharing**, which means employers will reduce workers' hours rather than laying workers off, is one rather straightforward approach. There are two types of work-sharing policies worthy of consideration. The first is an economy-wide permanent reduction in works hours. Today, the United States has significantly higher average weekly work hours than peer OECD nations (OECD 2018). Some of this is due to policies that dictate a workweek that is shorter than 40 hours, such as in France and Finland, which have 35- and 37.5-hour workweeks, respectively. Most other high-income countries have shorter work hours primarily because of vacation days, paid family and sick leave, and other social policies that provide time off. A reduction in work hours should lead to an increase in the number of jobs in the economy—but the relationship is not one-to-one.[33]

The second policy to reduce work hours would be counter-cyclical rather than permanent. Perhaps the best example of this is the recent German employment miracle, where unemployment actually declined in Germany during the Great Recession, despite the country having a deeper recession than the U.S. (Herzog-Stein et al. 2017). The idea is that during economic downturns, rather than laying off workers, firms should *temporarily* reduce workers' time on the job from say 40 to 35 hours, thus sharing the burden across workers rather than firing employees. Similar legislation could be designed to implement if the economy were to undergo a rapid technological change that resulted in large-scale technological unemployment—a scenario we do not think is likely.

***Such work-sharing arrangements not only have bipartisan support, but they already exist in some form in 26 states across the country.***

Such work-sharing arrangements not only have bipartisan support, but they already exist in some form in 26 states across the country. While these are currently part of the unemployment-insurance program, new federal legislation may be needed to provide substantial funding from the federal government for large-scale work-sharing arrangements.

## *Establish a Right to Free Higher Education and Training*

For decades, economists have been arguing that more education and training was the key to our economic problems, whether they be inequality, economic mobility, or economic growth. While these arguments may have held some weight in the past, they no longer carry the heft they once did. For instance, the college premium, in terms of wages, has been nearly flat over the past two decades. Even economist David Autor, a long-time proponent of the job polarization narrative, has been walking this back, instead noting that the labor market is not changing that fast, and that highly credentialed workers are also experiencing significant stagnation in respect to labor market earnings and job opportunities.[34]

While education and training will not solve our economic woes, they remain vital components in advancing our society and maintaining a highly productive workforce—especially one that can adapt to technological change in the future. In our current institutional setting the burden of higher education and training largely fall upon workers themselves. This has not always been the case.

33 While a general decline in work hours was once a central union demand, it has received little attention as worker power in the U.S. has declined.
34 For example, see Autor's discussion on a panel at the Hamilton Project: http://www.hamiltonproject.org/events/the_future_of_work_in_the_age_of_the_machine/.

For instance, the U.S. government used to invest in worker training programs at a significant higher rate than they do today (National Skills Coalition). Additionally, firms used to train workers on the job, providing pay and education while a worker was gainfully employed (Waddoups 2015). These types of opportunities have become a rare commodity in the 21st century, but that need not be the case.

Similar to the High School Movement during the transition from agriculture to manufacturing, we can imagine large-scale support for educating and modernizing our workforce, without burdening individuals with unnecessary mountains of debt. Higher education and additional worker training is a necessary, but insufficient, component of an equitable future of work policy toolkit.

***While education and training will not solve our economic woes, they remain vital components in advancing our society and maintaining a highly productive workforce—especially one that can adapt to technological change in the future.***

This is not meant to be a comprehensive list of policies to change who wins and who loses from technological development. Nor is this a complete list to remedy the fact that worker's wages have stagnated and a full employment economy remains elusive. Other policies worthy of consideration certainly exist, including, but not limited to: changes to tax policy, increasing the say of workers in corporate governance, increasing workers' right to collectively bargain, lump-sum redistribution, addressing the problem of short-termism, curbing market power, and more. The policies briefly discussed above are meant to a start conversation amongst policymakers and the public regarding how our society can start to think about changing our economic rules in order to build a more equitable economy in a time of ever-continuing technological change.[35]

35 We do not have space in this paper to discuss the position of those who argue technological progress has largely exhausted itself. For examples of this position, see Gordon (2016) and Cowan (2011).

# CONCLUSION

The evidence does not show that rapid automation is here, or even that it is just around the corner. But the evidence is clear that technological advances in the past few decades have not lead to broad-based wage gains across the income distribution. Further, a weak labor market that is far from full employment is the norm rather than the exception. With this in mind, we should recognize that technological change is a dynamic and ever-present process. The technologies of the future will indeed destroy specific jobs and occupations, but not work. Preparations for continued disruption in the labor market should be made. But to combat inequality and unemployment and rebuild an economy where productivity gains directly translate into higher living standards for all, the institutions that currently govern our economy must be transformed.

The idea that the robots are coming for our jobs is a convenient narrative for the ruling elite in the U.S., but this narrative is not shared across high-income countries. Blaming the robots, rather than the rules of the game, is a convenient narrative that misdirects workers' concerns over a weak labor market and poor institutions. This is not the case in countries such as Germany, Sweden, Norway, and other EU countries with strong collective bargaining units and social safety nets, where automation is largely welcomed with open arms. As discussed above, automation has the potential to function as a complement to workers and worker power, and it is broadly responsible for raising average living standards in an economy. Through technological advances, high-income countries maintain their competitiveness in a global economy. Further, in those countries, technology also results in reductions in work hours and improvements in job quality.[36] There is no secret about how this is achieved: Effective institutions that ensure economic gains from technology are shared, rather than hoarded, are achieved by rewriting the rules of our economy and rebuilding worker power to create a more equitable distribution of the ever-growing economic pie.

The constant displacement of workers is the price we pay for a dynamic economy. But policymakers should not allow the social benefits of technology to come with high private costs. Through policies, the government must counteract the adverse impacts of technological change as a first step. Additionally, it must take it upon itself to anticipate social change and implement policies to facilitate that change in a positive direction to provide a more equitable economy where the gains from technology are broadly shared. This means, for example, revisiting the existing distribution of property rights. The government created the hoarding of large returns from innovation, and it can also create policies to share those returns. After all, opportunity, distribution, and economic growth are all governed by political and economic institutions. And those institutions are perpetually in motion. Recent decades have swung the pendulum in the direction of change that serves the few, leading to an unprecedented rise in economic inequality. Let us choose to rebuild those institutions to support the public good instead.

36 For instance, a German union recently won a 28-hour workweek coupled with a 4.3 percent pay increase: https://www.ft.com/content/e7f0490e-0b1c-11e8-8eb7-42f857ea9f09.

# REFERENCES


Acemoglu, Daron, and Pascual Restrepo. 2017. "Robots and Jobs: Evidence from US Labor Markets." NBER Working Paper No. 23285. Cambridge, MA: National Bureau of Economic Research. http://www.nber.org/papers/w23285 (Accessed March 17, 2018).

Akst, Daniel. 2013. "What Can We Learn From Past Anxiety Over Automation?" *The Wilson Quarterly,* Summer 2013. https://wilsonquarterly.com/quarterly/summer-2014-where-have-all-the-jobs-gone/theres-much-learn-from-past-anxiety-over-automation/ (Accessed April 9, 2018).

Alloway, Tracy. 2015. "Goldman: How 'Grand Theft Auto' Explains One of the Biggest Mysteries of the U.S. Economy" *Bloomberg*, May 26, 2015. https://www.bloomberg.com/news/articles/2015-05-26/goldman-how-grand-theft-auto-explains-one-of-the-biggest-mysteries-of-the-u-s-economy (Accessed March 17, 2018).

American Nurses Association. 2011. "2011 ANA Health & Safety Survey: Hazards of the RN Work Environment." Silver Spring: American Nurses Association. https://www.nursingworld.org/~48dd70/globalassets/docs/ana/health-safetysurvey_mediabackgrounder_2011.pdf (Accessed April 8, 2018).

Atkinson, Robert D., and John Wu. 2017. "False Alarmism: Technological Disruption and the U.S. Labor Market, 1850-2015." Washington, D.C.: Information Technology and Innovation Foundation. http://www2.itif.org/2017-false-alarmism-technological-disruption.pdf (Accessed March 17, 2018).

Baker, Dean. 2016. *Rigged: How Globalization and the Rules of the Modern Economy were Structured to Make the Rich Richer*. Center for Economic and Policy Research. https://deanbaker.net/books/rigged.htm (Accessed March 17, 2018).

Baker, Dean, Arjun Jayadev, and Joseph E. Stiglitz. 2017. "Innovation, Intellectual Property, and Development: A Better Set of Approaches for the 21st Century" AccessIBSA: Innovation & Access to Medicines in India, Brazil & South Africa. http://cepr.net/images/stories/reports/baker-jayadev-stiglitz-innovation-ip-development-2017-07.pdf (Accessed March 17, 2018).

Bivens, Josh, and Lawrence Mishel. 2015. "Understanding the Historic Divergence Between Productivity and a Typical Worker's Pay." Washington, D.C.: Economic Policy Institute. https://www.epi.org/publication/understanding-the-historic-divergence-between-productivity-and-a-typical-workers-pay-why-it-matters-and-why-its-real/#epi-toc-11 (Accessed March 17, 2018).

Bivens, Josh, and Lawrence Mishel. 2017. "New Paper on Pay-Productivity Link Does Not Overturn EPI Finding." Washington, D.C.: Economic Policy Institute. https://www.epi.org/blog/new-paper-on-pay-productivity-link-does-not-overturn-epi-findings/ (Accessed March 17, 2018).

Boldrin, Michele, and David K. Levine. 2013. *Against Intellectual Monopoly*. Boston: Cambridge University Press.

Bowen, Harold R. 1966. Report of the National Commission on Technology, Automation, and Economic Progress. Washington, D.C.: U.S. Government Printing Office. Volume I. https://files.eric.ed.gov/fulltext/ED023803.pdf. (Accessed March 17, 2018).

Bryne, David M., John G. Fernald, and Marshall B. Reinsdorf. 2016. "Does the United States Have a Productivity Slowdown or a Measurement Problem?" Washington, D.C.: Brookings Papers on Economic Activity. https://www.brookings.edu/wp-content/uploads/2016/03/ByrneEtAl_ProductivityMeasurement_ConferenceDraft.pdf (Accessed March 17, 2018).

Bridgman, Benjamin, Andrew Dugman, Mikhael Lal, Matthew Osborne, and Shaunda Villones. 2012. "Accounting for Household Production in National Accounts, 1965-2010." Washington, D.C.: Bureau of Economic Analysis Survey of Current Business. https://www.bea.gov/scb/pdf/2012/05%20May/0512_household.pdf (Accessed March 17, 2018).

Brynjolfsson, Erik, and Andrew McAfee. 2011. *Race Against the Machine: How the Digital Revolution is Acceleration Innovation, Driving Productivity, and Irreversibly Transforming Employment and the Economy*. Lexington, MA: Digital Frontier Press.

Brynjolfsson, Erik, and Andrew McAfee. 2014. *The Second Machine Age: Work, Progress, and Prosperity in a time of Brilliant Technologies*. WW Norton & Company.

Brynjolfsson, Erik, Daniel Roch, and Chad Syverson. 2017. "Artificial Intelligence and the Modern Productivity Paradox: A Clash of Expectations and Statistics." NBER Working Paper No. 24001. Cambridge, MA: National Bureau of Economic Research. http://www.nber.org/papers/w24001 (Accessed March 17, 2018).

Bureau of Labor Statistics. 2018a. Press Release: "Productivity and Costs, Fourth Quarter and Annual Averages 2017, Revised." Washington, D.C.: Bureau of Labor Statistics. https://www.bls.gov/news.release/prod2.nr0.htm (Accessed March 17, 2018).

Bureau of Labor Statistics. 2018b. Press Release: "Job Openings and Labor Turnover Survey Summary." Washington, D.C.: Bureau of Labor Statistics. https://www.bls.gov/news.release/jolts.nr0.htm (Accessed March 17, 2018).

Bureau of Labor Statistics. "Nonfarm Business Sector: Real Output Per Hour of All Persons [OPHNFB]." Retrieved from FRED, Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org/series/OPHNFB (Accessed March 17, 2018).

Cardarelli, Roberto, and Lusine Lusinyan. 2015. "U.S. Total Factor Productivity Slowdown: Evidence from the U.S. States." IMF Working Paper no. 15/116. https://www.imf.org/external/pubs/ft/wp/2015/wp15116.pdf (Accessed March 17, 2018).

Case, Anne, and Angus Deaton. 2017. "Mortality and Morbidity in the 21st Century." Brookings Papers on Economic Activity. https://www.brookings.edu/wp-content/uploads/2017/03/6_casedeaton.pdf (Accessed May 15, 2018).

Cixin, Liu. 2016. "The Robot Revolution Will be the Quietest One." *The New York Times*, December 7, 2016. https://www.nytimes.com/2016/12/07/opinion/the-robot-revolution-will-be-the-quietest-one.html (Accessed March 16, 2018).

Congressional Budget Office. 2014. "Federal Policies and Innovation." Washington, D.C.: Congressional Budget Office. https://www.cbo.gov/sites/default/files/113th-congress-2013-2014/reports/49487-Innovation.pdf (Accessed March 16, 2018).

Cowen, Tyler. 2011. *The Great Stagnation*. New York, N.Y. : Dutton.

David, Paul A. 1990. "The Dynamo and the Computer: An Historic Perspective on the Modern Productivity Paradox. *The American Economic Review*, 80, no. 2: 355-361. http://www.jstor.org/stable/2006600?casa_token=yFR6-iXdWf4AAAAA:w6FmJX48UgEgwiIf4Mi-xpt55qLeJ70N0kEZw2ohsrQ4bJyY-QQ4Sg1mgy8_7N-8rRME6AZHxULtSh_UyGXKmoXxcU1rAvvannGZUG74s1rIH5wNTZ3p&seq=1#page_scan_tab_contents (Accessed March 16, 2018).

Dosi, Giovanni, and Joseph E. Stiglitz. 2014. "The Role of Intellectual Property Rights in the Development Process, with Some Lessons from Developed Countries: An Introduction." in: *Intellectual Property Rights: Legal and Economic Challenges for Development*, Mario Cimoli, Giovanni Dosi, Keith E. Maskus, Ruth L. Okediji, Jerome H. Reichman, and Joseph E. Stiglitz (eds.), Oxford, U.K., and New York, N.Y.: Oxford University Press, pp. 1-53.

Feldstein, Martin. 2015. "The U.S. Underestimates Growth." *The Wall Street Journal*, May 18, 2015. https://www.wsj.com/articles/the-u-s-underestimates-growth-1431989720 (Accessed March 16, 2018).

Frey, Carl Benedikt, and Michael A. Osborne. 2013. "The Future of Employment: How Susceptible are Jobs to Computerisation?" Oxford Martin Programme Working Paper. Oxford, England: Oxford Martin Programme on Technology and Employment. http://rooseveltinstitute.org/wp-content/uploads/2017/11/Monetary-Policy-Toolkit-Report-1.pdf (Accessed March 16, 2018).

Goodman, Peter S. 2017. "The Robots are Coming and Sweden is Fine." *The New York Times*, December 27, 2017. https://www.nytimes.com/2017/12/27/business/the-robots-are-coming-and-sweden-is-fine.html (Accessed March 16, 2018).

Gordon, Robert. *2016. The Rise and Fall of American Growth: The U.S. Standard of Living since the Civil War*. Princeton, NJ: Princeton University Press.

Greenhouse, Steven. 2002. "The Nation: The $100,000 Longshoreman; A Union Wins the Global Game." *The New York Times,* October 6, 2002. http://www.nytimes.com/2002/10/06/weekinreview/the-nation-the-100000-longshoreman-a-union-wins-the-global-game.html (Accessed March 16, 2018).

Greenwood, Jeremy, Ananth Seshadri, and Mehmet Yorukoglu. 2005. "Engine of Liberation." *Review of Economic Studies*. Issue No. 72:1. https://www.jstor.org/stable/3700686?seq=1#page_scan_tab_contents (Accessed March 16, 2018).

Hawking, Stephen. 2016. "Ask Me Anything." https://www.reddit.com/r/science/comments/3nyn5i/science_ama_series_stephen_hawking_ama_answers/cvsdmkv/ (Accessed March 16, 2018).

Herzog-Stein, Alexander, Fabian Lindner, and Simon Sturn. 2018. "The German Employment Miracle in the Great Recession: The Significant and Institutional Foundations of Temporary Work-time Reductions." *Oxford Economic Papers*, 70, no. 1: 206-224. https://academic.oup.com/oep/article-abstract/70/1/206/4582319 (Accessed March 16, 2018).

Hicks, John. 1932. *The Theory of Wages*. London: Macmillan.

Hobsbawm, E. J. 1952. "The Machine Breakers." *Past and Present*, no. 1: 57-70. http://web.csulb.edu/~ssayeghc/theory/wintertheory/machinebreakers.pdf (Accessed March 16, 2018).

Jacobs, Emma. 2015. "The Case of the Vanishing Secretary." *Financial Times*, March 26, 2015. https://www.ft.com/content/9420a7b0-d159-11e4-98a4-00144feab7de (Accessed March 16, 2018).

Kapczynski, Amy. 2012. "The Cost of Price: Why and How to Get Beyond Intellectual Property Internalism." *UCLA Law Review*, 59, no. 1: 970-2021.

Keynes, John Maynard. 2010. "Economic Possibilities for our Grandchildren." *Essays in Persuasion*. London: Palgrave Macmillan; 321-332.

Konczal, Mike, and J.W. Mason. 2017. "A New Direction for the Federal Reserve: Expanding The Monetary Policy Toolkit." New York, N.Y.: Roosevelt Institute. http://rooseveltinstitute.org/wp-content/uploads/2017/11/Monetary-Policy-Toolkit-Report-1.pdf (Accessed March 17, 2018).

Korinek, Anton, and Ding Xuan Ng. 2017. "The Macroeconomics of Superstars." Working paper. https://www.imf.org/~/media/Files/Conferences/2017-stats-forum/session-3-korinek.ashx (Accessed March 17, 2018).

Lindsey, Brink, and Steven M. Teles. 2017. *The Captured Economy: How the Powerful Enrich Themselves, Slow Down Growth, and Increase Inequality*. Oxford University Press

Lebergott, Stanley. 1966. "Labor Force and Employment, 1800-1960." In *Output, Employment, and Productivity in the United States After 1800*. Cambridge, MA: National Bureau of Economic Research. http://www.nber.org/chapters/c1567.pdf (Accessed March 17, 2018).

Leontief, Wassily. 1983. "National Perspective: The Definition of Problems and Opportunities." *Long-term Impact of Technology on Employment and Unemployment*. Washington, D.C.: The National Academy Press.

Levinson, Marc. 2016. *The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger*. Princeton University Press.

Manyika, James, Susan Lund, Michael Chui, Jacques Bughin, Jonathan Woetzel, Parul Batra, Ryan Ko, and Saurabgh Sanghvi. "Jobs Lost, Jobs Gained: Workforce Transition in a Time of Automation." Brussels: Belgium, McKinsey Global Institute. https://www.mckinsey.com/~/media/McKinsey/Global%20Themes/Future%20of%20Organizations/What%20the%20future%20of%20work%20will%20mean%20for%20jobs%20skills%20and%20wages/MGI-Jobs-Lost-Jobs-Gained-Report-December-6-2017.ashx (Accessed March 17, 2018).

Mason, J.W. 2013. "Recession is a Time of Harvest." *The Slack Wire*, March 12, 2013. http://slackwire.blogspot.com/2013/03/recession-is-time-of-harvest.html (Accessed March 17, 2018).

Mazzucato, Mariana. *The Entrepreneurial State*. London, U.K.: Demos. https://www.demos.co.uk/files/Entrepreneurial_State_-_web.pdf (Accessed March 17, 2018).

Mishel, Lawrence, and Heidi Shierholz. 2017. "Robots, or Automation, Are Not the Problem. Too Little Worker Power Is." Washington, D.C.: Economic Policy Institute. https://www.epi.org/publication/robots-or-automation-are-not-the-problem-too-little-worker-power-is/ (Accessed March 17, 2018).

Mishel, Lawrence, and Josh Bivens. 2017. "The Zombie Robot Argument Lurches On." Washington, D.C.: Economic Policy Institute. https://www.epi.org/publication/the-zombie-robot-argument-lurches-on-there-is-no-evidence-that-automation-leads-to-joblessness-or-inequality/ (Accessed March 17, 2018).

Mokyr, Joel. 2014. "Secular Stagnation? Not in Your Life." Chapter 6 in *Secular Stagnation: Facts, Causes and Cured*, edited by Coen Teulings and Richard Baldwin. London: CEPR Press.

Nakamura, Leonard, and Rachel Soloveichik. 2015. "Valuing 'Free' Media Across Countries in GDP." Federal Reserve Bank of Philadelphia Working Paper (No. 15-25) https://www.philadelphiafed.org/-/media/research-and-data/publications/working-papers/2015/wp15-25.pdf?la=en (Accessed March 17, 2018).

National Skills Coalition. Federal Policy: Interactive Federal Funding Tool. https://www.nationalskillscoalition.org/federal-policy/federal-funding-tool (Accessed March 17, 2018).

Nedelkoska, Ljubica, and Glenda Quintini. 2018. "Automation, Skills Use and Training." *OECD Social, Employment and Migration Working Papers*, No. 202, OECD Publishing, Paris. https://www.oecd-ilibrary.org/docserver/2e2f4eea-en.pdf?expires=1523454208&id=id&accname=guest&checksum=58B3B73134A4F7DF5DD9DA3705549E9F (Accessed April 10, 2018).

Occupational Safety and Health Administration. 2011. Press Release: "OSHA Timeline highlights 40 Years of Healthier Workers, Safer Workplaces, and a Stronger American." Washington, D.C.: U.S. Department of labor. https://www.osha.gov/news/newsreleases/trade/02242011 (Accessed March 17, 2018).

OECD. 2018. "OECD Statistics: Average Usual Weekly Hours Worked on the Main Job." Paris, France: Organization for Economic Co-Operation and Development. https://stats.oecd.org/Index.aspx?DataSetCode=AVE_HRS (Accessed March 17, 2018).

Paul, Mark, William Darity, Jr., and Darrick Hamilton. 2018. "The Federal Job Guarantee - A Policy to Achieve Permanent Full Employment." Washington, D.C.: Center for Budget and Policy Priorities. https://www.cbpp.org/sites/default/files/atoms/files/3-9-18fe.pdf (Accessed March 17, 2018).

Piketty, Thomas, Emmanuel Saez, and Gabriel Zucman. 2018. "Distributional National Accounts: Methods and Estimates for the United States." *Quarterly Journal of Economics*. Forthcoming. http://gabriel-zucman.eu/files/PSZ2018QJE.pdf (Accessed March 17, 2018).

Ritchie, Mark, and Kevin Ristau.1986. *Political History of U.S. Farm Policy*. Minneapolis, MN: League of Rural Voters. Print.

Smith, Aaron. 2016. "Public Predictions for the Future of Workforce Automation." Pew Research Center. http://www.pewinternet.org/2016/03/10/public-predictions-for-the-future-of-workforce-automation/ (Accessed March 17, 2018).

Smith, Aaron, and Janna Anderson. 2014. "AI, Robotics, and the Future of Jobs," August 6th, 2014. Pew Research Center. http://www.pewinternet.org/2014/08/06/future-of-jobs/ (Accessed March 17, 2018).

Steinbaum, Marshall, Eric Harris Bernstein, and John Strum. 2018. "Powerless: How Lax Antitrust and Concentrated Market Power Rig the Economy Against American Workers, Consumers, and Communities." New York, N.Y.: Roosevelt Institute. http://rooseveltinstitute.org/wp-content/uploads/2018/03/Powerless.pdf (Accessed April 10, 2018).

Solow, Robert M. 1987. "We'd Better Watch Out." *The New York Times Book Review,* July 12, 1987: 36. http://www.standupeconomist.com/pdf/misc/solow-computer-productivity.pdf (Accessed March 17, 2018).

Stansbury, Anna M., and Lawrence H. Summers. 2017. "Productivity and Pay: Is the Link Broken?" NBER Working Paper No. 24165. Cambridge, MA: National Bureau of Economic Research. http://www.nber.org/papers/w24165 (Accessed March 17, 2018).

Stewart, Ian, Debapratim De, and Alex Cole. 2015. Technology and People: The Great Job-Creating Machine. London: U.K.: Deloitte. https://www2.deloitte.com/uk/en/pages/finance/articles/technology-and-people.html (Accessed March 17, 2018).

Syverson, Chad. 2017. "Challenges to Mismeasurement Explanations for the US Productivity Slowdown." *Journal of Economic Perspectives*, 31, no. 2: 165-186 https://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.31.2.165 (Accessed March 17, 2018).

TIME. 1961. "The Automation Jobless." February 24, 1961. *TIME* magazine, February 24, 1961. http://content.time.com/time/subscriber/article/0,33009,828815-2,00.html (Accessed March 17, 2018).

USDA. 2017. "Ag and Food Sectors and the Economy." Washington, D.C.: United States Department of Agriculture. https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/ag-and-food-sectors-and-the-economy/ (Accessed March 17, 2018).

Waddoups, Jeffrey C. 2015. "Did Employers in the United States Back Away from Skills Training during the Early 2000s?" *Industrial and Labor Relations Review*, 69, no. 2: 405–434.