



---

# The Case Against Taxing Robots

---

BY ROBERT D. ATKINSON | APRIL 2019

---

---

*The last thing policymakers should do is reduce the incentive for companies to invest in new machinery and equipment, as that would slow down needed productivity growth.*

---

A disturbing trend in the world of public policy in recent years has been the extent to which fads and groupthink now shape public debates and galvanize support for ill-advised ideas and proposals. In the first phase of this process, someone—often a person of some notoriety, but not necessarily expertise—puts forth a new idea or claim, which is then amplified by a media increasingly focused on marketing the next new thing. Then comes a wave of articles, speeches, blogs, op-eds, and of course TED Talks, all providing supporting “evidence” and arguments for why the initial idea is the “best thing since sliced bread.” Voila: What begins as a loopy, even harmful, idea is now all the rage. Once this critical point of no return is reached—when “everyone” knows something is true—policymakers have only a short distance left to travel to turn what appears to be an inspired analysis into actual law.

In the subcategory of science, technology, and innovation policy, there is no better case in point than today’s increasingly popular view that governments should increase taxes on capital equipment. Or, as the advocates say, “It’s time to tax the robots.” This idea has been around for a while, and gained considerable traction in 2017 when Microsoft founder Bill Gates argued, “At a time when people are saying that the arrival of that robot is a net loss because of displacement, you ought to be willing to raise the tax level and even slow down the speed of that adoption somewhat.”<sup>1</sup> After all, as a technology pioneer and billionaire, Bill Gates is anything but a tinfoil-hat-wearing Luddite. Since then, the calls for taxing those job-killing robots have become a veritable tidal wave. One can barely go a week without reading yet another article or comment on the topic.

---

Robot taxers make three main arguments in support of their position:

1. If we do not tax robots, then government revenues will decline, because few people will be working;
2. If we do not tax robots, then income inequality will grow, because the share of national income going to labor will fall; and
3. Taxing robots would make the economy more efficient, because governments already tax labor, so not taxing robots at the same rate would reduce allocation efficiency.

As this paper will show, all three arguments are wrong.

At the end of the day, robot taxers are suffering from and contributing to a techno-panic over jobs. “Help!” they cry, “Robots are coming for our jobs! We can’t just eliminate any policies that support automation; we need to proactively erect barriers to it.” In fact, moving in that direction would be the worst possible thing for policymakers to do. Given that the U.S. economy has been in an unprecedented productivity growth slump for more than a decade, and the massive baby boom retirement wave is rising, economies desperately need faster productivity growth to have any hope of increasing after-tax wages faster than some minimal rate of growth.<sup>2</sup> The last thing policymakers should do is reduce the incentive for companies to invest in new machinery and equipment, as that would slow down needed productivity growth. Instead, with first-year expensing provisions set to expire automatically at the end of 2022, one of the best things Congress could do to ensure strong growth in the future would be to make that provision permanent and then couple it with an investment tax credit.

## **THE NEED FOR FASTER PRODUCTIVITY GROWTH**

The global economy is in need of a technological “shot in the arm” of the kind the world experienced in the 1950s and early 1960s with electromechanical and materials innovations (steel, chemicals, plastics, etc.), and again in the 1990s with ICT innovations (personal computing, the Internet, broadband, etc.). Indeed, the global economy is in a productivity slump. The Conference Board found that change in GDP per employed person has slowed from 2.6 percent per year from 1999 to 2006 to around 2 percent per year from 2012 to 2014.<sup>3</sup> Most of this decline has occurred in developed economies: Productivity growth in the EU, Japan, and the United States fell by more than half after 2007 compared with the period from 1999 to 2006. U.S. labor productivity—a key measure of economic growth that tallies all the goods and services the country produces per hour of work—has been inching up at an anemic rate of just 1.2 percent per year since 2008. That is half the rate of the prior 13 years. This is the principal reason why wage and GDP growth have stagnated.

Faster productivity growth in many functions and industries that involve moving or transforming physical things (including people) will be spurred by more automation. There are many technologies that can enable a production process to be automated, but robotics is an increasingly important one. While there is no hard and fast definition of what a robot

---

*Investment in robots contributed to 10 percent of GDP growth per capita in OECD countries from 1993 to 2016.*

---

is, the term generally refers to a physical machine that can be programmed to perform a variety of different tasks, with some level of interaction with the environment, and limited or no input from an operator.

Robots are already driving productivity.<sup>4</sup> Investment in robots contributed to 10 percent of GDP growth per capita in Organization for Economic Cooperation and Development (OECD) countries from 1993 to 2016.<sup>5</sup> There is also a 0.42 percent correlation between a country's wage-adjusted manufacturing robot adoption and growth in productivity between 2010 and 2017.<sup>6</sup> Graetz and Michaels found that robot densification increased annual growth of GDP and labor productivity between 1993 and 2007 by about 0.37 and 0.36 percentage points respectively across 17 countries studied, representing 10 percent of total GDP growth—this compared with the 0.35 percentage point estimated total contribution of steam technology to British annual labor productivity growth between 1850 and 1910.<sup>7</sup> Their subsequent study found that investment in robots contributed 10 percent of growth in GDP per capita in OECD countries from 1993 to 2016.<sup>8</sup> The same study found that a one-unit increase in robotics density (which the study defines as the number of robots per million hours worked) is associated with a 0.04 percent increase in labor productivity. A study by the Institute for Employment Research in Germany found that robot adoption led to a GDP increase of 0.5 percent per person per robot over the 10 years from 2004 to 2014.<sup>9</sup>

To date, most robot adoption has occurred in manufacturing, where they perform a wide variety of manual tasks more efficiently and consistently than humans. With continued innovation, robot use is spreading to other sectors, from agriculture to logistics to hospitality. Robots are also getting cheaper, more flexible, and more autonomous—in part because of the addition of artificial intelligence. Some robots will substitute for workers; others, “cobots” (“collaborative robots” that work alongside workers), will complement workers. As this trend continues, robot adoption will likely become a key determinant of productivity growth and potentially reshape global supply chains.

### **FLAWED ARGUMENTS FOR TAXING ROBOTS**

Despite the need for more automation—and the importance of robots in enabling it—a growing movement is calling for establishing policies to slow or even ban the production of robots.<sup>10</sup> Indeed, various groups and individuals have called for bans on lethal autonomous weapons, autonomous vehicles, and delivery robots.<sup>11</sup> But one anti-robot tactic that is getting increasing attention is to tax robots either directly or by reducing government tax incentives for companies to invest in automation equipment. Indeed, some try to sell the robot tax as the more enlightened policy than a crude anti-technology ban. Malcolm James, a lecturer at Cardiff Metropolitan university, wrote, “People are naturally anxious about the effects of such technology, but taxation [of robots] is a better way of allaying these fears than the alternative of banning aspects of it.”<sup>12</sup>

---

Robot taxers make three main arguments for their position:

### **Argument 1: Governments Need to Tax Robots Because There Will Be Little Else Left to Tax**

*New York Times* journalist Eduardo Porter summed up this argument when he wrote that governments should tax robots because they need the money. “In the United States, income taxes account for half of the \$3 trillion collected every year by the Internal Revenue Service; payroll taxes account for another third.... To afford any kind of government services in the robot era, governments will have to find something else to tax. Why not the robots themselves?”<sup>13</sup> University of Geneva professor Xavier Oberson agrees, having written, “Should mass workplaces for humans disappear in the future, from a tax perspective a double negative effect could occur. On the one hand, significant tax and social security revenues would be lost, while on the other hand, the need would increase for additional state revenue to support the growing number of unemployed human workers.”<sup>14</sup> In a long article, academics Ryan Abbot and Bret Bogenschneider wrote:

We need to tax robots because the vast majority of tax revenues are now derived from labor income, so firms avoid taxes by eliminating employees. Also, when a machine replaces a person, the government loses a substantial amount of tax revenue—potentially hundreds of billions of dollars a year in the aggregate. All of this is the unintended result of a system designed to tax labor rather than capital. Such a system no longer works once the labor is capital. Robots are not good taxpayers.<sup>15</sup>

This argument of having to tax robots is based on a foundational mistake in analysis and logic that holds that robots, and automation more generally, will lead to higher rates of unemployment, thereby reducing government revenues from income taxes and company payroll taxes, and also increasing social service expenditures. This, as we shall see, has never been the case, and will not be going forward.

### **Robots and Automation Do Not Reduce Employment**

There has been considerable ink spilled warning of the coming job destruction tsunami from the next production system. A widely cited 2013 study by Oxford University researchers Carl Benedikt Frey and Michael A. Osborne set the tone when it claimed that 47 percent of U.S. employment is at risk of job loss from new technology.<sup>16</sup> Yet, these and similar studies warning that the next production system will lead to massive job loss and potentially high levels of structural unemployment suffer from a number of mistakes.

First, these studies assume we are heading to a transformative “fourth industrial revolution” the likes of which the world has never seen, leading to rapid productivity growth. Berg, Buffie, and Zanna reflected this view when they wrote, “We are in the midst of a technological inflection point, a new ‘machine age’ in which artificial intelligence and robots are rapidly developing the capacity to do the cognitive as well as physical work of large fractions of the labor force.”<sup>17</sup> Chiacchio, Petropoulos, and David cited a McKinsey Global Institute study that “estimates that, compared to the Industrial Revolution of the

---

late eighteenth and early nineteenth centuries, AI's disruption of society is happening ten times faster and at 300 times the scale. That means roughly 3,000 times the impact. This observation suggests that past examples of major technological advancements might not be able to capture the dynamic markets forces of automation."<sup>18</sup>

There are two main problems with such speculations. First, they are just that—grounded in little evidence and completely unbound from historical analysis. Moreover, many estimates of exponential growth, such as the McKinsey estimate, refer to adoption rates of a few specific technologies, such as mobile phones, to extrapolate overall rates of technological innovation and productivity growth. In fact, Bloom, Jones, Van Reenen, and Webb found the productivity of R&D has been declining, making it harder to get innovation.<sup>19</sup>

Second, many studies on the impact of robots on jobs look only at the regions adopting the robots, and, not surprisingly, usually find that regions with higher robot adoption have either declining employment growth or slower-than-economy-wide employment growth. For example, Chiacchio, Petropoulos, and Pichler studied the impact of industrial robots on employment in 116 regions in 6 EU 15 nations and found that regions with faster rates of robot adoption had lower rates of labor-force growth.<sup>20</sup> This is not surprising, as regions that specialize in manufacturing will likely experience slower employment growth if manufacturing productivity grows faster than nonmanufacturing productivity. The relevant question is whether higher productivity in an overall economy leads to lower employment growth. In fact, there is a correlation of 0.15 percent between productivity growth from 1997 to 2015 and total growth in labor hours in EU15 nations, suggesting productivity does not have negative consequences for employment growth.<sup>21</sup>

Moreover, a number of other studies have found no evidence for job loss. In an analysis of industrial robots on employment in German labor markets between 1994 and 2014, Dauth, Findeisen, Suedekum, and Woessner found that the adoption of industrial robots had no effect on total employment in local labor markets specializing in industries with high robot usage.<sup>22</sup> In an analysis of the impact of automation on jobs in Europe Gregory, Salomons, and Zierahn found that while technology-based automation displaces jobs, "It has simultaneously created new jobs through increased product demand, outweighing displacement effects and resulting in net employment growth."<sup>23</sup>

Many studies at the industry level have found that productivity growth has no negative effect on employment, at least in the moderate term. Mayer found a higher share of robots help economies' manufacturing sectors gain global market share.<sup>24</sup> Because of this gain, the correlation between robot use and manufacturing as a share of national employment is negative, but only slightly.<sup>25</sup> Conversely, it is countries such as Canada, the United States, and the United Kingdom—those with low rates of manufacturing automation—that have seen the highest rates of manufacturing job loss over the past two decades.<sup>26</sup> There are three reasons countries can lose manufacturing employment: slower growth in manufacturing consumption relative to nonmanufacturing consumption, higher manufacturing productivity growth relative to nonmanufacturing, and reduced output from loss of

---

international competitiveness (e.g., manufacturing exports grow slowly or decline, while imports grow). In the case of the United States, ITIF estimated that over half of the very steep loss of manufacturing jobs between 2000 and 2011 (over 33 percent) was caused by trade (manufacturing imports increasing faster than exports), and less than half by faster manufacturing productivity.<sup>27</sup>

The biggest mistake “robophobes” make when they predict higher unemployment is to omit second-order effects. When companies invest in robots, they usually cut costs and pass a significant share of those savings to consumers in the form of lower prices (with some going to workers as higher wages and to shareholders in the form of higher profits). But these savings are not buried, but rather are recycled—and this added purchasing power from lower prices, higher wages, or higher profits is spent or invested, creating additional jobs. That is why, as ITIF found, from 1850 to 2015, despite some decades with significant occupational churning from automation technology (e.g., the tractor, the automatic elevator, the automatic telephone switch, etc.), employment grew at the same rate as that of the labor force.<sup>28</sup>

---

*The biggest mistake “robophobes” make when they predict higher unemployment is to omit second-order effects.*

---

This is also why OECD has found that, “Historically, the income-generating effects of new technologies have proved more powerful than the labor-displacing effects: technological progress has been accompanied not only by higher output and productivity, but also by higher overall employment.”<sup>29</sup> Likewise, in a study of 24 OECD nations, Tang found that, “At the aggregate level there is no evidence of a negative relationship between employment growth and labour productivity growth.”<sup>30</sup> Similarly, in its 2004 *World Employment Report*, the International Labor Organization found strong support for simultaneous growth in productivity and employment in the medium term.<sup>31</sup> Van Ark, Frankema, and Duteweerd also found strong support for simultaneous growth in per-capita income, productivity, and employment in the medium term.<sup>32</sup>

To be sure, it is likely that the emergence of the next production system and improvement in robotics technology will increase both productivity and labor market churning, as more workers are likely to lose their jobs due to technological displacement.<sup>33</sup> But higher labor market churning rates are not the same as higher unemployment rates.

#### **Firms That Adopt Robots Still Pay Taxes**

According to the robot taxers, firms that adopt automation equipment are close to being tax scofflaws. This leads to all sorts of proposals, each one more bizarre than the last. Some have advocated for an “automation tax,” for instance, based on the ratio of a company’s total sales to its number of employees. The higher the ratio of robots to sales, the higher the tax.<sup>34</sup> This would be a great proposal if the goal of U.S. policy were to emulate an economy such as India’s, wherein the sales-to-worker ratio at most companies is a fraction of that same ratio of companies in the United States.

Some of these proposals get downright loopy when, for example, their advocates claim governments should give legal-person status to robots in order to make them taxable. Xavier Oberson wrote:

---

Our analysis suggests that a tax on the use of robots would make sense, as a potential solution for addressing the development of robots on the labour market. In essence, we believe that granting a legal personality to robots could lead to the emergence of an electronic ability to pay, which should be recognized for tax purposes. After all, we have seen in the past that states, when required, may introduce new forms of legal personality. Consequently, a specific tax personality would have to be granted to robots... An alternative, and simpler, system would be to impose a lump-sum amount representing an approximated ability to pay the tax. Initially, this ability to pay would be attributed to the employer or owner of the robots, but as the technology evolves, the robot's ability to pay could be recognized. Consequently, the imputed income would also become subject to social security levies.

Would tax authorities such as the IRS put a robot that did not pay its taxes in jail? If the robot is paying social security taxes, could it retire after 40 years and collect social security? If the robot breaks, does it get disability pay?

Historically, governments did not tax tractors because they were more efficient than horses when it came to farming. They did not tax computers because they were more efficient than typewriters. Technology allowing firms to be more productive often leads to those firms gaining market share, which means they end up paying not only more corporate income taxes but more payroll taxes. It also usually results in relative prices falling such that workers in the economy have more real income, which again means higher taxes.

There is one final mistake the robot taxers make, and that is to avoid taxes by eliminating workers. Acemoglu and Restrepo wrote, "The vast majority of tax revenues are now derived from labor income, so firms avoid taxes by eliminating employees."<sup>35</sup> Porter wrote, "Machines don't incur payroll taxes, which are used to fund Social Security and Medicare. For every worker replaced by a robot, the employer saves on payroll taxes." In fact, there is a considerable economic literature that shows these employer matches come at the expense of higher wages.<sup>36</sup> So as companies avoid taxes when they automate, they are making a decision to save money on labor costs overall.

### **Argument 2: Governments Need to Tax Robots or Inequality Will Grow**

Many on the tax robots bandwagon have argued for taxing robots because otherwise inequality will grow, particularly because the share of total income going to labor will fall. For example, Keynesian economist Robert Skidelsky wrote:

How long will it take those headed for redundancy to up-skill sufficiently to complement the ever-improving machines? And, pending their up-skilling, won't they swell the competition for lousy jobs?... without collective action to control the pace and type of innovation, a new serfdom beckons.<sup>37</sup>

One recent report that has gotten attention is by International Monetary Fund (IMF) economists Berg, Buffie, and Zanna, *Should We Fear the Robot Revolution? (The Correct Answer is Yes)*. In it, they argue that robots will increase inequality, which is a bit surprising given that in another article for the IMF's *Finance & Development Journal*, they stated,

---

“Technology does not seem to be the culprit for the rise in inequality in many countries [which is] concentrated in a very small fraction of the population.”<sup>38</sup> Perhaps they think this time is different? Their study is a prime example of Kenneth Boulding’s famous quote, “Mathematics brought rigor to economics. Unfortunately it also brought mortis.”<sup>39</sup> The authors created “four models of the short and long-run effects of robots on output and its distribution in a family of dynamic general equilibrium models.” They found that in all four models, robots increase productivity but reduce wages. But the assumptions of all four models are unrealistic. For example, their first model has robots capable of doing all jobs, something even the most enthusiastic believer in the power of the next production revolution will admit is unrealistic.

Overall, this and related studies make three major methodological and logical mistakes. The first is they do not adequately account for second-order effects, and when organizations use robotics to automate and eliminate work, they do so to reduce costs. Acemoglu and Restrepo wrote that automation technologies “reduce overall labor demand because they are displacing workers from the tasks they were previously performing.”<sup>40</sup> But as the Economic Policy Institute pointed out, this conclusion is based on a fundamentally flawed methodology.<sup>41</sup> The reality is few if any organizations spend more on robots than they save in labor costs (unless they are using robots to boost quality). And those labor savings costs are not buried, but rather are spent—and that spending creates jobs. As Autor wrote:

Automation does indeed substitute for labor—as it is typically intended to do. However, automation also complements labor, raises output in ways that lead to a higher demand for labor, and interacts with adjustments in labor supply. Even expert commentators tend to overstate the machine substitution for human labor and ignore the strong complementarities between automation and labor that increase productivity, raise earnings and augment demand for labor.<sup>42</sup>

In some studies, researchers have accepted this reality, but then go on to assume that the lion’s share of the savings is captured by “capital” and little goes to labor, in the form of either higher wages or lower prices. In other words, these robot skeptics acknowledge that robots will boost productivity and overall economic output (GDP) will go up, but they then bizarrely predict workers’ share of this will drop so much their actual real incomes will fall. This is not only illogical, history suggests it is wrong. The only way business owners could capture the majority of the gains from automation is if there were only limited competition that allowed them the luxury of being able to take to retain the savings as profit. No one has made a convincing case that there is anything about the next production system that would lead to massive monopolization of the global economy in virtually all sectors. Competition, especially backed up by national antitrust authorities, will continue to be robust.

Second, these studies looked only at first-order effects, so not surprisingly, they found that unemployment goes up as automation makes tasks more efficient. Their models then determined the wage rate on the basis of supply and demand, which led to the illogical



---

finding that increased labor output (which all four of their models found) leads to decreased labor income and a larger share of income going to capital. Because they focused on allocation efficiency rather than on productive efficiency, they assumed less demand for, with the same supply of, labor—and that therefore the price of labor must fall. As Berg and colleagues wrote, “At first, the real wage is likely to fall in absolute terms, even as the economy grows.”<sup>43</sup>

There are several things wrong with this framing. The supply of labor does not fall once second-order effects are taken into account. Moreover, it is vast oversimplification to suggest that the real price of labor is a function solely—or even principally—of the relationship between supply of and demand for labor. If the Keynesian revolution told us one thing, it was that the classical economics view that labor prices were a function of supply was wrong: Wage rates are in fact sticky, which is why wages generally do not fall during recessions. Institutional factors such as the minimum wage, employer labor contracts, unionization, and the need for companies to maintain the goodwill of their workers, all mean that even if unemployment rates were to go up as a result of technology-based automation (which is extremely unlikely to happen in non-recessionary periods), wage rates would not fall. Therefore, when firms reduce costs through automation, those savings are used to raise wages or lower prices, or both. Likewise, in a review of the economic impact of industrial robots across 17 countries, Graetz and Michaels found that robots increased wages while having no significant effect on total hours worked.<sup>44</sup>

---

*The fall in the share of labor income had nothing to do with capital becoming more important than labor. It had more to do with housing becoming more dear.*

---

Finally, many of the claims that the next production system will boost inequality point to the decline in the labor share of national income in the United States over the last two decades as evidence that technology has harmed labor and helped capital. They then assume this trend will continue as technological innovation ramps up. However, this reflects a serious misreading of national income accounts—if the authors actually bothered to look at them in the first place. In the United States, the Bureau of Economic Analysis engages in careful national economic accounting of both the output side of the economy (GDP) and the income side (gross domestic income (GDI)).

First, when looked at over the longer term and using net income instead of gross, there has been no decline in the share of U.S. national income going to labor. GDI includes depreciation (what the U.S. Bureau of Economic Analysis terms “capital consumption”), which amounts to about 16 percent of GDI. It also includes business taxes that are around 7 percent of GDI. When these are pulled out, labor’s share of net income was around 70 percent of net domestic income in 2017. In 1949, it was 69 percent.<sup>45</sup> It is true that labor share rose slightly from the 1940s to the early 1990s to around 73 percent, and has fallen since then. But that decline was not from the rise of corporate profits, which the tax-robots advocates assert. Rather, the labor share of income fell largely because of the rise in housing income. When looking at GDI, the share of labor income fell by 1.8 percentage points from 1997 to 2017. But the share going to net interest and corporate profits increased by just 0.5 percentage points. So where did the income go? The biggest gainer was rental income, with its share of GDI increasing 2.1 percentage points.<sup>46</sup> We see the same pattern

---

from 2006 to 2017, when the labor share of income fell by just 0.25 percentage points, while the share going to profits was unchanged, and the share going to rental income increasing 2.4 percentage points. In other words, the fall in the share of labor income had nothing to do with capital becoming more important than labor. It had more to do with housing becoming more dear, as demographic forces coupled with regionally unbalanced growth pushed up demand for housing and government zoning limited supply.

Some studies simply assume that all the growth in inequality will be in labor, not between labor and capital. In other words, low-wage labor will do worse, and high-wage labor better. To start, it appears the automation impacts from the next technology wave, including robots, will be significantly larger for lower-wage and lower-skill occupations. To assess this, ITIF compared the risks of automation by occupation to occupational wage levels and years of schooling needed for each occupation, using two datasets: the Oxford study by Osborne and Frey, and a study by ITIF. The correlation between the average wage of an occupation and its risk of automation is negative and quite large for both datasets (-0.59 for Oxford, -0.52 for ITIF). The correlation of average years of schooling and risk of automation is also negative and large (-0.64 for Oxford, -0.51 for ITIF).<sup>47</sup> The Obama White House Council of Economic Advisors also used the Oxford data and found 83 percent of jobs making less than \$20 per hour would come under pressure from automation, as compared with 31 percent of jobs making between \$20 and \$40 per hour, and just 4 percent of jobs making above \$40 per hour.<sup>48</sup> This is not a reflection of the actual wage of the jobs (in fact, the incentive to automate jobs is greater the higher the wage level.) Rather, it refers to the kinds of jobs/tasks (routine, low-productivity jobs that pay poorly) that are most amenable to automation. OECD also estimated 44 percent of American workers with less than a high school degree hold jobs made up of highly automatable tasks, while only 1 percent of people with a bachelor's degree or higher hold such a job.<sup>49</sup>

Many will argue that these future occupational automation patterns are problematic, as lower-income jobs are more at risk. While true, if this occupational impact pattern occurs, the occupational profile of advanced economies will by definition shift to one with a higher share of middle- and upper-wage jobs (as lower-wage jobs are automated at higher rates and therefore employ fewer people). This would result in relatively fewer lower-paying jobs and more higher-wage jobs—a plus for millions of workers now employed in occupations whose wages remain low and stagnant because the productivity of those jobs remains low and stagnant. The reason behind employment shifting to more middle- and higher-wage jobs is not necessarily intuitive. Here's why: As more lower-wage jobs become automated, the prices of the goods and services still produced by the lower-wage workers (were there no associated cost savings, firms would have no incentive to employ technology to boost productivity) also declines in relative terms. These savings result in consumers across the income spectrum spending more on other goods and services—with the employment generated by this added production in industries with low-, middle-, and high-wage jobs. Thus, added demand creates more middle- and higher-wage jobs.

---

Moreover, the fact that many workers in low-wage jobs are more skilled than their current jobs require suggests that at least some workers now holding low-wage jobs have enough skills to move relatively easily into higher-paid, moderately-skilled jobs.<sup>50</sup> In most developed nations, there are workers who have college degrees but are employed in jobs that do not require one. Although some are in these occupations by choice, many others settle for these positions because there are simply not enough available jobs that require a college education. On average, these workers should have an easier time transitioning to newly created middle-wage jobs than workers with less education and skills. For the latter, policies to boost skills, especially of workers in low-wage jobs, will be a key to ensuring more workers are able to successfully make employment transitions.

In short, there is no evidence or logic to believe that increased automation—from robots, AI, or any other new tools—will lead to an increase in inequality. As the Economic Policy Institute found, inequality did not increase as a result of jobs in middle-wage occupations being eliminated by productivity gains.<sup>51</sup> Rather, virtually all of the increase was *within* occupations, with some individuals making winner-take-all incomes at the expense of other workers within the same occupation. In short, inequality is not caused by robots, it is caused by a small share of the 0.1 percenters gaining an increasing share of national income.<sup>52</sup> Maybe we need robots to put hedge fund managers out of work!

### **Argument 3: We Need to Tax Robots Because the Current Tax Code Leads to Inefficient Investment in Machines**

In order to avoid appearing to be anti-growth, many robot taxers try to ground their argument in conventional neoclassical economics, arguing the tax code unfairly discriminates against labor and in favor of capital equipment, and that by definition this “distortion” of free-market allocation is welfare reducing. For example, Eduardo Porter claimed:

A lot of automation these days is not deployed to enhance economic productivity. Instead, many businesses are investing in automation simply because the tax code is urging them to do so. The purpose of taxing robots is not simply to stop them from killing jobs. It is to level the playing field, to ensure that investments in automation raise productivity.... This means that eliminating the tax break for robots would not hurt economic growth. It would, in fact, improve economic efficiency. By subsidizing capital investment, the government is encouraging businesses to use capital when they otherwise would not, to replace workers with machines.<sup>53</sup>

Likewise, Abbott and Bogenschneider wrote, “The tax system incentivizes automation even in cases where it is not otherwise efficient.”<sup>54</sup> And so they proposed, “Firms with high levels of worker automation could have their tax depreciation automatically reduced beyond a certain threshold.”<sup>55</sup> Acemoglu and Restrepo agreed, writing, “Subsidies induce firms to substitute capital for labor even when this is not socially cost-saving, though it is privately beneficial because of the subsidy.”<sup>56</sup> This is why they argue that automation often produces benefits of dubious value to the business itself. Likewise, Duke University economist Juan Carlos Suárez Serrato stated, “If you believe that the market is doing things correctly, the

---

*It would be one thing if the tax incentives for investing in machinery were ineffective. But the scholarly evidence is clear that such incentives spur more capital equipment investment.*

---

rate at which we invest in these things should not be accelerated artificially.”<sup>57</sup> Some praise South Korea, whose new left-of-center government recently reduced tax incentives for businesses investing in automation. (Given that Korean productivity has fallen to near all-time postwar lows, and it faces the worst retirement bulge of any OECD nation, such a policy borders on folly.)

It would be one thing if the tax incentives for investing in machinery were ineffective. But the scholarly evidence is clear that such incentives spur more capital equipment investment. As one recent study critical of accelerated depreciation because it did not create enough jobs found, this provision led to “significant and persistent increases in the capital stock.” Other studies have found similar results.<sup>58</sup> For example, Zwick and Mahon (2016) found that “bonus depreciation raised investment in eligible capital relative to ineligible capital by 10.4 percent between 2001 and 2004 and 16.9 percent between 2008 and 2010.”<sup>59</sup> In their study, House and Shapiro found, “Capital that benefitted substantially from the policy saw sharp increases in investment,”<sup>60</sup> Auerbach and Hassett reviewed the evidence and concluded, “The partial expensing provision would have a small and positive effect on investment.”<sup>61</sup> Williamson found that section 179 of the IRS tax code has a significant effect on farm capital investment.<sup>62</sup>

So, what is behind this widespread opposition? For economists who subscribe to the neoclassical school—of which there are more in the United States and United Kingdom—the ideal tax code is one that raises the necessary amount of revenue in the least distorting way. For them, the previously discussed incentives, despite leading to higher rates of economic growth, are “distortions” that should be eliminated. These views are often framed as if they were some kind of iron law of economics on the order of the second law of thermodynamics. Brookings Institution’s William Gale summed up the view: “The *sine qua non* of meaningful tax reform is to clean out and rationalize the exclusions, exemptions, deductions, and credits in the tax system.”<sup>63</sup> Congress gets this advice on a regular basis as the Congressional Research Service’s Jane Gravelle told them, “Economic analysis suggests that capital is allocated efficiently and the economy is more productive, absent some market failure or other existing distortion, if all capital income is taxed at the same rate.”<sup>64</sup>

To see the ideological straightjacket conventional economics imposes, consider the 1979 National Bureau of Economic Research article “The Investment Tax Credit: An Evaluation” by then-economics professor Larry Summers and fellow economist Alan Auerbach.<sup>65</sup> In it, they modeled the economic impact of an investment tax credit (ITC), and concluded that a 12 percent ITC would increase the stock of equipment by 18 percent because companies would invest more as the after-tax cost of new equipment declined—which they found would in turn lead to higher GDP than the baseline case.

Sounds good, right? Wrong. Summers and Auerbach went on to say, “While it is relatively clear that the credit will spur investment in equipment... The credit will bid up interest rates... discouraging the purchase of non-favored capital goods, principally structures.”<sup>66</sup>

---

In other words, the ITC would lead to slightly fewer housing starts because mortgage interest rates would increase very slightly. In fact, the authors averred that the absence of a credit would have meant 600,000 more housing units by 1979, while “a constant 12 percent credit would have eliminated another one million housing units.”<sup>67</sup> As a consequence, Summers and Auerbach concluded, “On balance, our examination of the empirical evidence leads us to conclude that the investment tax credit has had and continues to have an undesirable effect on the economy.”<sup>68</sup> Summers and Auerbach advised Congress to eliminate the investment tax credit, which it did seven years later in the 1986 Tax Reform Act. Yet, after the massive overinvestment in housing in the first half of the 2000s brought the global economy to its knees in 2008, it is a bit strange to be opposing policies because they reduce housing starts while increasing sustainable economic growth and competitiveness.

So why do so many neoclassical economists hold the view that incentives for investing in machinery and equipment are bad, and that a neutral tax code that taxes all firms, industries, and activities alike maximizes economic welfare—even in the face of their own studies that show the opposite? It is because one overarching principle guides their thinking and shapes their advice: maximize allocative efficiency. Allocative efficiency is the market condition whereby resources are allocated in a way that maximizes the net benefit attained through their use; and the quantity of goods produced is that which is most beneficial to society. A market that allocates efficiently is one in which scarce goods and services are consumed on the basis of the prices consumers are willing to pay for them; and scarce goods and services are produced on the basis of marginal costs equaling the prices charged for them.<sup>69</sup>

From the standpoint of a neoclassical economist, it would be a cardinal sin to propose a policy that would alter the “natural” allocation of factors of production—capital, labor, and goods and services—produced by market price signals determined by individuals and firms making free choices not influenced by regulations, taxes, market power, or other “distortions.” That is why Summers and Auerbach recommended that Congress eliminate the investment tax credit, even though they found that it spurred GDP growth. But as innovation economists Phillipe Aghion, Paul David, and Dominique Foray noted with respect to claims that a neutral tax code maximizes welfare, “The empirical foundations for such sweeping statements remain remarkably fragile.”<sup>70</sup> As Canadian Treasury economist Aled ab Iorwerth wrote, “Distortions that favor the contributors to long-run growth will be welfare-enhancing.” In other words, tax distortions such as the R&D tax credit or accelerated depreciation for investments in new equipment lead to more growth because these investments are more productive than others and have significant positive externalities.

Yet, notwithstanding their predilection for a “neutral” tax code, some neoclassical economists do support tax incentives, such as the R&D tax credit. This is in large part because there is a well-developed body of economic theory and empirical research demonstrating that companies do not capture anywhere near all the benefits from the

---

research they conduct.<sup>71</sup> As a result, there is a market failure when it comes to business investment in research because it generates considerable “spillovers”—benefits that accrue to the economy in excess of the benefits to the firm making the investment receives.

But many economists have assumed there are few if any spillovers or other market failures related to investing in machinery and equipment. In fact, there appear to be significant spillovers from investing in physical assets, especially capital equipment. Economic research suggests companies only get about half of the total societal return from their investment in new capital equipment. One of the earliest studies that found this was performed by Lawrence Summers and Brad DeLong.<sup>72</sup> While that particular study has since been criticized, other studies have found similar results.

Jonathan Temple found externalities from capital investment.<sup>73</sup> Bart van Ark found that the spillovers from investment in new capital equipment are larger than the size of the benefits accrued by the investing firm.<sup>74</sup> Lauren Hitt found that the spillovers from firms’ investments in IT are “significant and almost as large in size as the effects of their own IT investment.”<sup>75</sup> In other words, firms capture on average only about half the total societal benefits from their investments in IT, suggesting that the current level of IT investment is significantly less than societally optimal. Xavier Sala-i Martin found that both equipment and non-equipment investment are strongly and positively related to growth, but equipment investment has about four times the effect on growth as non-equipment investment (e.g., buildings).<sup>76</sup> Kenneth Judd found that imperfect competition in intermediate capital goods, because innovation is concentrated there, implies that the price is higher than the marginal cost.<sup>77</sup> He therefore argues there should be greater subsidy for goods with prices significantly higher than marginal costs—and they are more likely to be equipment than structures.

---

*There appear to be significant positive spillovers from investing in physical assets, especially capital equipment.*

---

There are a number of reasons why firms are unable to capture all the benefits from their investments in capital equipment. One is that investments in new machinery give workers knowledge about these new investments that they then disclose to their next employer, which is then incentivized to also invest in that same new machinery. Indeed, users of new equipment learn what modifications need to be made and then transfer this experience to other firms through a host of means, including interfirm labor movement, trade shows, and professional association meetings. In addition, some equipment, especially information technology, has network effects wherein the benefits to other firms from a firm adopting the technology are significant. As Hitt noted, “Firm-level investments in communications technologies can create benefits for business partners. Alternatively, investments in information technologies can produce knowledge that can spill over between firms.”<sup>78</sup>

This is not to say all kinds of corporate capital investment share all of these characteristics. When a company buys, for example, office furniture or a car, or builds a new building, it is more likely to reap the full benefit from the investment. To the extent this investment creates jobs, it is with the suppliers (the makers of the furniture, car, or building), which is not spillover because the equivalent number of jobs would have to be created from other

---

spending elsewhere in the economy. But when a firm buys new equipment or software, it is not likely to capture all the benefits because other firms are able to boost their own productivity as a result. This is one of the key economic rationales for preferential tax treatment of investing in equipment.

### Tax Incentives for Investing in Robots Spur National Economic Competitiveness

There is another reason for a nation using the tax code to encourage investment: increased global competitiveness. In a relatively closed economy with little mobile capital, a highly effective corporate tax rate can have the effect of reducing overall investment but do little to affect the location of investment between nations. This situation essentially describes the U.S. economy until the late 1970s. But since then, competition for internationally mobile investment has significantly increased, spurred by reduced trade and capital barriers as well as technological innovations that enable global supply chains (e.g., shipping containers, software to manage logistics, etc.).

In response to this increased competition for globally mobile economic activity, a number of nations have implemented tax incentives for investment in capital equipment. Taiwan's Statute for Upgrading Industries, established in 1991, provides a package of corporate tax incentives, including accelerated depreciation and tax credits for investments in R&D, automation, worker training, pollution controls, and investments in newly emerging important and strategic industries. Companies can also take a credit of up to 20 percent of funds invested in hardware, software, and technology to promote their "digital information efficiency." While the tax credit for investing in automation costs the government NT\$7.8 billion (US\$268 million), it spurred growth that led to an increase in overall tax revenues of NT\$13.3 billion (US\$458 million).<sup>79</sup> Many other nations also have corporate tax incentives for investment, including Austria, where firms can receive a tax credit of 6 percent of the costs of education and training their workforce.<sup>80</sup> In Malaysia, companies can depreciate general plant and equipment over six years, with heavy machinery over four years, and computer and IT equipment even faster.<sup>81</sup> In the United Kingdom, firms can expense investments for plant and machinery of up to £100,000 (US\$130,000) in the first year, while other investments can be depreciated relatively quickly (equal to 20 percent per year). In Singapore, firms can expense all computer and prescribed automation equipment, robots, and energy efficiency equipment in the first year.<sup>82</sup> In addition, companies in manufacturing and engineering services industries may receive investment allowances for projects in addition to depreciation allowances. In Japan, companies can benefit from a modestly accelerated depreciation scheme consisting of "increased initial depreciation" and "accelerated depreciation."<sup>83</sup> France allows 50 percent of its capital investments for research buildings to be written off in the first year. In Canada, purchases of computers are eligible for a 55 percent declining-balance capital cost allocation rate in the first year. Manufacturing equipment is also eligible for accelerated depreciation.<sup>84</sup> In comparison, even after the passage of the recent Tax Cuts and Jobs Act, the United States ranks 16th in terms of percentage of total investment a business can recover through depreciation. Also, the tax generosity toward capital investment has fallen since 1979.<sup>85</sup>

---

## TAXING ROBOTS WOULD SLOW GDP GROWTH

Many robot taxers rely on the ideologically based argument that the tax code should be neutral when it comes to investing in machinery and equipment, and therefore call for a neutral tax code between capital and labor. For example, rather repealing such tax incentives as accelerated depreciation, many try to “level the playing field” by repealing the employer contributions to the Social Security and Medicare systems.<sup>86</sup> In other words, according to their thinking, companies have to pay taxes on workers, but not on robots. But economic research has clearly found that employees, not employers, bear the cost of employer-provided contributions. As a result, even if they were to be eliminated in a quest for the vaunted neutrality between labor and machine, it would not make labor any cheaper. Over the moderate term, real wages would rise by the same amount employer taxes fall. Moreover, if progressives who support taxing robots are intellectually consistent in their goal of having government reduce the cost of labor relative to capital equipment, they should oppose any increases to the minimum wage, and even support its abolition—which would certainly make labor relatively cheaper than capital.

But even if policy could make labor cheaper, it would have no effect on the overall rate of employment. To see why, it is important to understand that job creation is determined in the realm of macroeconomics, not microeconomics. We see this when considering the effects of a higher minimum wage. Opponents of a reasonable increase in the minimum wage often say something like, “A fundamental law of economics—the law of demand—states that when the price of anything (including labor) increases, the quantity demanded will decrease.”<sup>87</sup> This is certainly true for products and services. If a company raises the price of a good or service, demand will likely fall, and the firm will employ fewer workers. But labor demand is fundamentally different: It is largely determined at the macroeconomic level, not the microeconomic level, by what federal monetary and fiscal policies do.

To see why, for the sake of argument, let us stipulate that a higher minimum wage would lead to increased prices at Joe’s Pizzeria (because Joe has to pay his workers more), and that this reduces the demand for his pizza (more people choose to cook their food at home). Therefore, Joe does not need to employ as many workers. Those workers would be unemployed until they found new jobs, just as the minimum wage opponents warned. And this would raise the national unemployment rate. But wait, the argument does not stop there. What happens when the unemployment rate increases? The Federal Reserve reduces interest rates, which spurs increased spending and investment. This dynamic continues until the economy regains full employment. So even if there were a one-time economic “shock” from a higher minimum wage, that effect would be addressed by easing federal monetary policy, and the economy would return to full employment relatively quickly.

Leveling the so-called playing field is not enough for many robot opponents; they want to make employers pay a tax just to use robots. As Bill Gates proposed:



---

Right now, the human worker who does, say, \$50,000 worth of work in a factory, that income is taxed and you get income tax, social security tax, all those things. If a robot comes in to do the same thing, you'd think that we'd tax the robot at a similar level: Some of it can come on the profits that are generated by the labor-saving efficiency there. Some of it can come directly in some type of robot tax.<sup>88</sup>

Likewise, William Meisel has called for an automation tax that is calibrated according to the ratio of a company's profit to its employee compensation, in order to counterbalance the perceived incentives for "hiring" robots instead of people.<sup>89</sup> For them and other supporters of an affirmative tax, the logic is government needs more revenues to support key public spending priorities. But rather than get that through boosting productivity or taxing wealthy individuals, they would have government get it from taxing automation, thereby leading to the perverse outcome of reduced investment—which in turn would lower productivity and hence GDP growth. This would then lower the rate of federal revenue growth. The converse is also true. If, through supporting technological innovation and the adoption of automation equipment—including robots—U.S. productivity could grow by a rate of 3.6 percent, it would boost federal tax revenues by \$1,778 trillion per year in 2038, which would equal 18 times all federal spending on federal expenditures on education, training, employment, and social services.<sup>90</sup>

---

*Before giving into fears that an eventual last human worker will have nothing left to do but turn off the lights, it's worth remembering we've seen this movie before, and it has never ended the way people expected at the time.*

---

### **TECHNO-PANICS ABOUT JOBS ARE NOT NEW**

Many of these robot taxers sound like those same voices in the past that reacted to new waves of innovation that promised to spur productivity. For example, Secretary of Labor James Davis, who was serving under President Calvin Coolidge in 1927, wrote, "We must ask ourselves, 'Is automatic machinery ... going to leave on our hands a state of chronic and increasing unemployment?'"<sup>91</sup> Thirty-five years later, President Kennedy stated, "I regard it as the major domestic challenge to maintain full employment at a time when automation, of course, is replacing men."<sup>92</sup>

Business leaders and technologists were not immune to these panics. The so-called Ad Hoc Committee on the Triple Revolution, writing to President Johnson in 1964, declared that a new era of production had begun," in which there may soon be no more need for a vast pool of workers."<sup>93</sup> Mathematician, philosopher, and cybernetics pioneer Norbert Wiener wrote, "Let us remember that the automatic machine ... is the precise economic equivalent of slave labor. Any labor which competes with slave labor must accept the economic conditions of slave labor. It is perfectly clear that this will produce an unemployment situation, in comparison with which ... the depression of the thirties will seem a pleasant joke."<sup>94</sup> In his 1984 essay, "Artificial Intelligence, Employment and Income," AI scientist Nils Nilsson cited Wassily Leontief, "We are beginning a gradual process whereby over the next 30–40 years many people will be displaced, creating massive problems of unemployment and dislocation."<sup>95</sup>

They and many others before and after them have sounded alarms very similar to the warnings we hear today from the likes of Klaus Schwab, chairman of the World Economic Forum, who has taken stock of ongoing advances in AI, robotics, and automation, and

---

concluded, “The speed of current breakthroughs has no historical precedent.”<sup>96</sup> Except that it does—including the sweeping changes that came with the steam engine, the railroad, electric power, agricultural mechanization, the telegraph and telephone, the automobile, and commercial aviation—to name just a few. Leaps forward have always been disruptive, to be sure, yet labor markets have always adapted. So, before we give into fears that an eventual last human worker will have nothing left to do but turn off the lights, it is well worth remembering that we have seen this movie before, and it has never ended the way people expected it would at the time.<sup>97</sup>

As economist George Terborgh made clear in his compelling 1966 book *The Automation Hysteria*, a common thread in this sort of foreboding over the years has been the mistaken notion that technology will make the economy so productive it will outrun society’s capacity to consume—that is, only part of the labor force will need to work to produce everything everyone else could ever need or want. So, the rest of the population, perforce, will have to remain idle. This has never come to pass, and is unlikely to ever happen in the future. Yet the urge to prepare for it never seems to subside.

Economist David A. Wells got it right in 1888 when he wrote,

“While ... cases of displacement of labor appeal most strongly to human sympathy, and pre-eminently constitute a field for individual or societary [sic] action for the purpose of relief, it should be at the same time remembered that the world, especially during the last century, has had a large experience in such matters.... All experience shows that, whatever of disadvantage or detriment the introduction and use of new and improved instrumentalities or methods of production and distribution may temporarily entail on individuals or classes, the ultimate result is always an almost immeasurable degree of increased good to mankind in general.”<sup>98</sup>

This is because, as Senator Paul H. Douglas wrote in 1930, “Improved machinery and greater efficiency of management do not throw workers permanently out of employment. Instead they raise the national income and enable the level of earnings and of individual incomes to rise.”<sup>99</sup>

## CONCLUSION AND RECOMMENDATIONS

An effective growth and competitiveness policy needs to be based in part on lower prices for equipment, machinery, and software, as they play a key role in driving productivity and competitiveness. This is only partly through the simple expansion of capital. The bigger impact is from the introduction of new equipment (e.g., better robots). As Nobel Prize winning economist Paul Romer has written, the channel of new capital investment is one of the major ways innovation diffuses through the market place.<sup>100</sup> For example, Moore’s law of improvement in semiconductors is only an engineering marvel if companies do not buy new computers and other machines with the latest chips in them.

Accelerated depreciation and expensing expand the rate of new capital equipment investment. However, an even more effective incentive would be a tax credit for investment in new capital equipment (e.g., machinery, equipment, and software). Some argue that

---

*It would be a grave mistake for policymakers to “tax robots,” as it would mean turning their backs on progress.*

---

because of the difference between book-tax and accounting earnings, expensing and accelerated depreciation do not have as much of an incentive effect on companies as would an investment tax credit (ITC).<sup>101</sup> Approximately 20 states have modest ITCs to boost capital investment. But at the urging of neoclassical economists the federal ITC was eliminated in 1986 when Congress reformed depreciation tax write-offs to create the Modified Accelerated Cost Recovery System.

Both accelerated depreciation and an investment tax credit reduce the after-tax price of investment, thereby raising the level of domestic investment and the productivity of workers. Economic research has shown that an investment tax credit spurs more investment in new machinery, equipment, and software. As Summers and Auerbach found, an investment tax credit “will spur investment in equipment.”<sup>102</sup> Likewise, in his article, “The Determinants of Investment,” current Federal Reserve Bank Chair Ben Bernanke found that “a one percentage point increase in the investment tax credit raises net equipment investment 1.9 percent... in the first year.”<sup>103</sup>

To be sure, policies supporting faster automation and greater robot use need to be complemented with policies to help affected workers learn the skills necessary to use robots, and if dislocated, to be able to make more effective transitions. As such, policymakers should reform worker-training and adjustment policies for the current era of technological change, as ITIF has outline in a detailed agenda.<sup>104</sup>

In summary, it would be a grave mistake for policymakers to “tax robots,” as it would mean turning their backs on progress. As the White House Council of Economic Advisors noted in 1964, “To yield to apprehension that the machine will become our master, that we are unable to absorb and adjust to rapid change, that we must deny ourselves the continued rise in material well-being that ever-growing knowledge and understanding place within our grasp and the increased freedom it brings to pursue higher goals—such a defeatist view is both unworthy of our heritage and unjustified.”<sup>105</sup> This was true then, and it remains just as true today.

---

## ENDNOTES

1. Kevin J. Delaney, “The Robot that Takes Your Job Should Pay Taxes, Says Bill Gates,” *Quartz*, February 17, 2017, <https://qz.com/911968/bill-gates-the-robot-that-takes-your-job-should-pay-taxes/>.
2. Robert D. Atkinson, *Think Like an Enterprise: Why Nations Need Comprehensive Productivity Strategies* (Information Technology and Innovation Foundation, May 2016), <https://itif.org/publications/2016/05/04/think-enterprise-why-nations-need-comprehensive-productivity-strategies>.
3. The Conference Board, “The Conference Board Total Economy Database,” accessed March 9, 2016, <https://www.conference-board.org/retrievefile.cfm?filename=The-Conference-Board-2015-Productivity-Brief-Summary-Tables-1999-2015.pdf&type=subsite>.
4. For example, see Georg Graetz and Guy Michaels, *Robots at Work* (Discussion paper no 1335, Centre for Economic Performance, March 2016), <http://cep.lse.ac.uk/pubs/download/dp1335.pdf>.
5. Centre for Economics and Business Research (CEBR). 2017. “The Impact of Automation,” CEBR. [https://cebr.com/reports/new-study-shows-u-s-is-world-leader-in-robotics-automation/impact\\_of\\_automation\\_report\\_23\\_01\\_2017\\_final/](https://cebr.com/reports/new-study-shows-u-s-is-world-leader-in-robotics-automation/impact_of_automation_report_23_01_2017_final/).
6. The Conference Board International Labor Comparisons program, <https://www.conference-board.org/signin/?page=https%3A%2F%2Fwww%2Econference-board%2Eorg%2Fprogram%2Findex%2Ecfm>.
7. Georg Graetz and Guy Michaels, *Robots at Work* (Discussion paper no 1335, Centre for Economic Performance, March 2016), <http://cep.lse.ac.uk/pubs/download/dp1335.pdf>.
8. Georg Graetz and Guy Michaels, “The Impact of Automation” (Centre for Economics and Business Research Centre for Economics and Business Research, 2017).
9. Wolfgang Dauth et al., “German Robots—The Impact of Industrial Robots on Workers” (discussion paper, CEPR, September 2017), [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3039031##](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3039031##).
10. Daniel Castro and Michael McLaughlin, “Ten Ways the Precautionary Principle Undermines Progress in Artificial Intelligence” (Information Technology and Innovation Foundation, February 2019), <https://itif.org/printpdf/8235>.
11. Samuel Gibbs, “Elon Musk Leads 116 Experts Calling for Outright Ban of Killer Robots,” *The Guardian*, August 20, 2017, <https://www.theguardian.com/technology/2017/aug/20/elon-musk-killer-robots-experts-outright-ban-lethalautonomous-weapons-war>; Woodrow Hartzog, “Facial Recognition Is the Perfect Tool for Oppression,” *Medium*, August 2, 2018, <https://medium.com/s/story/facial-recognition-is-the-perfect-tool-for-oppression-bc2a08f0fe66>; “India Says No to Driverless Cars to Protect Jobs,” BBC, July 25, 2017, <https://www.bbc.com/news/technology-40716296>; Greg Nichols, “San Francisco Bans Delivery Robots in Most of the City,” ZDNet, December 12, 2017, <https://www.zdnet.com/article/san-francisco-bans-delivery-robots-in-most-of-the-city/>; Adam Brinklow, “San Francisco Ready to Permit robots on City Sidewalks,” *Curbed*, March 14, 2018, <https://sf.curbed.com/2018/3/14/17120628/sanfrancisco-robot-ban-fees-yee-tech>.
12. Malcolm James, “Here’s How Bill Gates’ Plan to Tax Robots Could Actually Happen,” *Business Insider*, March 20, 2017, <https://www.businessinsider.com/bill-gates-robot-tax-brighter-future-2017-3>.
13. Eduardo Porter, “Don’t Fight the Robots. Tax Them.” *The New York Times*, February 23, 2019, <https://www.nytimes.com/2019/02/23/sunday-review/tax-artificial-intelligence.html>.
14. Xavier Oberson, “How Taxing Robots Could Help Bridge Future Revenue Gaps” (OECD, 2017), <http://www.oecd.org/employment/how-taxing-robots-could-help-bridge-future-revenue-gaps.htm>.
15. Ryan Abbott and Bret Bogenschneider, “Should Robots Pay Taxes? Tax Policy in the Age of Automation” *Harvard Law and Policy Review*, Vol 12, no. 1 (2018): 145-175, <http://harvardlpr.com/wp-content/uploads/2018/03/AbbottBogenschneider.pdf>.

16. Carl Benedikt Frey and Michael A. Osborne, “The Future of Employment: How Susceptible Are Jobs to Computerisation?” (Oxford Martin Programme, September 2013), [http://www.oxfordmartin.ox.ac.uk/downloads/academic/The\\_Future\\_of\\_Employment.pdf](http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf).
17. Ibid, 43.
18. Francesco Chiacchio, Georgios Petropoulos, and David Pichler, “The Impact of Industrial Robots on EU Employment and Wages: A Local Labour Market Approach” (working paper 25186, Bruegel, April 2018), <http://bruegel.org/2018/04/the-impact-of-industrial-robots-on-eu-employment-and-wages-a-local-labour-market-approach/>.
19. Nicholas Bloom et al., *Are Ideas Getting Harder to Find?* (NBER, March 2018), <https://web.stanford.edu/~chadj/IdeaPF.pdf>.
20. Francesco Chiacchio, Georgios Petropoulos, and David Pichler, “The Impact of Industrial Robots on EU Employment and Wages: A Local Labour Market Approach” (working paper 25186, Bruegel, April 2018), <http://bruegel.org/2018/04/the-impact-of-industrial-robots-on-eu-employment-and-wages-a-local-labour-market-approach/>.
21. Calculations based on: The Conference Board, “Total Economy Database: Total GDP and Total Annual Hours Worked,” accessed April 30, 2018, <https://www.conference-board.org/data/economydatabase/index.cfm?id=27762>.
22. Wolfgang Dauth et al., *Adjusting to Robots: Worker-Level Evidence* (working paper, Opportunity & Inclusive Growth Institute, 2018), <https://www.minneapolisfed.org/institute/institute-working-papers/adjusting-to-robots-worker-level-evidence>.
23. Terry Gregory, Anna Salomons, Ulrich Zierahn, *Racing With or Against the Machine? Evidence from Europe* (working paper no 7247, CESifo, September 2018), [https://www.cesifo-group.de/DocDL/cesifo1\\_wp7247.pdf](https://www.cesifo-group.de/DocDL/cesifo1_wp7247.pdf).
24. Joerg Mayer, Robots and Industrialization: What Policies for Inclusive Growth? (working paper, Group 24 and Friedrich-Ebert-Stiftung, New York, 2018), [https://www.g24.org/wp-content/uploads/2018/08/Mayer\\_-\\_Robots\\_and\\_industrialization.pdf](https://www.g24.org/wp-content/uploads/2018/08/Mayer_-_Robots_and_industrialization.pdf).
25. Ibid.
26. Georg Graetz and Guy Michaels, *Robots at Work* (Discussion paper no 1335, Centre for Economic Performance, March 2016), <http://cep.lse.ac.uk/pubs/download/dp1335.pdf>; Mark Muro and Scott Andes, “Robots Seem to Be Improving Productivity, Not Costing Jobs,” *Harvard Business Review*, June 16, 2015, <https://hbr.org/2015/06/robots-seem-to-be-improving-productivity-not-costing-jobs>.
27. Adams Nager, “Trade vs. Productivity: What Caused U.S. Manufacturing’s Decline and How to Revive It” (Information Technology and Innovation Foundation, February 2017), <http://www2.itif.org/2017-trade-vs-productivity.pdf>.
28. Robert D. Atkinson, and John Wu, “False Alarmism: Technological Disruption and the U.S. Labor Market, 1850–2015” (Information Technology and Innovation Foundation, May 2017), <https://itif.org/publications/2017/05/08/false-alarmism-technological-disruption-and-us-labor-market-1850-2015>.
29. Organisation for Economic Co-operation and Development (OECD), “Technology, Productivity and Job Creation: Best Policy Practices” (OECD, July 1998), <http://www.oecd.org/dataoecd/39/28/2759012.pdf>.
30. Jianmin Tang, “Employment and Productivity: Exploring the Trade-off,” *Industry Canada*, accessed March 3, 2016, <http://www.csls.ca/ipm/28/tang.pdf>.
31. *World Employment Report 2004–05: Employment, Productivity, and Poverty Reduction* (International Labour Organization, 2004), [http://www.ilo.org/global/publications/ilo-bookstore/order-online/books/WCMS\\_PUBL\\_9221148130\\_EN/lang--en/index.htm](http://www.ilo.org/global/publications/ilo-bookstore/order-online/books/WCMS_PUBL_9221148130_EN/lang--en/index.htm).

- 
32. Bart van Ark, Ewout Frankema, Hedwig Duteweerd, *Productivity and Employment Growth: An Empirical Review of Long and Medium Run Evidence* (Groningen Growth and Development Centre, May 2004), [https://www.researchgate.net/publication/277292406\\_Productivity\\_and\\_Employment\\_Growth\\_An\\_Empirical\\_Review\\_of\\_Long\\_and\\_Medium\\_Run\\_Evidence](https://www.researchgate.net/publication/277292406_Productivity_and_Employment_Growth_An_Empirical_Review_of_Long_and_Medium_Run_Evidence).
  33. Robert Atkinson, “False Alarmism: Technological Disruption and the U.S. Labor Market, 1850–2015” (Information Technology and Innovation Foundation, May 2017). <https://itif.org/publications/2017/05/08/false-alarmism-technological-disruption-and-us-labor-market-1850-2015>.
  34. Xavier Oberson, “How Taxing Robots Could Help Bridge Future Revenue Gaps” (OECD, 2017), <http://www.oecd.org/employment/how-taxing-robots-could-help-bridge-future-revenue-gaps.htm>.
  35. Daron Acemoglu and Pascual Restrepo, “Artificial Intelligence, Automation and Work,” *Economics of Artificial Intelligence*, January 4, 2018, <https://economics.mit.edu/files/14641>.
  36. Jonathan Gruber and Alan B Krueger, “The Incidence of Mandated Employer-Provided Insurance: Lessons from Workers’ Compensation Insurance,” *Tax Policy and the Economy*, vol 5, (1991): 111-143, <https://www.journals.uchicago.edu/doi/abs/10.1086/tpe.5.20061802>.
  37. Robert Skidelsky, “The AI Road to Serfdom?” *Project Syndicate*, February 21, 2019, <https://www.project-syndicate.org/commentary/automation-may-not-boost-worker-income-by-robert-skidelsky-2019-02>.
  38. Andrew Berg, Edward F. Buffie, and Luis-Felipe Zanna, “Robots, Growth and Inequality,” *Finance & Development*, vol. 53, no.3, <https://www.imf.org/external/pubs/ft/fandd/2016/09/berg.htm>.
  39. Kenneth E. Boulding, Good Reads. <https://www.goodreads.com/quotes/801902-mathematics-brought-rigor-to-economics-unfortunately-it-also-brought-mortis>.
  40. Daron Acemoglu and Pascual Restrepo, “The Wrong Kind of AI,” *Technology, Academics, Policy*, December 21, 2018. <http://www.techpolicy.com/Blog/December-2018/The-Wrong-Kind-of-AI.aspx>.
  41. Lawrence Mishel and Josh Bivens, “The Zombie Robot Argument Lurches On” (Economic Policy Institute, May 24, 2017), <https://www.epi.org/publication/the-zombie-robot-argument-lurches-on-there-is-no-evidence-that-automation-leads-to-joblessness-or-inequality/>.
  42. David Autor, “Why Are There Still So Many Jobs? The History and Future of Workplace Automation,” *Journal of Economic Perspectives*, vol. 29, no 3., (2015).
  43. Ibid, 44.
  44. Georg Graetz and Guy Michaels, *Robots at Work* (Discussion paper no 1335, Centre for Economic Performance, March 2016), <http://cep.lse.ac.uk/pubs/download/dp1335.pdf>.
  45. Alan Cole, “A Walkthrough of Gross Domestic Income,” *Tax Foundation*, May 20, 2015, <https://taxfoundation.org/walkthrough-gross-domestic-income/>.
  46. Bureau of Economic Analysis, U.S. Department of Commerce, Interactive Data, Table 1.10. Gross Domestic Income by Type of Income, [www.bea.gov](http://www.bea.gov).
  47. Robert Atkinson, “How G7 Nations Can Support and Prepare for the Next Technology Wave” (Information Technology and Innovation Foundation, March 2018), <https://itif.org/publications/2018/03/27/emerging-technologies-and-preparing-future-labor-market>.
  48. Executive Office of the President, “Artificial Intelligence, Automation, and the Economy,” accessed January 5, 2018, <https://www.whitehouse.gov/sites/whitehouse.gov/files/images/EMBARGOED%20AI%20Economy%20Report.pdf>.
  49. Melanie Arntz, Terry Gregory, Ulrich Zierahn, *The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis* (working paper, OECD, May 2016), [http://www.oecd-ilibrary.org/social-issues-migration-health/the-risk-of-automation-for-jobs-in-oecd-countries\\_5j1z9h56dvq7-en](http://www.oecd-ilibrary.org/social-issues-migration-health/the-risk-of-automation-for-jobs-in-oecd-countries_5j1z9h56dvq7-en).

- 
50. One recent study found that over one-third of U.S. college graduates are overeducated in terms of the jobs they have, with similar numbers for EU nations. See research working paper by Brian Clark and Arnaud Maurel from Duke University and Clément Joubert from University of North Carolina at Chapel Hill titled “The career Prospects of Overeducated Americans,” which uses data from the National Longitudinal Survey of Youth 1979 and Current Population Survey to look at overeducation’s effects on employment and wages over time. To analyze these effects, the researchers tracked almost 5,000 college graduates for 12 years after they entered the workforce. Their study shows that over one-third of college graduates are working in what the researchers call “overeducated employment.”; Bureau of Labor Statistics, “High-Employment-Growth Firms: Defining and Counting Them,” *Monthly Labor Review*, June 2013, <https://www.bls.gov/opub/mlr/2013/article/clayton.htm>; Michael Giandrea, “Office of Survey Methods Research.” Bureau of Labor Statistics, July 2008, <https://www.bls.gov/osmr/abstract/ec/ec060110.htm>.
  51. Josh Bivens and Lawrence Mishel, “Understanding the Historic Divergence Between Productivity and a Typical Worker’s Pay: Why It Matters and Why It’s Real” (Economic Policy Institute, September 2, 2015), <https://www.epi.org/publication/understanding-the-historic-divergence-between-productivity-and-a-typical-workers-pay-why-it-matters-and-why-its-real/>.
  52. Economic Policy Institute, op. cit.
  53. Eduardo Porter, “Don’t Fight the Robots. Tax Them,” *The New York Times*, February 23, 2019, <https://www.nytimes.com/2019/02/23/sunday-review/tax-artificial-intelligence.html>.
  54. Ryan Abbott and Bret Bogenschneider, “Should Robots Pay Taxes? Tax Policy in the Age of Automation,” *Harvard Law and Policy Review*, vol. 12, 2018, <http://harvardlpr.com/wp-content/uploads/2018/03/AbbottBogenschneider.pdf>.
  55. Ibid
  56. Daron Acemoglu and Pascual Restrepo, “Artificial Intelligence, Automation and Work,” *Economics of Artificial Intelligence*, January 4, 2018, <https://economics.mit.edu/files/14641.1>.
  57. Christopher Ingraham, “A \$300 Billion Business Tax Break Meant to Raise Wages Is Instead Helping Companies Replace Workers With Machines, Study Says,” *The Washington Post*, February 13, 2019, <https://www.washingtonpost.com/us-policy/2019/02/13/billion-business-tax-break-meant-raise-wages-is-instead-helping-companies-replace-workers-with-machines-study-says>.
  58. Cecilia Llambí et al., “Are Tax Credits Effective in Developing Countries?: The Recent Uruguayan Experience,” *Brookings Institution Press*, vol. 18 no. 2, (Spring 2018): 25-58, <https://muse.jhu.edu/article/694083/summary>.
  59. Eric Zwick and James Mahon, “Tax Policy and Heterogeneous Investment Behavior” (working paper, National Bureau of Economic Research no. 21876, January 2016), <https://doi.org/10.1257/aer.20140855>.
  60. Christopher House and Matthew Shapiro, “Temporary Tax Incentives: Theory with Evidence from Bonus Depreciation,” *American Economic Review*, June 2016.
  61. Alan Auerbach and Kevin Hassett, “Taxes and Business Investment: Lessons from the Past Decade,” in Alan D. Viard, ed., *Tax Policy Lessons from the 2000s*, American Enterprise Institute, (Washington, D.C., AEI Press, 2009).
  62. James M. Williamson and Sarah Stutzman, “Tax Policy and Farm Capital Investment: Section 179 Expensing and Bonus Depreciation,” *Agricultural Finance Review*, vol. 76 issue 2, 246-269, <https://www.emeraldinsight.com/doi/abs/10.1108/AFR-07-2015-0031>.
  63. NationalJournal.com, National Journal Expert Blogs: Economy, William Gale’s response to “Tax Reform Handcuffs,” May 4, 2009, <http://economy.nationaljournal.com/2009/05/tax-reform-handcuffs.php>.
  64. Jane Gravelle, “What Can Private Investment Incentives Accomplish? The Case,” *National Tax Journal* 46, no. 3 (1993): 277.

- 
65. Alan Auerbach and Lawrence Summers, “The Investment Tax Credit: An Evaluation” (working paper, NBER, 1979), <https://www.nber.org/papers/w0404>.
  66. Ibid.
  67. Ibid.
  68. Ibid.
  69. The standard view is expressed by Devereux when he states, “Production is allocated efficiently if it’s not possible to reallocate resources between activities in a way that would increase total output.” Alan Auerbach, Michael Devereux, and Helen Simpson, *Taxing Corporate Income* (working paper series 14494, NBER, 2008), <https://www.nber.org/papers/w14494>.
  70. Philippe Aghion, Paul A. David, Dominique Foray, “Linking Policy Research and Practice in ‘STIG Systems’: Many Obstacles, but Some Ways Forward” (working paper, College of Management Technology, École Polytechnique Fédérale De Lausanne, Switzerland, 2007), 13, <http://cdm-it.epfl.ch/repec/cmi-wpaper/cemi-workingpaper-2007-002.pdf>.
  71. Robert D. Atkinson, “The Research and Experimentation Tax Credit: A Critical Policy Tool for Boosting Research and Enhancing U.S. Economic Competitiveness” (Information Technology and Innovation Foundation, September 2006), <http://www.itif.org/publications/research-and-experimentation-tax-credit-critical-policy-tool-boosting-research-and-enha>.
  72. Bradford DeLong and Lawrence Summers, “Equipment Investment and Economic Growth: How Strong is the Nexus?” *Brookings Papers on Economic Activity*, vol. 23 (Washington, D.C.: Brookings Institution, 1992).
  73. Jonathan Temple and Hans-Joachim Voth, “Human capital, equipment investment, and industrialization,” *European Economic Review* 42(7) (1998): 1343–62.
  74. Bart van Ark, “Measuring the New Economy, An International Comparative Perspective,” *Review of Income and Wealth* 48 (2002): 1–14.
  75. Lorin M. Hitt and Prasanna Tambe, “Measuring Spillovers from Information Technology Investments,” *Proceedings of the 27th International Conference on Information Systems*, Milwaukee, WI, 2006: 1793.
  76. Xavier Sala-i-Martin, “15 Years of New Growth Economics: What Have We Learnt?” Keynote address to the fifth annual conference of the Central Bank of Chile The Challenges of Economic Growth, Santiago, Chile, November 29–30, 2001.
  77. Kenneth Judd and Karl Schmedders, “Optimal Rules for Patent Races” (Discussion papers 1342, Northwestern University, Center for Mathematical Studies in Economics and Management Science, 2002), <https://ideas.repec.org/p/nwu/cmsems/1343.html>.
  78. Hitt, op. cit.
  79. Wen-Jung Lien et al., “The Economic Impact of Taiwan’s Investment Tax Credits and its direction of Adjustment,” *International Journal of Technology Management* 49, no. 1–3 (2010): 140–154.
  80. “Tax Aspects of Industrial Investment in Austria” (study, Austrian Business Agency, March 2011), [http://www.investinaustria.at/uploads/ABA\\_Tax\\_Aspects\\_Austria\\_2011\\_10699\\_EN.pdf](http://www.investinaustria.at/uploads/ABA_Tax_Aspects_Austria_2011_10699_EN.pdf).
  81. “International Tax and Business Guide: Malaysia” (Deloitte, 2010).
  82. “Tax Guides and Highlights,” Deloitte, accessed October 3, 2011, <http://www.deloitte.com/taxguides>.
  83. Thomas Dalsgaard, “Japan’s Corporate Income Tax—Overview and Challenges” (working paper, International Monetary Fund, March 2008), 5, <http://www.imf.org/external/pubs/ft/wp/2008/wp0870.pdf>.
  84. Canadian Department of Finance, “Description of Corporate Income Tax Provisions,” accessed October 3, 2011, <http://fin.gc.ca/taxexp-depfisc/2010/taxexp1004-eng.asp#tocnotes-05>.



- 
85. Amir El-Sibaie, “Capital Cost Recovery Across the OECD, 2018,” Tax Foundation, May 24, 2018, <https://taxfoundation.org/capital-cost-recovery-across-oecd-2018/>.
  86. Ibid, 71.
  87. James Dorn, “Obama’s Minimum Wage Hike: A Case of Zombie Economics,” *Forbes*, February 20, 2013, <https://www.forbes.com/sites/jamesdorn/2013/02/20/obamas-minimum-wage-hike-a-case-of-zombie-economics>.
  88. Kevin J. Delaney, “The Robot That Takes Your Job Should Pay Taxes, Says Bill Gates,” *Quartz*, February 17, 2017, <https://qz.com/911968/bill-gates-the-robot-that-takes-your-job-should-pay-taxes/>.
  89. William Meise, *The Software Society: Cultural and Economic Impact*, (Indiana: Trafford Publishing, 2013).
  90. Productivity and budget estimate from forthcoming ITIF report *Why Federal R&D Policy Needs to Prioritize Productivity to Drive Growth and Reduce the Debt-to-GDP Ratio*; Social spending from “Table 3.2-Outlays by Function and Subfunction: 1962-2023,” Office of Management and Budget, <https://www.whitehouse.gov/omb/historical-tables/>.
  91. James J. Davis, “Productivity of Labor and Industry,” *Monthly Labor Review*, vol. 25, no. 3, (September 1927): 3237 <https://www.jstor.org/stable/41860549>.
  92. John F. Kennedy, “News Conference 24, February 14, 1962,” *John F. Kennedy Presidential Library and Museum*, <https://www.jfklibrary.org/archives/other-resources/john-f-kennedy-press-conferences/news-conference-24>.
  93. The Ad Hoc Committee on the Triple Revolution, *The Triple Revolution*, (Santa Barbara, California, 1964), 5, <http://scarc.library.oregonstate.edu/coll/pauling/peace/papers/1964p.7-05.html>.
  94. Norbert Wiener, *The Human Use of Human Beings*, (London: Houghton Mifflin, 1950), [https://archive.org/stream/NorbertWienerHumanUseOfHumanBeings/NorbertWienerHuman\\_use\\_of\\_human\\_beings\\_djvu.txt](https://archive.org/stream/NorbertWienerHumanUseOfHumanBeings/NorbertWienerHuman_use_of_human_beings_djvu.txt).
  95. Nils J. Nilsson, “Artificial Intelligence, Employment and Income,” *AI Magazine*, vol. 5 no. 2 (1984), <https://www.aaai.org/ojs/index.php/aimagazine/article/view/433/369>.
  96. Klaus Schwab, “The Fourth Industrial Revolution: What it Means, How to Respond” (World Economic Forum, January 2016), <https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/>.
  97. Mike Rettig, “Will the Last Human Worker Please Turn Out the Lights?” *The Hill*, September 21, 2015, <https://thehill.com/blogs/pundits-blog/labor/254337-will-the-last-human-worker-please-turn-out-the-lights>.
  98. David A. Wells, “The Economic Outlook-Present and Prospective,” *The Popular Science Monthly*, March 1888, [https://en.wikisource.org/wiki/Popular\\_Science\\_Monthly/Volume\\_32/March\\_1888/The\\_Economic\\_Outlook:\\_Present\\_and\\_Prospective\\_II](https://en.wikisource.org/wiki/Popular_Science_Monthly/Volume_32/March_1888/The_Economic_Outlook:_Present_and_Prospective_II).
  99. John R. Commons, *Institutional Economics: Its Place in Political Economy*, (New Jersey: Transaction Publishers, 2009).
  100. Paul M. Romer, “Increasing Returns and Long-Run Growth,” *The Journal of Political Economy*, vol. 94, no. 5, (October 1986), 1002-1037, <http://www.dklevine.com/archive/refs42232.pdf>.
  101. J. Edgerton, “Investment, Accounting, and the Salience of the Corporate Income Tax” (working paper, Federal Reserve Board, 2011), [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=1805757](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1805757).
  102. Alan J. Auerbach and Lawrence H. Summers, “The Investment Tax Credit: An Evaluation” (working paper, NBER, Cambridge, MA, 1979), [www.nber.org/papers/w0404](http://www.nber.org/papers/w0404).
  103. Ben S. Bernanke, “The Determinants of Investment: Another Look,” *The American Economic Review* (1983), <http://www.jstor.org/pss/1816817>.

- 
104. Robert Atkinson, *How to Reform Worker-Training and Adjustment Policies for an Era of Technological Change* (Information Technology and Innovation Foundation, February 2018), <https://www.itif.org/publications/2018/02/20/technological-innovation-employment-and-workforce-adjustment-policies>.
  105. David Nobel, "Deployment: Power in Numbers," in *Forces of Production: A Social History of Industrial Automation*, (New Jersey: Transaction Publishers, 2011).

---

## **ABOUT THE AUTHOR**

Robert D. Atkinson is the founder and president of the Information Technology and Innovation Foundation. He is also the co-author of the book *Innovation Economics: The Race for Global Advantage* (Yale, 2012). Atkinson received his Ph.D. in city and regional planning from the University of North Carolina at Chapel Hill in 1989.

## **ABOUT ITIF**

The Information Technology and Innovation Foundation (ITIF) is a nonprofit, nonpartisan research and educational institute focusing on the intersection of technological innovation and public policy. Recognized as the world's leading science and technology think tank, ITIF's mission is to formulate and promote policy solutions that accelerate innovation and boost productivity to spur growth, opportunity, and progress.

**FOR MORE INFORMATION, VISIT US AT [WWW.ITIF.ORG](http://WWW.ITIF.ORG).**