Should Robots Pay Taxes? Tax Policy in the Age of Automation

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Existing technologies can already automate most work functions, and the cost of these technologies is decreasing at a time when human labor costs are increasing. This, combined with ongoing advances in computing, artificial intelligence, and robotics, has led experts to predict that automation will lead to significant job losses and worsening income inequality. Policy makers are actively debating how to deal with these problems, with most proposals focusing on investing in education to train workers in new job types, or investing in social benefits to distribute the gains of automation.

The importance of tax policy has been neglected in this debate, which is unfortunate because such policies are critically important. The tax system incentivizes automation even in cases where it is not otherwise efficient. This is 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.

We argue that existing tax policies must be changed. The system should be at least "neutral" as between robot and human workers, and automation should not be allowed to reduce tax revenue. This could be achieved through some combination of disallowing corporate tax deductions for automated workers, creating an "automation tax" which mirrors existing unemployment schemes, granting offsetting tax preferences for human workers, levying a corporate self-employment tax, and increasing the corporate tax rate.

Introduction

An automation revolution is underway.[1] Current technologies can already mechanize most work activities, and the cost of these technologies is

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[1] *See, e.g.*, Bank of America Merrill Lynch, Robot Revolution: Global Robot & AI Primer 3 (Dec. 16, 2015) (on file with the Harvard Law School Library) ("The pace of disruptive technological innovation has gone from linear to parabolic in recent years. Penetration of robots and artificial intelligence (AI) has hit every industry sector, and has become an integral part of our daily lives. Technology has also expanded beyond routine work, and moved into complex problem-solving, and replicating human perception, tasks that only people were capable of."); *see also Relating to the Training and Utilization of the Manpower Resources of the Nation: Hearing Before the Subcomm. on Emp't and Manpower of the Comm. on Labor and Pub. Welfare*, 88th Cong. 1659 (1963) (statement of Isaac L. Auerbach, President, International Federation for Information Processing) ("The word 'automation' was coined by Delmar S. Harder, then executive vice president of the Ford Motor Co., in attempting to describe the latest kind of assembly line technique involving engine-block transfer machines then being installed at Ford's River Rouge and Cleveland plants."). For a definition of the term "automation," see Meg Leta Jones, *The Ironies of Automation Law: Tying Policy Knots with Fair Auto-*

decreasing at a time when human labor costs are increasing.[2] On top of that, ongoing and exponential improvements in computing, artificial intelligence (AI), and robotics are permitting automation in an ever-increasing number of fields.[3] As a result, academic and industry experts are widely predicting that automation will result in substantial "technological unemployment" in the near future.[4] For instance, the McKinsey Global Institute has claimed that the disruption caused by AI will "happ[en] ten times faster and at 300 times the scale, or roughly 3,000 times the impact," of the Industrial Revolution.[5] We

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mation Practices Principles, 18 VAND. J. ENT. & TECH. L. 77, 84 (2015) ("Broadly, automation includes all the ways computers and machines help people perform tasks more quickly, accurately, and efficiently. The term 'automation' refers to: (1) the mechanization and integration of the sensing of environmental variables through artificial sensors, (2) data processing and decision making by computers, and (3) mechanical action by devices that apply forces on the environment or information action through communication to people of information processed. The term encompasses open-loop operations and closed-loop control, as well as intelligent systems.") (citations omitted). One of the most cited studies on technological unemployment claims that forty-seven percent of American jobs are at high risk of loss due to automation. *See* Carl Benedikt Frey & Michael A. Osborne, *The Future of Employment: How Susceptible are Jobs to Computerisation?*, 114 TECH. FORECASTING & SOC. CHANGE 254, 265–66 (2017), https://ac.els-cdn.com/S0040162516302244/1-s2.0-S0040162516302244-main.pdf?_tid=14d233e0-c236-11e7-a741-00000aacb362&acdnat=1509892499_c57668bde931faf6de11b39073cccfc5 [https://perma.cc/LFE2-2T7A] ("[O]ur findings suggest recent developments in [machine learning] will put a substantial share of employment, across a wide range of occupations, at risk in the near future.").

[2] *See* Frey & Osborne, *supra* note 1, at 265–68; *but see* JAMES MANYIKA ET AL., MCKINSEY GLOBAL INST., A FUTURE THAT WORKS: AUTOMATION, EMPLOYMENT, AND PRODUCTIVITY 21 (2017), https://www.mckinsey.com/~/media/McKinsey/Global%20Themes/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works_Full-report.ashx [https://perma.cc/2F6U-U259] (predicting that fewer than five percent of occupations could be entirely automated with existing technologies).

[3] For examples of automation in white-collar and professional settings, see Roger Parloff, *Why Deep Learning is Suddenly Changing Your Life*, FORTUNE (Sept. 28, 2016, 5:00 PM), http://fortune.com/ai-artificial-intelligence-deep-machine-learning/ [https://perma.cc/5A6Q-5U4T]. Of particular concern to future attorneys is that AI is already automating work functions in the legal services industry. *See, e.g.*, Jane Croft, *Legal Firms Unleash Office Automatons*, FIN. TIMES, May 16, 2016 at 4 (discussing various software programs that can outperform attorneys and paralegals in document review); *but see generally* Dana Remus & Frank Levy, *Can Robots Be Lawyers?: Computers, Lawyers, and the Practice of Law*, 30 GEO. J. LEGAL ETHICS 501 (2017) (arguing that AI will refocus rather than replace attorneys).

[4] *See supra* note 1. In the 1930s, the economist John Maynard Keynes popularized the term "technological unemployment" to refer to "unemployment due to our discovery of means of economising the use of labour outrunning the pace at which we can find new uses for labour." *The Future of Jobs: The Onrushing Wave*, ECONOMIST (Jan. 18, 2014), https://www.economist.com/news/briefing/21594264-previous-technological-innovation-has-always-delivered-more-long-run-employment-not-less [https://perma.cc/QQ3N-9AWN].

[5] Richard Dobbs et al., *The Four Global Forces Breaking All the Trends*, MCKINSEY GLOBAL INST. (Apr. 2015), https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/the-four-global-forces-breaking-all-the-trends [https://perma.cc/LC89-B23C] (excerpting RICHARD DOBBS ET AL., NO ORDINARY DISRUPTION: THE FOUR GLOBAL FORCES BREAKING ALL THE TRENDS (2015)); *see also* JAMES MANYIKA ET AL., MCKINSEY GLOBAL INST., DISRUPTIVE TECHNOLOGIES: ADVANCES THAT WILL TRANSFORM LIFE, BUSINESS, AND THE GLOBAL ECONOMY (2013), https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/McKinsey%20Digital/Our%20Insights/Disruptive%20technologies/MGI_Disruptive_technologies_Full_report_May2013.ashx [https://perma.cc/EV85-WHVG] (predicting also trillions of dollars in economic impact by 2025 from advanced robotics, 3D printing and autonomous vehicles).

are entering an era in which the combined impact of technological improvements in many different areas is going to be profoundly transformative—and disruptive.[6]

Automation has the potential to create widespread benefits. Not only will automation increase productivity, it will also improve safety and lead to new scientific breakthroughs.[7] But without oversight, automation will also exacerbate unemployment and economic inequality.[8] Even if workers rendered technologically unemployed are able to transition to new jobs, as has been the case during previous eras of rapid change, there will still be significant short-term disruptions. Moreover, many experts are predicting that today's technological advances are different in kind from those of the past, and that large-scale permanent increases in unemployment are inevitable.[9] In 1990, the three largest companies in Detroit with a combined market capitalization of $36 billion employed 1.2 million workers.[10] In 2014, the three

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[6] *See, e.g.*, HERRING KAGERMANN, ET AL., INDUSTRIE 4.0 WORKING GRP., RECOMMENDATIONS FOR IMPLEMENTING THE STRATEGIC INITIATIVE INDUSTRIE 4.0, at 5 (2013), http://www.acatech.de/fileadmin/user_upload/Baumstruktur_nach_Website/Acatech/root/de/Material_fuer_Sonderseiten/Industrie_4.0/Final_report__Industrie_4.0_accessible.pdf [https://perma.cc/PA7X-YSRE] ("The first three industrial revolutions came about as a result of mechanisation, electricity and IT. Now, the introduction of the Internet of Things and Services into the manufacturing environment is ushering in a fourth industrial revolution."); *see also* VERNOR VINGE, THE COMING TECHNOLOGICAL SINGULARITY: HOW TO SURVIVE IN THE POST-HUMAN ERA (1993) https://edoras.sdsu.edu/~vinge/misc/singularity.html [https://perma.cc/K4C9-LRDE] (coining the term "singularity" to refer to the argument that "we are on the edge of change comparable to the rise of human life on Earth. The precise cause of this change is the imminent creation by technology of entities with greater than human intelligence.").

[7] *See generally* Ryan Abbott, *The Reasonable Computer: Disrupting the Paradigm of Tort Liability*, 86 GEO. WASH. L. REV. (forthcoming 2018) (discussing the potential of automation to result in substantial safety benefits, for instance in the transportation industry); *see also* Ryan Abbott, *I Think, Therefore I Invent: Creative Computers and the Future of Patent Law*, 1079 B.C. L. REV. 1083–91 (2016) (discussing examples in which AI has generated patentable subject matter under circumstances in which the computer rather than a person has qualified for inventorship).

[8] *See* COMM. ON TECH., NAT'L SCI. & TECH. COUNCIL, PREPARING FOR THE FUTURE OF ARTIFICIAL INTELLIGENCE 2 (2016) [hereinafter COMM. ON TECH.], https://obamawhitehouse.archives.gov/sites/default/files/whitehouse_files/microsites/ostp/NSTC/preparing_for_the_future_of_ai.pdf [https://perma.cc/DEH5-AQBK].

[9] *See* Klaus Schwab & Richard Samans, *Preface* to WORLD ECON. F., THE FUTURE OF JOBS: EMPLOYMENT, SKILLS AND WORKFORCE STRATEGY FOR THE FOURTH INDUSTRIAL REVOLUTION, at v–vi (2016), http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf [https://perma.cc/K6B4-2EDL]; *see also* Brian Dorini, *The End of Work: The Decline of the Global Labor Force and the Dawn of the Post-Market Era*, 9 HARV. J.L. & TECH. 231, 232–33 (1995) (reviewing JEREMY RIFKIN, THE END OF WORK: THE DECLINE OF THE GLOBAL LABOR FORCE AND THE DAWN OF THE POST-MARKET ERA 136–43 (1995)) ("The ranks of the unemployed are swelling with former service sector workers, such as secretaries, receptionists, clerks, and cashiers. These workers are being replaced by what Rifkin calls the silicon-collar workforce: answering machines, scanners, voice and handwriting recognition devices, electronic mail, and inventory control and monitoring devices.") (citation omitted).

[10] *See* Michael Chui & James Manyika, *Digital Era Brings Hyperscale Challenges*, FIN. TIMES (Aug. 13, 2014), https://www.ft.com/content/f30051b2-1e36-11e4-bb68-00144feabdc0 [http://perma.cc/4QHG-ZKDL].

largest companies in Silicon Valley with a combined market capitalization of $1.09 trillion employed 137,000 workers.[11]

These are not new problems.[12] In 1962, President Kennedy stated, "I regard it as the major domestic challenge, really, of the sixties, to maintain full employment at a time when automation, of course, is replacing men."[13] His solution was to pass the nation's first and most sweeping federal program to train workers unemployed due to technological advances.[14] More recently, in December 2016, the Executive Office of the President issued a report which outlined a three-pronged policy response to automation and AI, namely, to: (i) "[i]nvest in and develop AI for its many benefits," (ii) "[e]ducate and train Americans for jobs of the future," and, (iii) "[a]id workers in the transition and empower workers to ensure broadly shared growth."[15] These and other proposals for dealing with automation have focused on improving education and improving social benefit systems. Concerns about technological unemployment have even breathed new life into an old social benefit proposal—guaranteed minimum income, which could involve the government making fixed payments to each of its citizens regardless of their circumstances.[16] While education reform often enjoys bipartisan support, enhanced social benefits are a politically challenging goal since liberals and conservatives often disagree on their desirability.[17] In any

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[11] *See id.*

[12] *See generally* JOHN FORBES DOUGLAS, SOME EVIDENCES OF TECHNOLOGICAL UNEMPLOYMENT IN ANCIENT ATHENS AND ROME (1932). For instance, the Roman Emperor Vespasian once refused to use a labor-saving transportation machine, famously stating, "You must allow my poor hauliers to earn their bread." *See* Steve Welch, *The Real Political Divide is Education*, TECH CRUNCH (Dec. 30, 2016), https://techcrunch.com/2016/12/30/the-real-political-divide-is-education/ [https://perma.cc/EL6C-JKAQ].

[13] John F. Kennedy, The President's News Conference, AM. PRESIDENCY PROJECT (Feb. 14, 1962), http://www.presidency.ucsb.edu/ws/index.php?pid=9003 [https://perma.cc/2L35-QTT7].

[14] *See* Gladys Roth Kremen, *MDTA: The Origins of the Manpower Development and Training Act of 1962*, U.S. DEP'T OF LAB. (1974), www.dol.gov/general/aboutdol/history/mono-mdtatext [https://perma.cc/KFC7-MPCV] (describing the law's origins). Also of note, in 1961 (a year before the MDTA), the Office of Automation and Manpower was created at the Department of Labor to anticipate technological change and create occupational guidance. *See id*. For reviews of automation issues in the 1960s, see JAMES L. SUNDQUIST, POLITICS AND POLICY: THE EISENHOWER, KENNEDY, AND JOHNSON YEARS 77 (1968).

[15] EXEC. OFFICE OF THE PRESIDENT, ARTIFICIAL INTELLIGENCE, AUTOMATION, AND THE ECONOMY 3 (2016) [hereinafter ARTIFICIAL INTELLIGENCE, AUTOMATION, AND THE ECONOMY], https://obamawhitehouse.archives.gov/sites/whitehouse.gov/files/documents/Artificial-Intelligence-Automation-Economy.pdf [https://perma.cc/LK89-E5RG].

[16] Guaranteed minimum income was proposed during the Industrial Revolution by Charles Fourier, and then later Joseph Charlier, before being adopted by John Stuart Mill. *See* Philippe Van Parijs, *A Basic Income for All*, BOS. REV. (2000), bostonreview.net/forum/ubi-van-parijs [https://perma.cc/6E52-Q63K]. (According to Mill's proposal, "[A] certain minimum is first assigned for the subsistence of every member of the community, whether capable or not of labour.").

[17] *See* Yvonne A. Stevens, *The Future: Innovation and Jobs*, 56 JURIMETRICS J. 367, 373 (2016) ("One of the most commonly considered government payout schemes is what is referred to as a basic income guarantee (BIG). Generally speaking, BIG is a monetary government-backed and issued guarantee such that all adults have access to an amount of money necessary to meet basic needs."). President Richard Nixon also once proposed a guaranteed

event, both education and social benefit reforms to deal with automation would require significant financial support.[18]

While there has been a lively public discourse on technological unemployment and income disparity, the automation debate has historically ignored the issue of taxation. That has very recently started to change. In February 2017, the European Parliament rejected a proposal to impose a "robot tax" on owners to fund support for displaced workers, citing concerns of stifling innovation.[19] The next day, Bill Gates stated that he thought governments should tax companies' use of robots to slow the spread of automation and to fund other types of employment.[20] Former U.S. Secretary of the Treasury Lawrence Summers then claimed Gates's argument was "profoundly misguided."[21] In August 2017, South Korea announced plans for the world's first "tax on robots" by limiting tax incentives for automated machines.[22] Currently, Korean businesses may deduct three to seven percent of an investment in automation equipment from their corporate taxes, depending on the size of their operation.[23] The announced reform would decrease the deduction rate by up to two percent.[24]

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basic income of about $10,000 in today's dollars for families of four. This proposal, the Family Assistance Plan, passed through the House before it was voted down by Senate Democrats. *See* Whitney Mallett, *The Town Where Everyone Got Free Money*, VICE: MOTHERBOARD (Feb. 4, 2015), https://motherboard.vice.com/en_us/article/nze99z/the-mincome-experiment-dauphin [https://perma.cc/R7E7-3NTL].

[18] For example, in 2016, Switzerland voted down proposed guaranteed minimum income legislation that would have provided each citizen with about $30,000 a year. The cost of the legislation was estimated at about $200 billion, about three times Switzerland's current annual federal spending. *See* John Thornhill & Ralph Atkins, *Universal Basic Income: Money for Nothing*, FIN. TIMES.COM (May 26, 2016), https://www.ft.com/content/7c7ba87e-229f-11e6-9d4d-c11776a5124d [https://perma.cc/GR78-WG5H]. In the United Kingdom, it was estimated that distributing the current total welfare spending of £251 billion to 64.5 million persons as a universal basic income would result in a monthly payment to all residents of just £324. *See* Jim Edwards & Will Heilpern, *Here's How Much We'd All Get if the UK Introduced a 'Fiscally Neutral' Universal Basic Income Scheme*, BUS. INSIDER (June 6, 2016, 10:25 AM), http://www.businessinsider.com/universal-basic-income-scheme-for-the-uk-2016-6?r=UK&IR=T [https://perma.cc/4YRW-35G9]. This analysis is overly simplified, but demonstrates that providing a meaningful level of social benefits on a widespread basis requires significant funding.

[19] *See* Reuters Staff, *European Parliament Calls for Robot Law, Rejects Robot Tax*, REUTERS (Feb. 16, 2007, 2:03 PM), http://ca.reuters.com/article/technologyNews/idCAKBN15V2KM [https://perma.cc/5KTN-6VTJ].

[20] *See* Kevin J. Delaney, *The Robot That Takes Your Job Should Pay Taxes*, *Says Bill Gates*, QUARTZ (Feb. 17, 2017), https://qz.com/911968/bill-gates-the-robot-that-takes-your-job-should-pay-taxes/ [https://perma.cc/6SHD-L7WY] ("Exactly how you'd do it, measure it, you know, it's interesting for people to start talking about now.").

[21] Sarah Kessler, *Lawrence Summers Says Bill Gates' Idea for a Robot Tax is "Profoundly Misguided"*, QUARTZ (Mar. 6, 2017), https://qz.com/925412/lawrence-summers-says-bill-gates-idea-for-a-robot-tax-is-profoundly-misguided/ [https://perma.cc/ATV3-DXEG].

[22] *See* Cara McGoogan, *South Korea Introduces World's First 'Robot Tax'*, TELEGRAPH: TECH (Aug. 9, 2017, 12:54 PM), http://www.telegraph.co.uk/technology/2017/08/09/south-korea-introduces-worlds-first-robot-tax/ [https://perma.cc/H93H-RPMC].

[23] *See* Yoon Sung-won, *Korea Takes First Step to Introduce 'Robot Tax'*, KOREA TIMES (Aug. 7, 2017, 8:47 PM), http://www.koreatimes.co.kr/www/news/tech/2017/08/133_234312.html [https://perma.cc/82WW-B4QL].

[24] *See id.*

The critical importance of tax policies on automation has not been appreciated. The current system encourages automation by providing employers with preferential tax treatment for robot workers. Automation allows firms to avoid employee and employer wage taxes levied by federal, state, and local taxing authorities. It also permits firms to claim accelerated tax depreciation on capital costs for automated workers, and it creates a variety of indirect incentives for machine workers. All of this is the unintended result of a tax system designed to tax labor rather than capital. Tax policies may thus result in automation in some cases in which a firm would otherwise choose a human worker.

Even more concerning, automation significantly reduces the government's tax revenue since most tax revenue comes from labor-related taxes.[25] When firms replace employees with machines, the government loses income due to taxation. A very rough estimate of revenue loss can be arrived at by multiplying an effective tax rate by the gross salary loss due to automation. In January 2017, the McKinsey Global Institute claimed that about half of current work activities could be automated using currently demonstrated technologies, which would eliminate $2.7 trillion in annual wages in the United States alone.[26] Workers pay high effective tax rates ranging from twenty-five percent to fifty-five percent when all tax types are taken into account.[27] This suggests that worker automation could result in hundreds of billions or even trillions of dollars in tax revenue lost per year at various levels of government.[28]

In the United States and most other developed nations, the bulk of taxes are currently remitted by workers either through wage withholding, taxation of labor income, or indirect taxation of workers as consumers.[29] Since robots are not subject to these types of tax regimes, automation reduces the overall tax base. Robots are simply not taxpayers, at least not to the same extent as human workers. If all workers were to be replaced by machines tomorrow,

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[25] *See* OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT, FISCAL YEAR 2015 HISTORICAL TABLES: BUDGET OF THE U.S. GOVERNMENT 32–33 tbl.2.1 (2015), https://www.gpo.gov/fdsys/pkg/BUDGET-2015-TAB/pdf/BUDGET-2015-TAB.pdf [https://perma.cc/TT33-T3HA] (showing that individual income taxes, Social Security taxes, Medicare taxes, and other taxes assessed on labor wages comprised more than fifty percent of overall revenue); I.R.S., PUB. NO. 55B, DATA BOOK, 2014, at 3 tbl.1 (2015), https://www.irs.gov/pub/irs-pdf/p55b.pdf [https://perma.cc/Q4YU-GUFD]; CONG. BUDGET OFFICE, DISTRIBUTION OF HOUSEHOLD INCOME AND FEDERAL TAXES, 2010 (2013), https://www.cbo.gov/sites/default/files/113th-congress-2013-2014/reports/44604-AverageTaxRates.pdf [https://perma.cc/GH9J-YNQW]; *see also* Lester B. Snyder & Marianne Gallegos, *Redefining the Role of the Federal Income Tax: Taking the Tax Law "Private" Through the Flat Tax and Other Consumption Taxes*, 13 AM. J. TAX POL'Y 1, 86 (1996).

[26] MANYIKA ET AL., *supra* note 2, at 6 exhibit E3.

[27] *See* Bret N. Bogenschneider, *The Effective Tax Rate of U.S. Persons by Income Level*, 145 TAX NOTES 117, 117 tbl.1 (2014).

[28] *See* MANYIKA ET AL., *supra* note 2, at 5; *see also* Frey & Osborne, *supra* note 1, at 267 (asserting that many creative science, engineering, and general knowledge work jobs will be done by computers in the long run).

[29] *See* REVENUE STATISTICS - OECD COUNTRIES: COMPARATIVE TABLES, ORG. FOR ECON. CO-OPERATION & DEV. (2016), http://stats.oecd.org/Index.aspx?DataSetCode=REV [https://perma.cc/74EJ-2KS8].

most of the tax base would immediately disappear. As a matter of taxation, automated workers represent a type of capital investment, and capital income is currently taxed at much lower rates than labor income.[30] This is not accidental; it is based on the historic belief that the taxation of labor income is more efficient than the taxation of capital income. This concept is discussed in tax policy analysis as the "tax incidence" of capital taxation.[31]

Tax is thus critically important to the automation debate. Tax policies should not encourage automation unless it is part of a deliberate strategy based on sound public policy. We believe the solution is to adjust the tax system to be at least neutral as between robot and human workers.[32] More ambitiously, changes to tax policies are necessary to account for the loss of government tax revenue due to automation. This is particularly critical because the education and social benefit reform necessitated by automation will only be possible with more, not less, tax revenue.

This article outlines several potential tax policy solutions to address the automation revolution. Tax "neutrality" between human and automated workers could be achieved through some combination of disallowing corporate tax deductions for automated workers, creating an "automation tax" which mirrors existing unemployment schemes, granting offsetting tax preferences for human workers, levying a corporate self-employment tax, and increasing the corporate tax rate. Neutrality in this setting refers to a system in which various alternatives are taxed equally, and so actors make decisions based on non-tax reasons.

Tax neutrality is widely accepted as an economically efficient principle for organizing a tax system.[33] Neutral taxes are more likely to have fewer negative effects, lower administration and compliance costs, promote distri-

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[30] The term "capital taxation" refers here to corporate income taxation. For a comparison of effective tax rates between U.S. and EU multinationals, see Reuven S. Avi-Yonah & Yaron Lahav, *The Effective Tax Rate of the Largest U.S. and EU Multinationals*, 65 TAX L. REV. 375 (2012).

[31] In a strange twist of economic theory, the ultimate cost of wage taxation paid by workers is generally thought to be borne by capital. *See* Arnold C. Harberger, *Tax Policy in a Small, Open Developing Economy*, *in* THE ECONOMICS OF THE CARIBBEAN BASIN 1 (Michael B. Connolly & John McDermott eds., 1985). For the extension of the "small open economy" model beyond the small open economy context, see A. Lans Bovenberg, *Capital Income Taxation in Growing Open Economies*, 31 J. PUB. ECON. 347 (1986); Anne Sibert, *Taxing Capital in a Large, Open Economy*, 41 J. PUB. ECON. 297 (1990); Alan J. Auerbach, *Who Bears the Corporate Tax? A Review of What We Know*, 20 TAX POL'Y & ECON. 1 (2006).

[32] *See* WILLIAM MEISEL, THE SOFTWARE SOCIETY: CULTURAL AND ECONOMIC IMPACT 226 (2013) ("There are other alternatives using the tax code. One option suggested by Martin Ford in *The Lights in the Tunnel* is modification of the payroll tax, a tax that discourages hiring people and encourages automation since it makes the use of people more expensive. He suggests a reform of the tax system where we get away from taxing based on workers to reduce the disincentive to hiring.") (citing MARTIN FORD, THE LIGHTS IN THE TUNNEL: AUTOMATION, ACCELERATING TECHNOLOGY, AND THE ECONOMY (2009)).

[33] *See Tax: Fundamentals in Advance of Reform: Hearing Before the S. Comm. on Fin.*, 110th Cong. 41–50 (2008) (prepared statement of Jason Furman, Senior Fellow and Director of The Hamilton Project, The Brookings Institution) [hereinafter Prepared Statement of Jason Furman], https://www.finance.senate.gov/imo/media/doc/56020.pdf [https://perma.cc/Y98J-RN8K].

butional fairness, and increase transparency.[34] Tax neutrality can thus result in a broader tax base with lower rates.[35] Non-neutralities in the tax system distort choices and behavior other than for economic reasons, and encourage socially wasteful efforts to reduce tax payments.[36] They can thus "create complexity, encourage avoidance, and add costs for both taxpayers and governments."[37]

However, non-neutral taxes can be used deliberately to advance social policy—for instance, incentivizing activities like medical research, education, and homeownership.[38] Taxes may also be used to disincentivize certain activities, as so-called "Pigouvian" taxes. For instance, consumer goods such as alcoholic beverages and tobacco products bear an exceptional tax burden. In turn, this results in increased consumer costs, with the goal of decreasing consumption—but due to taxes rather than to other market and economic factors.

The advantage of tax neutrality as between human and automated workers is that it permits the marketplace to adjust without tax distortions. With a level playing field, firms should only automate if it will be more efficient, without taking taxes into account. Since the current tax system favors automated workers, a move toward a neutral tax system could increase the appeal of human workers. Policy solutions could even be implemented to make human workers *more* appealing than machines in terms of tax costs and benefits, to the extent policy makers choose to discourage automation.

The remainder of this article is divided into three parts. Part I discusses the phenomenon of automation and provides historical background on efforts to deal with its harmful effects. Part II analyzes current tax policies and contends that they promote automation even where it would not otherwise be efficient. Finally, Part III argues that changes to tax policy are needed to prevent the unintended consequences of encouraging automation and to offset the government's loss of tax revenue. We provide several potential solutions for achieving these goals.

The increased tax revenue from our proposal could be used to provide improved education and training for workers rendered unemployed by robots and computers. Should the pessimistic prediction of a near future with substantially increased unemployment due to automation manifest, these taxes could also support social benefit programs such as a guaranteed minimum income. Automation will likely generate more wealth than has ever been possible. It should not come at the expense of the most vulnerable.

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[34] *See* JAMES MIRRLEES ET AL., INST. FOR FISCAL STUDIES, TAX BY DESIGN 22–23 (2011), https://www.ifs.org.uk/docs/taxbydesign.pdf [https://perma.cc/JSU8-KS5Q].

[35] *See* Prepared Statement of Jason Furman, *supra* note 33, at 33.

[36] *See* MIRRLEES ET AL., *supra* note 34, at 40.

[37] *Id.* at 41.

[38] *See, e.g.*, Daniel J. Hemel & Lisa Larrimore Ouellette, *Beyond the Patents–Prizes Debate*, 92 TEX. L. REV. 303 (2013).

I. The Problem with Automation

A. Automation is Coming

Experts are widely predicting that automation is going to have a substantial impact on employment even in the near term. Bank of America Merrill Lynch argues that by 2025, AI may eliminate $9 trillion in employment costs by automating knowledge work.[39] A report by the World Economic Forum estimates that automation could result in the net loss of 5.1 million jobs by 2020.[40] The consulting firm Deloitte claims that thirty-five percent of jobs in the United Kingdom are at high risk of redundancy due to automation in the next ten to twenty years.[41] This is due to a combination of factors: improvements in automation technologies, decreased costs for such technologies, and increased labor costs. Whereas it was previously *possible* to automate a large number of work processes, it has now become *practicable*. As automation technologies continue to both improve and decrease in cost, it is difficult to think of work functions that will not eventually be susceptible to automation.[42]

1. The Good: Increased Productivity and New Jobs

Automation increases productivity, which generates value and creates wealth.[43] Partly due to technological advances and automation, the U.S. Gross Domestic Product (GDP) has steadily risen from $1.37 trillion in 1960 to $73.5 trillion in 2015.[44] Despite academic criticism, GDP has remained the dominant economic indicator of welfare and standard of living for half a century.[45]

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[39] Bank of America Merrill Lynch, *supra* note 1, at 1 (noting also that AI will yield $14–33 trillion in annual economic impact).

[40] *See* World Econ. F., The Future of Jobs: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution 13 (2016), http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf [https://perma.cc/K6B4-2EDL].

[41] Deloitte, Agiletown: The Relentless March of Technology and London's Response 5 (2014), https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/uk-futures/london-futures-agiletown.pdf [https://perma.cc/Z5HU-PY25].

[42] *See* Ryan Abbott, *Hal the Inventor: Big Data and Its Use by Artificial Intelligence*, *in* Big Data is Not a Monolith 188–91 (Cassidy R. Sugimoto et al. eds., 2016) (noting the ways in which automation technologies could replace workers in the pharmaceutical sciences).

[43] *See generally* Joel Mokyr et al., *The History of Technological Anxiety and the Future of Economic Growth: Is This Time Different?*, 29 J. Econ. Persp. 31 (2015).

[44] *See GDP (Current US$)*, World Bank: Data (2016), https://data.worldbank.org/indicator/NY.GDP.MKTP.CD [https://perma.cc/C34J-U67E].

[45] *See, e.g.*, Jeroen C.J.M. van den Bergh, *The GDP Paradox*, 30 J. Econ. Psychol. 117, 117–18 (2008) ("Gross domestic product (GDP) is the monetary, market value of all final goods and services produced in a country over a period of a year. The real GDP per capita (corrected for inflation) is generally used as the core indicator in judging the position of the economy of a country over time or relative to that of other countries. The GDP is thus implicitly, and often even explicitly, identified with social welfare—witness the common substituting phrase 'standard of living'. . . . For over half a century now, the GDP (per capita) has been

Automation can also create new jobs.[46] Human workers may be needed to build and maintain automation technologies. Automation may free up capital for investments in new enterprises, result in the creation of new products, or decrease production costs for existing products. Decreased production costs may result in lower consumer prices and thus greater consumer demand. All of this may increase employment. Technological advances have also historically upgraded the labor force: automation has reduced the need for unskilled workers but increased the need for skilled workers.[47] For instance, some of today's most in-demand occupations did not exist even five years ago.[48]

2. The Bad: Unemployment and Inequality

Automation can cause under- and un-employment. While worker productivity has risen robustly since 2000, employment has stagnated.[49] This may be due in part to technological advances.[50] When a company like McDonald's introduces computer cashiers, the company may save money and consumers may enjoy lower prices.[51] But human cashiers now find themselves in a more competitive labor market. The enhanced competition may result in lower wages, less favorable employment terms, fewer working

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severely criticized as not adequately capturing human welfare and progress. All the same, the GDP has maintained a firm position as a dominant economic indicator. . . .").

[46] The following arguments were referred to as "compensation theory" by Karl Marx, who argued none of these effects were guaranteed and that automation could result in forcing workers into lower paying jobs. *See* KARL MARX, CAPITAL, VOLUME I: THE PROCESS OF PRODUCTION OF CAPITAL 570 (1867).

[47] *See Automation and Technological Change: Hearing Before the Subcomm. on Econ. Stabilization of the J. Comm. on the Econ. Rep.*, 84th Cong. 29, 34–35 (Statement of Walter S. Buckingham, Jr., Associate Professor, Georgia Institute of Technology), https://www.jec.senate.gov/reports/84th%20Congress/Automation%20and%20Technological%20Change%20-%20Hearings%20%2875%29.pdf [https://perma.cc/B348-CT38].

[48] *See* WORLD ECON. F., *supra* note 40, at 3.

[49] *See, e.g.*, STEVEN GREENHOUSE, THE BIG SQUEEZE: TOUGH TIMES FOR THE AMERICAN WORKER 3 (2008).

[50] *See id.* at 9.

[51] *Cf.* Ted Goodman, *Fight for $15? McDonald's To Place Automated Ordering Stations At All US Locations*, DAILY CALLER (Nov. 18, 2016, 6:44 PM), http://dailycaller.com/2016/11/18/fight-for-15-mcdonalds-to-place-automated-ordering-stations-at-all-us-locations [https://perma.cc/VS4R-X35Y]. Standard economic principles suggest that in a competitive market lower business costs will result in lower consumer prices. *See*, *e.g.*, Arthur A. Thompson, Jr., *Strategies for Staying Cost Competitive*, HARV. BUS. REV. (Jan. 1984), https://hbr.org/1984/01/strategies-for-staying-cost-competitive [https://perma.cc/Y3SR-2WQC]. In fairness, fast food automation has been around since the nineteenth century. *See* Angelika Epple, *The "Automat": A History of Technological Transfer and the Process of Global Standardization in Modern Fast Food around 1900*, 7 FOOD & HISTORY 97, 98 (2009), http://wwwhomes.uni-bielefeld.de/aepple/Aufsatz12TheAutomat2009.pdf [https://perma.cc/LZ7F-MSXS] (discussing the restaurant chain "Automat" which opened its first location in 1896). ("One of [Automat's] highly unique selling features around 1900 was that no waiters were to be seen in the guest room. The Automat of that time was—at first sight—operated by vending machines only. 'You absolutely help yourself' was one of its most prominent marketing slogans.") *Id.* at 99. The Automat's technology transferred around the U.S. and Europe and eventually developed into the world's largest restaurant chain: Horn & Hardart. *Id.* at 97.

hours, reduced hiring, or layoffs.[52] As the former CEO of McDonald's USA famously quipped, "[i]t's cheaper to buy a $35,000 robotic arm than it is to hire an employee who's inefficient making $15 an hour bagging French fries. . . ."[53] McDonald's is now expanding its use of automated cashiers throughout the United States and in other countries.[54]

Also, while automation generates wealth, it does so unevenly. Over the past twenty-five years, partly due to automation technologies, the income share of the top 0.1% has increased substantially.[55] The top 0.1% of the U.S. population is now worth about as much as the bottom 90%.[56] CEO-to-worker pay ratios have increased a thousand-fold since 1950,[57] but overall wages have been stagnant for thirty-five years.[58] Increased automation is likely to accelerate these trends. The White House Council of Economic Advisers has predicted that future automation will disproportionately affect lower-wage jobs and less educated workers, causing greater economic inequality.[59]

Worsening employment coupled with growing income inequality is a recipe for social unrest.[60] As physicist Stephen Hawking has warned,

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[52] *See* Simon Neville, *McDonald's ties nine out of 10 workers to zero-hours contracts*, GUARDIAN (Aug. 5, 2013, 4:13 PM), https://www.theguardian.com/business/2013/aug/05/mcdonalds-workers-zero-hour-contracts [https://perma.cc/UF3D-D4S4] (noting that 90% of McDonald's UK workers have no guaranteed hours); *see also* Stephanie Strom, *McDonald's Introduces Screen Ordering and Table Service*, N.Y. TIMES (Nov. 17, 2016), https://www.nytimes.com/2016/11/18/business/mcdonalds-introduces-screen-ordering-and-table-service.html?_r=0 [https://perma.cc/3DZ7-R68J] (reporting that the cost of purchasing and installing eight touch order screens is $56,000).

[53] Julia Limitone, *Fmr. McDonald's USA CEO: $35K Robots Cheaper Than Hiring at $15 Per Hour*, FOX BUS. (May 24, 2016), http://www.foxbusiness.com/features/2016/05/24/fmr-mcdonalds-usa-ceo-35k-robots-cheaper-than-hiring-at-15-per-hour.html [https://perma.cc/W65G-697K] (claiming that a $15 minimum wage results in $30,000 a year for a full-time employee).

[54] *See* Ed Rensi, *The Ugly Truth About a $15 Minimum Wage*, FORBES (Apr. 25, 2016, 6:30 AM), https://www.forbes.com/sites/realspin/2016/04/25/mcdonalds-minimum-wage-reality/#1f50a0d93edd [https://perma.cc/TT3E-G5SR]. Automated cashiers are already the "norm" in European countries with high labor costs, and McDonald's is now experimenting with self-serve McCafe kiosks. *See id.*

[55] *See* CARL BENEDIKT FREY & MICHAEL OSBORNE, TECHNOLOGY AT WORK: THE FUTURE OF INNOVATION AND EMPLOYMENT 14 (2015) http://www.oxfordmartin.ox.ac.uk/downloads/reports/Citi_GPS_Technology_Work.pdf [https://perma.cc/YE22-D6AE].

[56] *See* Angela Monaghan, *US Wealth Inequality - Top 0.1% Worth as Much as the Bottom 90%*, GUARDIAN (Nov. 13, 2014, 7:00 AM), https://www.theguardian.com/business/2014/nov/13/us-wealth-inequality-top-01-worth-as-much-as-the-bottom-90 [https://perma.cc/62U8-6ADA].

[57] Elliot Blair Smith & Phil Kuntz, *CEO Pay 1,795-to-1 Multiple of Wages Skirts U.S. Law*, BLOOMBERG MARKETS (Apr. 30, 2013, 12:01 AM), https://www.bloomberg.com/news/articles/2013-04-30/ceo-pay-1-795-to-1-multiple-of-workers-skirts-law-as-sec-delays [https://perma.cc/NNF6-P2X6].

[58] *See* ELISE GOULD, ECONOMIC POLICY INSTITUTE, 2014 CONTINUES A 35-YEAR TREND OF BROAD-BASED WAGE STAGNATION (2015), http://www.epi.org/files/pdf/stagnant-wages-in-2014.pdf [https://perma.cc/YN3U-9LMJ].

[59] COMM. ON TECH., *supra* note 8, at 2.

[60] *See* Katie Allen, *ILO Warns of Rise in Social Unrest and Migration as Inequality Widens*, GUARDIAN (Jan. 12, 2017, 4:00 PM), https://www.theguardian.com/business/2017/jan/12/ilo-warns-of-rise-in-social-unrest-and-migration-as-inequality-widens [https://perma.cc/3DHG-T2WH].

"[e]veryone 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."[61]

3. The Ugly: Reduced Tax Remittances

One of automation's most pronounced and unappreciated effects relates to taxes. Automation substantially reduces tax revenue. Most of the U.S. government's tax revenue comes from taxes on workers.[62] By stating that most tax revenue comes from workers, we refer to the aggregate amount of wage tax, income tax, and indirect taxes levied on income or wages derived from work at all levels of government. Much of the prior tax policy debate focused solely on income taxation by the federal government.[63] Of course, a substantial portion of income subject to federal income tax arises from work and falls within our definition of worker taxation. However, the tax policy debate has been misleading since wage taxes are also levied on labor income and comprise more than one-third of federal remittances. Likewise, indirect state taxes are levied on workers. Consequently, by replacing employees with machines, the government loses out on employee and employer wage taxes levied by federal, state, and local taxing authorities. In addition, tax revenue may be further reduced from businesses claiming accelerated tax depreciation on capital outlays for machines and from other tax incentives related to indirect taxation, such as sales tax or value-added tax (VAT) exemptions.[64]

B. History of the Automation Scare

Fears of the consequences of automation have been expressed since the industrial revolution.[65] In 1801, the writer Thomas Mortimer objected to machines, "which are intended almost totally to exclude the labor of the human

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[61] Akshat Rathi, *Stephen Hawking: Robots aren't just taking our jobs, they're making society more unequal*, Quartz (Oct. 9, 2015), http://qz.com/520907/stephen-hawking-robots-arent-just-taking-our-jobs-theyre-making-society-more-unequal [https://perma.cc/A2BN-VYY5].

[62] *See* Office of Mgmt. & Budget, *supra* note 25, at 32–33 tbl.2.1.

[63] *See, e.g.*, Curtis S. Dubay, The Heritage Foundation, The Rich Pay More Taxes: Top 20 Percent Pay Record Share of Income Taxes (2009), http://www.heritage.org/poverty-and-inequality/report/the-rich-pay-more-taxes-top-20-percent-pay-record-share-income-taxes [https://perma.cc/N97H-VETS].

[64] *See infra* Part III.

[65] For that matter, broader social issues related to automation have been discussed since Aristotle's time. *See, e.g.*, Johannes Hanel, Assessing Induced Technology: Sombart's Understanding of Technical Change in the History of Economics 91 (2008) (noting Aristotle's hope that machines could occupy the place of slaves in a utopian society).

race."[66] In 1821, the economist David Ricardo argued that automation would result in inequality, and that "substitution of machinery for human labour, is often very injurious to the interests of the class of labourers. . . . [It] may render the population redundant, and deteriorate the condition of the labourer."[67] In 1839, the philosopher Thomas Carlyle more poetically wrote:

> [T]he huge demon of Mechanism smokes and thunders, panting at his great task, in all sections of English land; changing his *shape* like a very Proteus; and infallibly, at every change of shape, *oversetting* whole multitudes of workmen, as if with the waving of his shadow from afar, hurling them asunder, this way and that, in their crowded march and course of work or traffic; so that the wisest no longer knows his whereabout[s].[68]

The Industrial Revolution even gave birth to a social movement and group protesting the use of new technologies: the Luddites.[69] Luddites were primarily English textile workers who objected to working conditions in the nineteenth century. They believed that automation threatened their livelihoods, and they were opposed to the introduction of industrial machinery.[70] Some Luddites engaged in violent episodes of machine-breaking, in response to which the English government made machine-breaking a capital offense.[71]

The Luddite movement died out, but automation concerns persisted throughout the twentieth century, often flaring during times of rapid technological progress.[72] For instance, the debate was revitalized in the 1950s and 1960s with the widespread introduction of office computers and factory ro-

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[66] THOMAS MORTIMER, LECTURES ON THE ELEMENTS OF COMMERCE, POLITICS, AND FINANCES 72 (London, A. Strahan, for T. N. Longman and O. Rees 1801).

[67] DAVID RICARDO, ON THE PRINCIPLES OF POLITICAL ECONOMY AND TAXATION 283–84 (Batoche Books 2001) (3d ed. 1821).

[68] 2 THOMAS CARLYLE, THE WORKS OF THOMAS CARLYLE: CRITICAL AND MISCELLANEOUS ESSAYS 141–42 (Henry Duff Traill ed., Cambridge Univ. Press 2010) (1899). Thomas Carlyle called the Industrial Revolution "the Mechanical Age." *Id* at 59. Carlyle wrote that technology was causing a "mighty change" in their "modes of thought and feeling. Men are grown mechanical in head and in heart, as well as in hand." *Id*. at 63.

[69] *See* Richard Conniff, *What the Luddites Really Fought Against*, SMITHSONIAN MAG. (Mar. 2011), https://www.smithsonianmag.com/history/what-the-luddites-really-fought-against-264412/ [https://perma.cc/98RV-LNJ2].

[70] *See* Ian Coulson, *Power, Politics & Protest: The Growth of Political Rights in Britain in the 19th Century: Luddites*, NAT'L ARCHIVES (U.K.), https://www.nationalarchives.gov.uk/education/politics/g3/ [https://perma.cc/96H4-4NAR].

[71] *See id*.; *see also* Conniff, *supra* note 69. The "Luddite fallacy" now describes the fear that innovation will have long-term harmful labor effects. *See* Vivek Wadhwa, *Sorry, but the jobless future isn't a luddite fallacy*, WASH. POST (July 7, 2015), https://www.washingtonpost.com/news/innovations/wp/2015/07/07/sorry-but-the-jobless-future-isnt-a-luddite-fallacy/?utm_term=.f52e3687022c [https://perma.cc/5JUA-YPUE].

[72] In 1924, Mohandas Karamchand Gandhi wrote, "What I object to, is the craze for machinery, not machinery as such. The craze is for what they call labour-saving machinery. Men go on 'saving labour', till thousands are without work and thrown on the open streets to die of starvation." MOHANDAS K. GANDHI, YOUNG INDIA (1924), *reprinted in* ALL MEN ARE BROTHERS: LIFE AND THOUGHTS OF MAHATMA GANDHI AS TOLD IN HIS OWN WORDS 126 (Krishna Krapilani ed., 1958).

bots.[73] In his 1960 election campaign, John F. Kennedy suggested that automation offered "hope of a new prosperity for labor and a new abundance for America," but that it also "carries the dark menace of industrial dislocation, increasing unemployment, and deepening poverty."[74]

Despite these concerns, technological advances have historically resulted in overall job creation. The computer eliminated jobs, but created jobs for working with information created by computers. The automobile eliminated jobs, but created jobs in the motel and fast-food industries. The tractor and other agricultural advances eliminated jobs, but drove job growth in other areas of the economy. In 1900, forty-one percent of the workforce was employed in agriculture.[75] In 2000, less than two percent of the employed labor force worked in agriculture.[76] Yet this has not translated to a thirty-nine percent increase in unemployment. Even as agriculture-based employment and agriculture's relative contribution to the GDP decreased, the productivity of farmworkers skyrocketed and agriculture's absolute contribution to the GDP increased.[77] Indeed, in each era when concerns have been expressed about automation causing mass unemployment, technology has created more jobs than it has destroyed.

C. Is This Time Different?

The automation debate is resurfacing with a vengeance due to recent advances in AI and other automation technologies. Once more, prognosticators are divided into two camps: the optimists who claim there will be a net creation of jobs, and the pessimists who predict mass unemployment and growing inequality.[78]

History favors the optimists.[79] They argue that technological advances will generate widespread benefits together with overall job creation. They

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[73] *See* Kremen, *supra* note 14 ("The dawn of the Atomic Age had witnessed the implementation of a new technology that threatened to replace men with machines."); *see also* Douglas A. Irwin, *Comments*, *in* JAGDISH BHAGWATI & ALAN S. BLINDER, OFFSHORING OF AMERICAN JOBS: WHAT RESPONSE FROM U.S. ECONOMIC POLICY? 79 (Benjamin M. Friedman ed., 2009).

[74] Irwin, *supra* note 73, at 80.

[75] *See* CAROLYN DIMITRI ET AL., U.S. DEP'T OF AGRIC., THE 20TH CENTURY TRANSFORMATION OF U.S. AGRICULTURE AND FARM POLICY 2 (June 2005), https://www.ers.usda.gov/webdocs/publications/44197/13566_eib3_1_.pdf?v=41055 [https://perma.cc/FRJ7-V3QA].

[76] *See id.*

[77] *Id.*; *see also* JULIAN M. ALSTON ET AL., PERSISTENCE PAYS: U.S. AGRICULTURAL PRODUCTIVITY GROWTH AND THE BENEFITS FROM PUBLIC R&D SPENDING 43, 105 (2010).

[78] *See* Schwab & Samans, *supra* note 9, at v–vi; *see also* Dorini, *supra* note 9, at 233 ("The ranks of the unemployed are swelling with former service sector workers, such as secretaries, receptionists, clerks, and cashiers. These workers are being replaced by what Rifkin calls the silicon-collar workforce: answering machines, scanners, voice and handwriting recognition devices, electronic mail, and inventory control and monitoring devices.") (citation omitted).

[79] *See* John Maynard Keynes, *Economic Possibilities for our Grandchildren*, *in* ESSAYS IN PERSUASION 321–32 (Palgrave Macmillan 2010) (1930) (predicting that the combination of technological innovation and capital accumulation will eventually solve the problem of material needs).

also argue that current unemployment may relate more to globalization and offshoring than to technology, and that any future technological unemployment would be "only a temporary phase of maladjustment."[80]

But there is reason to think that this time may be different.[81] Computers are improving exponentially, and there are fewer limits to what they can do than ever before. Computers can replace low-skilled workers and manual laborers as well as white-collar workers and professionals in a variety of fields. Computers are already working as doctors, lawyers, artists, and inventors.[82] All of this is occurring at a time when labor costs are rising and computer costs are declining. In 2012, Vinod Khosla, the co-founder of Sun Microsystems, predicted that diagnostic software would take the jobs of eighty percent of physicians in the next twenty years.[83]

While the optimists and pessimists disagree about automation's effects on long-term unemployment, both agree it causes short-term job losses and industry-specific disruption. During past episodes of widespread automation and technological change, it took decades to develop new worker skill sets on a significant scale and to build new job markets.[84] Although the Industrial Revolution ultimately resulted in net job creation, it also resulted in periods of mass unemployment and human suffering. In the coming "Automation Revolution," whether there are detrimental long-term effects, there will almost certainly be significant short-term disruptions.[85]

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[80] *Id.* at 325; *see also* 1 JOHN STUART MILL, PRINCIPLES OF POLITICAL ECONOMY 97 (Cosimo Classics 2006) (1848).

[81] *See, e.g.*, Stevens, *supra* note 17, at 368–69 ("This time there may be some distinctions requiring widespread and perhaps novel solutions, unlike other periods in history.").

[82] *See* Parloff, *supra* note 3; *see also* Yonghui Wu et al., *Google's Neural Machine Translation System: Bridging the Gap between Human and Machine Translation*, CORNELL U. LIBR.: ARXIV 20 (Oct. 8, 2016), arxiv.org/abs/1609.08144 [https://perma.cc/KGU8-9RRB] (claiming that the Google Neural Machine Translation system is approaching human-level accuracy); *see also* Croft, *supra* note 3 (discussing various software programs that can outperform attorneys and paralegals in document review); *but see generally* Remus & Levy, *supra* note 3 (arguing that AI will refocus rather than replace attorneys).

[83] *See* Liat Clark, *Vinod Khosla: Machines Will Replace 80 Percent of Doctors*, WIRED UK (Sept. 4, 2012), http://www.wired.co.uk/article/doctors-replaced-with-machines [https://perma.cc/QNL8-WP4M].

[84] *See* Schwab & Samans, *supra* note 9, at 20.

[85] For example, a substantial number of transportation workers are likely to be displaced by self-driving vehicles, and about three percent of the population is employed in the transportation industry. *See* Richard Henderson, *Industry Employment and Output Projections to 2024*, BUREAU OF LAB. STAT.: MONTHLY LAB. REV. tbl. 1 (Dec. 2015), https://www.bls.gov/opub/mlr/2015/article/industry-employment-and-output-projections-to-2024.htm [https://perma.cc/54FB-LDMM]. Tesla, for example, plans to make all its vehicles self-driving. *See Tesla to Make All Its New Cars Self-Driving*, BBC NEWS: TECH. (Oct. 20, 2016), http://www.bbc.co.uk/news/technology-37711489 [https://perma.cc/DS4X-YYM2]. Tesla is only one of many companies developing such technologies. *See 44 Corporations Working on Autonomous Vehicles*, CB INSIGHTS (May 18, 2017), https://www.cbinsights.com/blog/autonomous-driverless-vehicles-corporations-list/ [https://perma.cc/4YNE-KDTZ]; *see also Investment Into Auto Tech On Pace To Break Annual Records*, CB INSIGHTS (July 14, 2016), https://www.cbinsights.com/blog/auto-tech-funding-h1-2016/ [https://perma.cc/HY5A-XGFH]. Elon Musk, the CEO of Tesla, has even claimed that self-driving cars will be so much safer than human drivers that there will need to be a future ban on human driving. *See* Stuart Dredge, *Elon Musk: Self-driving Cars Could Lead to Ban on Human Drivers*, GUARDIAN (Mar. 18, 2015, 3:22 AM),

D. Automation Social Policy

It is important that policy makers act to ensure that automation benefits everyone. Our policy goal should be to accommodate and even encourage advances that promote economic value, while redistributing benefits to those negatively affected. In the midst of the Industrial Revolution, the philosopher John Stuart Mill wrote that while automation would ultimately benefit laborers:

> this does not discharge governments from the obligation of alleviating, and if possible preventing, the evils of which this source of ultimate benefit is or may be productive to an existing generation. . . . [T]here cannot be a more legitimate object of the legislator's care than the interests of those who are thus sacrificed to the gains of their fellow-citizens and of posterity.[86]

Or, as the U.S. National Science and Technology Council Committee on Technology argued in 2016:

> Public policy can address these risks, ensuring that workers are retrained and able to succeed in occupations that are complementary to, rather than competing with, automation. Public policy can also ensure that the economic benefits created by AI are shared broadly, and assure that AI responsibly ushers in a new age in the global economy.[87]

Efforts to alleviate the harms and share the benefits of automation have focused on education and social benefits. As mentioned earlier, in December 2016, the Executive Office of the President, then under Barack Obama, issued a report which outlined policy responses to AI and automation, namely: to invest in AI, educate and train Americans for future jobs, and transition workers to ensure widespread benefits.[88] In terms of education, it is thought that technologically unemployed workers need retraining to transition to new job types. Historically, numerous government and industry programs have combated technological unemployment with education.[89] The nation's first and most sweeping federal training program, the Manpower Development and Training Act of 1962, was signed into law by President Kennedy to train workers unemployed due to technological advances and automation.[90] More

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https://www.theguardian.com/technology/2015/mar/18/elon-musk-self-driving-cars-ban-human-drivers [https://perma.cc/5CPB-PVHS].

[86] MILL, *supra* note 80, at 98.

[87] COMM. ON TECH., *supra* note 8, at 2.

[88] *See* ARTIFICIAL INTELLIGENCE, AUTOMATION, AND THE ECONOMY, *supra* note 15, at 3.

[89] A particularly interesting example is the Armour Meat Packing Company, which created "a special 'automation fund' for retraining purposes. The company paid a 14-cent levy into the fund, established in 1959, for every 100 tons of meat shipped, up to $500,000, to pay for retraining operations." Kremen, *supra* note 14.

[90] *Id.* Also of note, a year earlier, the Office of Automation and Manpower was created at the Department of Labor to anticipate technological change and create occupational guidance. *Id*. For extensive reviews of automation issues in the 1960s, see generally OFFICE OF MAN-

recently, President Obama provided billions of dollars to fund worker training in part to address technological unemployment.[91] More ambitiously, he proposed a plan to make two years of community college free for "responsible students" in his 2015 State of the Union Address, although this proposal was never adopted.[92]

As the third prong of President Obama's 2016 strategy report notes, social benefit investments are also critical.[93] The report advocates strengthening the social safety net through greater investments in programs such as unemployment insurance and Medicaid.[94] It also proposes the creation of new programs for wage insurance and emergency aid.[95] In addition, it argues for building a twenty-first century retirement system, expanding health care access, and increasing worker bargaining power.[96] President Trump's administration does not appear to have announced a policy response to AI and automation.[97]

POWER, AUTOMATION, & TRAINING, U.S. DEP'T OF LABOR, UNEMPLOYMENT AND RETRAINING: AN ANNOTATED BIBLIOGRAPHY OF RESEARCH (1965), https://babel.hathitrust.org/cgi/pt?id=umn.31951p010922940;view=1up;seq=1 [https://perma.cc/BZK8-3UYR]; *see also* SUNDQUIST, *supra* note 14, at 77.

[91] *See* Press Release, The White House Office of the Press Sec'y, Fact Sheet: President Obama Proposes New 'First Job' Funding to Connect Young Americans with Jobs and Skills Training to Start Their Careers (Feb. 4, 2016), www.whitehouse.gov/the-press-office/2016/02/04/fact-sheet-president-obama-proposes-new-first-job-funding-connect-young [https://perma.cc/CV2T-SGB3].

[92] John Morgan, *Barack Obama Free Community College Plan Backed by $100M Funding*, TIMES HIGHER EDUC. (Apr. 27, 2016), www.timeshighereducation.com/news/barack-obama-free-community-college-plan-backed-by-one-hundred-million-dollar-funding [https://perma.cc/5NTN-P3ZP].

[93] *See* ARTIFICIAL INTELLIGENCE, AUTOMATION, AND THE ECONOMY, *supra* note 15, at 3–4.

[94] *See id.*

[95] *See id.* at 4.

[96] *See id.*

[97] Treasury Secretary Steve Mnuchin stated in March 2017 when asked about technological unemployment that, "In terms of artificial intelligence taking over American jobs, I think we're . . . so far away from that that [it's] not even on my radar screen . . . . I think it's 50 or 100 more years." Interview on Health Care and Tax Reform with Steven Mnuchin, Treasury Secretary, at 33:30–47, C-SPAN (Mar. 24, 2017), https://www.c-span.org/video/?425894-1/treasury-secretary-steven-mnuchin-talks-axios-founder-mike-allen.&start=1992 [https://perma.cc/6KYR-A82G]. By contrast, Larry Summers, the Obama administration's first director of the National Economic Council, predicted that AI could result in about "a third of men between the ages of 25 and 54 not working by the end of this half century." Christopher Matthews, *Summers: Automation is The Middle Class' Worst Enemy*, AXIOS, https://www.axios.com/summers-automation-is-the-middle-class-worst-enemy-1513302420-754facf2-aaca-4788-9a41-38f87fb0dd99.html (last visited Jan. 7, 2018) [https://perma.cc/2UEA-PVU4]. Of note, China appears be adopting the findings of the White House strategy. On July 20, 2017, China's State Council released its Next Generation Artificial Development Plan which adopts many of the policies proposed in the White House strategy. CHINA STATE COUNCIL, STATE COUNCIL NOTICE ON THE ISSUANCE OF THE NEXT GENERATION ARTIFICIAL INTELLIGENCE DEVELOPMENT PLAN (Rogier Creemers et al. trans., 2017), https://www.newamerica.org/cybersecurity-initiative/blog/chinas-plan-lead-ai-purpose-prospects-and-problems/ [https://perma.cc/5F3L-YE9K]. The plan argues that AI will be foundational to future economic growth and military dominance, and calls for China to surpass other nations in AI technology by 2030. *See generally id.*

Revitalized concerns about technological unemployment have breathed new life into an old social benefit proposal—guaranteed minimum income.[98] The basic idea is that the government would provide a fixed amount of money to its citizens regardless of their situation. This has been implemented numerous times on a relatively small scale, most recently in Finland.[99] In 2017, Finland began a pilot program to give about $600 per month to 2,000 unemployed citizens, with no other requirements.[100] Proponents argue this will reduce unemployment, poverty, and disincentives for the unemployed to work (as under conventional unemployment schemes recipients generally lose their unemployment benefits after returning to work).[101] It might also encourage education by providing support for a period of training. Critics have argued that a guaranteed minimum income will encourage recipients to remain unemployed and discourage additional education.[102] In any case, Finland plans to eventually replace earnings-based insurance benefits with a basic income.[103] Y Combinator, the Silicon Valley start-up incubator, has plans to launch a similar private program in Oakland, California.[104]

Improving education and social benefit systems will not be easy. Liberals and conservatives alike can agree on the desirability of improving worker training as it will enlarge the productive labor force, but "[d]elivering this education and training will require significant investments."[105] Enhancing the social benefit system will also require significant investment, but such a goal is even more challenging because liberals and conservatives generally disagree that enhanced benefits are a desirable aim.[106]

That automation creates a need for greater government investment is well known, but what has so far been largely ignored in the automation debate is that automation will make it far more difficult for the government to *make* investments once tax revenues are reduced.

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[98] *See supra* note 16 and accompanying text.

[99] *See* Mallett, *supra* note 17.

[100] *See* Kevin Lui, *Finland is Giving Nearly $600 a Month to 2,000 Jobless Citizens, No Questions Asked*, FORTUNE (Jan. 3, 2017, 1:26 AM), amp.timeinc.net/fortune/2017/01/03/finland-universal-basic-income-experiment/?source=dam [https://perma.cc/BFY3-JX2L]. It is also worth noting that the U.S. has operated a guaranteed basic income since 1999. The Alaska Permanent Fund pays each person who has lived the past year in Alaska $1,680. *See* Van Parijs, *supra* note 16.

[101] *See supra* note 16 and accompanying text.

[102] *See id.*

[103] *See* Lui, *supra* note 100.

[104] *See* Chris Weller, *The Inside Story of One Man's Mission to Give Americans Unconditional Free Money*, BUS. INSIDER UK (June 27, 2016, 1:07 PM), uk.businessinsider.com/inside-y-combinators-basic-income-project-2016-6?r=US&IR=T [https://perma.cc/48QT-H66H].

[105] COMM. ON TECH., *supra* note 8, at 3.

[106] *See supra* note 17 and accompanying text.

II. Current Tax Policies Favor Automation and Reduce Tax Revenue

A. Introduction

Worker automation is often thought of as a matter of efficiency, where efficiency refers to the ratio of useful output to total input.[107] For example, if a machine and a person create the same output, but the machine is less expensive, then automation generates cost savings and improves efficiency.[108] If a robot costs a firm $40,000 a year and a human worker costs $45,000 a year, with both workers producing the same output, the firm would yield a $5,000 annual cost savings by automating.

However, it may also be the case that the robot costs more than a human worker before taxes, and only becomes cheaper on a post-tax basis. For instance, the capital outlay for the robot, which includes money spent to acquire, maintain, repair, or upgrade fixed or capital assets such as robots, together with the costs for operating the robot (electricity, etc.), might be estimated at $50,000 over some period, whereas the wages and other costs associated with an employee (healthcare, retirement funding, etc.) might be $45,000 over the same period. The robot may be associated with tax benefits that do not apply to human workers and which reduce its cost to $40,000. A firm using a rational cost-based decision model would choose to automate and realize the machine's tax benefit. In this example, tax policy has rendered the robot a more efficient worker. In simple terms, the heavy relative taxation of the living worker drives the firm toward automation to generate tax savings.

The tax system is not neutral as between work performed by robots versus people.[109] Automation provides several major tax advantages. Firms that automate avoid employee and employer wage taxes levied by federal, state, and local taxing authorities and claim accelerated tax depreciation on capital costs for automated workers. The tax system also provides indirect incentives for automated workers. Any outputs produced by human labor are thus effectively penalized compared to outputs produced by capital.[110] In

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[107] Expressed mathematically, efficiency "r" is equal to the amount of useful output ("P") divided by the amount ("C") of resources consumed: r=P/C.

[108] *See* Stevens, *supra* note 17, at 373 ("Technology is very attractive to owners of capital. Machines require no pay, benefits, sick leave, vacation, lunch breaks, or weekends off. They are less prone to err and are more productive than human beings. In a race for the same job, it is therefore difficult for humans to compete with machines.").

[109] The analysis of the "neutrality" of taxation is a common practice in the field of taxation. *See generally* Peggy Richman (Musgrave), *Taxation of Foreign-Source Business Income and the Incentive to Foreign Investment*, *in* Peggy Richman, Taxation of Foreign Investment Income: An Economic Analysis (1963), *reprinted in* Peggy R. Musgrave, Tax Policy in the Global Economy: Selected Essays 3–57 (E. Elgar Publishing 2002) (introducing the term "capital export neutrality").

[110] *See* Meisel, *supra* note 32, at 220 ("An automation tax described as a payroll tax on computers conveys the basic concept. It helps level the playing field. The automation tax serves two purposes: (1) it provides an incentive for a company to create jobs by means such

fact, as described below, automated workers are taxed less than human workers at both the employer *and* employee level.

B. Avoiding Employee and Employer Wage Taxes via Automation

Wage taxes as discussed here are levied solely on wages paid to individuals to fund social benefit programs including Social Security, Medicare, and Medicaid. Presently, in the United States, the employer and employee pay matching amounts totaling 12.4% of an employee's salary, plus matching Medicare payments totaling 2.9% (applied on the first $127,200 of earnings), plus an additional 0.9% Medicare surcharge (applied on earnings over $200,000).[111] Many states and localities also levy wage taxes that apply in addition to the federal levies.[112]

C. Tax Benefit from Accelerated Tax Depreciation on Capital Outlays for Automated Workers

"Tax depreciation" refers here to the deduction (a reduction in the tax base) claimed by the firm in respect to capital outlay for automated workers. Deductions for capital outlays for automation equipment will allow the firm to reduce its tax base over time, which reduces the amount of tax that is payable. Of course, wages paid to individuals are also tax deductible, but the timing of the deduction works differently for robot and human workers.

The timing of claiming a deduction may have a significant effect on a firm's tax burden. An accelerated tax deduction means that the deduction may be claimed earlier than its actual economic depreciation (the reduction in the value of an asset over time).[113] For example, assume a robot has a total

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as investing in human-computer synergy; and (2) it proves governmental revenues that, properly used, can create more consumption and thus boost the economy.").

[111] *See* I.R.C. § 3101(a) (2012 & Supp. II 2014), § 3111(a) (Supp. III 2016), § 3102(a) (2012), § 3121(a)(1) (2012 & Supp. II 2014); I.R.S., Social Security and Medicare Withholding Rates (2017), www.irs.gov/taxtopics/tc751.html [https://perma.cc/3F5R-UEES]; *see also* Richard Winchester, *The Gap in the Employment Tax Gap*, 20 Stan. L. & Pol'y Rev. 127, 132 (2009) ("The tax imposed by FICA has two components. The first is the old-age, survivors, and disability insurance component, often referred to as OASDI. It is [levied on] . . . 'wages' from employment. One half of the tax is deducted from the employee's compensation. The employer pays the other half. This component of the FICA tax is earmarked to cover social security benefits. There is a limit on the amount of wages that can be taxed. . . . The contribution and benefit base is adjusted each year to reflect increases in average wages of the U.S. economy.") (citations omitted).

[112] For an explanation of the U.S. states that levy sales taxes, see generally Scott Drenkard & Nicole Kaeding, Tax Found., State and Local Sales Tax Rates in 2016 (2016), https://files.taxfoundation.org/legacy/docs/TaxFoundation_FF504.pdf [https://perma.cc/VLE2-KCHV]. For an explanation of EU tax policy including the VAT, see generally Cécile Remeur, Eur. Parliamentary Research Serv., Tax Policy in the EU: Issues and Challenges (2015), http://www.europarl.europa.eu/RegData/etudes/IDAN/2015/549001/EPRS_IDA(2015)549001_EN.pdf. [https://perma.cc/FUE9-ZV58].

[113] *See* Yoram Margalioth, *Not a Panacea for Economic Growth: The Case of Accelerated Depreciation*, 26 Va. Tax Rev. 493, 494–95, 499 (2007) ("Accelerated depreciation policy can be traced back to an influential 1953 paper by Evsey Domar. . . . [Elaborating on the]

capital cost of $100,000 and seven years of useful life, while an employee has a total wage cost of $100,000 over seven years. If accelerated depreciation for capital is available,[114] the firm may be able to claim a large portion of the $100,000 depreciation as a tax deduction in year one rather than pro-rata over seven years.[115] For instance, the firm might claim tax depreciation for an automated worker of $50,000 in year one, $30,000 in year two, $10,000 in year three, and in diminishing amounts to year seven. By contrast, wage taxes must be deducted as paid (i.e., 1/7th in each year). In this case, a present value benefit will accrue from claiming accelerated tax deductions for automated workers relative to the pro-rata tax deductions for employee wages, even where the $100,000 capital outlay is paid up-front.[116] This is possible because the present value of the accelerated tax deduction on capital investment is greater than the discounted value of the return the firm could make by investing the free cash held on its balance sheet.

Tax depreciation (whether accelerated or not) is also generally available even where the actual rate of inflation is equal to or greater than the economic depreciation.[117] "Inflation" here refers to the rate at which the general level of prices for goods and services is rising such that it would cost more to buy the same robot next year than it costs today. The issue becomes significant where, as in the prior example, it was presumed for tax purposes that

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Harrod-Domar model, [Domar predicted] that Gross Domestic Product (GDP) was proportional to the number of machines; namely, that investment is the key to growth. . . . A later model, developed by Nobel Laureate Robert Solow between 1956–57, points out that the Harrod-Domar model cannot explain sustained growth. Solow showed that as capital per worker increases, the marginal productivity of capital declines until the capital-labor ratio approaches a steady-state level. At that point, savings . . . are just sufficient to replace worn out machines and equip new workers (assuming population growth), so productivity growth is zero.") (citing Evsey D. Domar, *Capital Expansion, Rate of Growth, and Employment*, 14 ECONOMETRICA 137 (1946); Roy F. Harrod, *An Essay in Dynamic Theory*, 49 ECON. J. 14 (1939); Robert M. Solow, *A Contribution to the Theory of Economic Growth*, 70 Q. J. ECON. 65 (1956); Robert M. Solow, *Technical Change and the Aggregate Production Function*, 39 REV. ECON. & STAT. 312 (1957)).

[114] *See* Margalioth, *supra* note 113, at 505 ("For tax reporting purposes, the Code allows the use of much more accelerated depreciation methods than the straight-line method.").

[115] *See id.* at 505–506 ("The vast majority of U.S. corporations use a depreciation method called 'straight-line' for financial reporting purposes. According to the straight-line depreciation method, annual depreciation is calculated by subtracting the salvage value of the asset from the purchase price and dividing this number by the estimated useful life of the asset. The outcome is equal periodical deductions throughout the asset's useful life. If the asset in the above example is depreciated under the straight-line method, its $1000 cost is allocated uniformly over its useful life period of five years, resulting in $200 of depreciation deduction each year.") (citations omitted).

[116] Most large corporations have significant cash accumulations and do not need to borrow funds (and pay interest) to make capital expenditure on automation. Notably, if corporate borrowing is required to fund capital expenditure, then present value will depend on the adjusted cost of capital, taking into account the value of tax deductions for interest paid. In summary, *accelerated* tax depreciation yields an economic benefit where the firm has balance sheet cash earning a low rate of return that it can instead deploy to yield tax deductions on an accelerated basis.

[117] *See* Margalioth, *supra* note 113, at 508 ("In times of inflation, recovery of the nominal cost of investment is not sufficient to match income and expenses. Because of inflation, the income generated by the asset is expressed in a larger number of dollars though it has the same purchasing power.").

the robot wears out after seven years, but it turns out the robot actually *increases* in nominal value. An incremental tax benefit thus accrues where the rate of inflation is higher than the rate of the actual diminishment in economic value, and where the nominal (or inflationary) difference is never recaptured in the tax system. In the corporate setting, this recapture of tax book to inflation difference would only accrue on the disposal of the asset, which rarely occurs. The same principle applies to commercial real estate, where tax depreciation is allowable on an asset that is actually increasing (not decreasing) in nominal value over time, and the difference is not adjusted for tax purposes.

Finally, firms can use accounting "tricks" to report a tax benefit to earnings due to automation, which they may want to do for a variety of reasons, such as making the company look more attractive to potential investors. Where tax depreciation is accelerated relative to *book* depreciation (the amount reported on financial statements), a firm may generally claim a profit (or earnings benefit) to reported earnings from the tax benefit.[118] Thus, a large corporation enjoys a book benefit to reported financial earnings from the differential in depreciation periods. Any firm seeking to accelerate reported earnings could use automation to achieve such a timing benefit. This increase to reported earnings may be an even more significant motivation for large firms to automate than a cash tax savings.

D. Indirect Tax Incentives for Automated Workers

The indirect tax system also benefits automated workers at the firm level. Indirect taxation refers to taxes levied on goods and services rather than on profits; the primary examples are the Retail Sales Tax (RST) levied by states and municipalities in the United States and the VAT in most other countries. Employers are thought to bear some of the incidence of indirect tax, as worker salaries and retirement benefits must be increased proportionately to offset the indirect tax.[119] In the case of automated workers, however, the burden of indirect taxes is entirely avoided by the firm because it does not need to provide for a machine's consumption.[120] In general, business ex-

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[118] *See id.* at 505 ("Accounting for depreciation is also required for financial reporting purposes. Generally accepted accounting principles (GAAP) require the depreciation of the (depreciable) cost of income generating assets, usually, tangible assets. The cost has to be allocated among accounting periods on a systematic and rational basis that reflects the use of the asset in the revenue generating process over the asset's operational life.") (citations omitted).

[119] *See* CTR. FOR RESEARCH ON THE PUB. SECTOR AT UNIV. BOCCONI, THE ROLE AND IMPACT OF LABOR TAXATION 14 (2011) [hereinafter BOCCONI].

[120] The capital assets comprising automated workers might be subject to property taxation by some local jurisdictions as business personal property. However, such personal property taxation is often successfully mitigated by tax planning or with tax waivers by local jurisdictions and municipalities negotiated by municipalities. Further, human employees also engender some degree of attached personal property (e.g., office fixtures, personal computers), which are also subject to personal property taxation.

penditures for capital assets such as machinery are exempt from indirect taxation or yield a deduction for RST or VAT.[121]

E. Automation Reduces Tax Revenue

The share of the tax base borne by labor is increasing.[122] For 2015, the Internal Revenue Service (IRS) reported that out of the nearly $3 trillion in net collections, individual income taxes accounted for 49.8%, employment taxes 35.2%, business income taxes 11.7%, excise taxes 2.6%, and estate and gift taxes 0.7%.[123] In the European Union, high rates of wage taxation are levied in addition to VAT, which is also thought to burden workers, this time in their role as consumers. Moreover, capital taxation is trending sharply downwards in nearly all jurisdictions. Corporate taxation now comprises roughly one-half of its respective share compared to prior decades.[124] In fact, the Trump administration's recently enacted Tax Cuts and Jobs Act reduces the corporate tax rate from a maximum of 35 percent to a flat 21 percent beginning in 2018.[125] In Europe, lower taxation of capital relative to other types of taxes is welcomed as a means of international tax competition.[126]

Worker taxation is different from corporate taxation in several respects. Tax avoidance planning is not generally available to wage earners. For instance, an employee cannot use transfer pricing techniques to shift earned income into a 0%-taxed entity in the Cayman Islands.[127] Also, wage earnings are not subject to potential deferral, meaning labor income is taxed currently whereas capital may be taxed upon future disposition of an asset. Human

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[121] *See* John Mikesell, *Sales Tax Incentives for Economic Development: Why Shouldn't Production Exemptions Be General?*, 54 NAT'L TAX J. 557, 562 (2001).

[122] *See SOI Tax Stats – Collections and Refunds, by Type of Tax*, *IRS Data Book Table 1*, I.R.S. (Aug. 28, 2017), https://www.irs.gov/statistics/soi-tax-stats-collections-and-refunds-by-type-of-tax-irs-data-book-table-1 [https://perma.cc/R282-7P76] (containing reported aggregate collections and refunds from 2015 to 1995). For example, from 1995 to 2015, business income taxes decreased from 12.3% of total collections to 11.7%, while individual taxes increased from 46.5% to 49.8%. *Id.*

[123] *See id.* Individual income taxes here include estate and trust incomes taxes, which represent 1.1% of overall collections. Employment taxes consist of primarily old-age, survivors, disability, and hospital insurance, which is almost entirely Federal Insurance Contributions payments and a small amount of Self-Employment Insurance Contributions. It also includes a small amount of Unemployment Insurance and Railroad retirement. *Id.*

[124] *See* JOEL FRIEDMAN, CTR. ON BUDGET AND POL'Y PRIORITIES, THE DECLINE OF CORPORATE INCOME TAX REVENUES 3 (2003), https://www.cbpp.org/sites/default/files/atoms/files/10-16-03tax.pdf [https://perma.cc/66JG-QSU3].

[125] *See* Act of Dec. 22, 2017 (Tax Cuts & Jobs Act) Pub. L. No. 115-97, §13001, 131 Stat. 2054 (codified as amended at 26 U.S.C. § 11).

[126] *See* MEISEL, *supra* note 32, at 223 ("What numbers are used in the ratio of revenues to employees? I recommend using revenues generated *within* the taxing country and employees *within* the country in the ratio.").

[127] The Cayman Islands has no corporate tax. *See* DELOITTE, INTERNATIONAL TAX: CAYMAN ISLANDS HIGHLIGHTS 2017 1 (2017), https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Tax/dttl-tax-caymanislandshighlights-2017.pdf [https://perma.cc/FZL8-33YR].

capital is also not depreciable, so a person does not typically get a tax deduction for education or medical costs, at least not up to the full amount of the investment.[128] By contrast, machinery or other equipment yields an immediate and ongoing tax deduction to a firm until the equipment's tax basis is reduced to zero. Workers are additionally subject to various forms of indirect taxation, particularly in Europe and in states or local jurisdictions, whereas business machinery is often exempted from RST and VAT.[129]

If corporate taxes decline as a share of the tax base while the overall level of taxation holds constant, other types of taxation may increase to cover the difference. While a government may choose to increase borrowing or decrease spending, this would be expected to have negative economic effects over the long term.

III. Tax Policy Options for an Automation Tax

The current tax system is designed to principally tax human workers and not robot workers. All else being equal, this creates a situation in which firms prefer robots since substantially less tax per output is accrued or remitted in respect of an automated worker. At the same time, the automation of large segments of the labor force threatens long-term fiscal solvency because of the potential reduction in tax collections.

A major automation policy issue is therefore how to adjust the tax system to be neutral as between robot and human workers, or even to create incentives for human rather than robot workers to incentivize employment. In doing so, it is important to consider that capital investment of any kind (including for robots) is thought to be beneficial to economic growth.[130] Nations engage in tax competition to draw capital into their jurisdictions. Any disallowance of capital deduction would serve as a disincentive to investment and would, theoretically, be economically undesirable. For example, if only one taxing jurisdiction disallowed tax deductions for automated workers, multinational firms might shift their capital investments to other juris-

[128] For the U.S. incentives with an election for deduction or credit on higher education costs, see 26 U.S.C. § 25A (2012 & Supp. III 2016).

[129] *See, e.g.*, Bocconi, *supra* note 119, at 14.

[130] *See, e.g.*, Eduardo Borensztein et al., *How Does Foreign Direct Investment Affect Economic Growth?*, 45 J. Int'l Econ. 115, 116 (1998); *see also* Gert Wehinger, *Fostering Long-Term Investment and Economic Growth: Summary of a High-Level OECD Roundtable*, 2011 OECD J. Fin. Mkt. Trends 1, 2 (2011).

dictions.[131] It is therefore important to consider international tax competition in evaluating various options to create an automation-neutral tax system.[132]

A. Disallowance of Corporate Tax Deductions for Automated Workers

A first option is to attempt to disallow the respective corporate income tax deductions for capital investments that give rise to the automation tax benefit. The basic idea is to reverse each of the tax benefits accruing in the case of worker automation in relation to avoidance of levy of wage taxes, accelerated or timing difference of deductions, and indirect tax benefits. The recent South Korean "robot tax" adopted this strategy in part by reducing deductions for investment in automated machines.[133]

To begin with federal income taxation, the disallowance of tax preferences upon some threshold of income level is a common practice in the Internal Revenue Code and is often referred to as a "phase out."[134] Phase outs reduce tax benefits for higher-income taxpayers, such as the child tax credit and certain contributions to retirement accounts, and they target tax benefits to middle- and lower-income taxpayers.[135] For instance, student loan interest is deductible, but not for individuals with more than $80,000 in modified adjusted gross income (MAGI) ($160,000 for joint filers).[136] Some phase outs reduce credits, others reduce deductions.[137]

A new code provision could be designed with a similar phase out, where depreciation or other expenses related to automated workers would be disallowed based on a reported level of automation, rather than income. For example, firms with high levels of worker automation could have their tax depreciation automatically reduced beyond a certain threshold. The Treasury Department would need to craft detailed regulations and criteria to identify the threshold and to measure the level of automation required to trigger the disallowance.

In respect of indirect taxation, a simpler solution may be possible. Indirect tax preferences for capital outlay in respect to automated workers could

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[131] However, the shift would be from one high-tax jurisdiction to another high-tax jurisdiction to claim the deduction's full value, rather than a shift into tax havens with a zero percent corporate tax rate, where the capital tax deductions for automated workers would not have any value (i.e., the value of a tax deduction in a zero percent tax jurisdiction is zero). Thus, multinational firms should not be expected to make capital investment in robots in tax havens where the value of deductions is zero, especially where transfer pricing strategies are available to shift income arising from the automated workers.

[132] *See* MEISEL, *supra* note 32.

[133] *See* McGoogan, *supra* note 22.

[134] *See, e.g.*, Emmanuel Saez, *Do Taxpayers Bunch at Kink Points?*, 2 AM. ECON. J. ECON POL'Y 180, 180 (2010).

[135] *See, e.g.*, I.R.S., TEN FACTS ABOUT THE CHILD TAX CREDIT (2011), https://www.irs.gov/newsroom/ten-facts-about-the-child-tax-credit [https://perma.cc/3YEV-V8XD].

[136] *See* I.R.S., TAX BENEFITS FOR EDUCATION 2 (2016), https://www.irs.gov/pub/irs-pdf/p970.pdf [https://perma.cc/X5ZV-MXMX].

[137] *See generally* I.R.S., TAX GUIDE 2016: FOR INDIVIDUALS 25, (2016), https://www.irs.gov/pub/irs-pdf/p17.pdf [https://perma.cc/FS97-G5LE] (discussing the various types of credits and deductions available and the income levels at which they phase out).

be disallowed outright at the state level. Thus, for example, where the firm attempts to claim an RST/VAT exemption or refund for tax payments made to purchase and maintain automated workers, this would not be permitted.

These measures could achieve greater balance between taxing human workers and robots, but the disallowance of corporate income tax deductions will not adequately address the decline in the wage tax base used to fund social insurance benefits.

B. Levy of an Automation Tax

A second option is to levy an incremental federal "automation tax" to the extent workers are laid off or replaced by machines.[138] A similar system is in place with respect to unemployment compensation in many states where worker layoffs are tracked and employers are given corresponding ratings.[139] Employers must pay into an unemployment insurance scheme based on their ratings, so a business which has more layoffs pays more in taxes for unemployment insurance.[140] A federal automation tax could be designed to do essentially the same thing where worker layoff data could be obtained from the states and then used to levy an additional federal tax to the extent the Treasury Department determined the layoffs were due to automation.

A potential drawback to the levy of an additional automation tax is that it would essentially increase the corporate effective tax rate for many firms, and also increase the relative complexity of the tax system. Economic theory suggests that higher rates and added complexity are negatives in terms of international tax competition.[141] Another drawback is that firms might accelerate layoffs upon passage (or debate) of the bill prior to implementation to

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[138] *Cf.* Michael Kraich, *The Chilling Realities of the Telecommuting Tax: Adapting Twentieth Century Policies for Twenty-First Century Technologies*, 15 U. PITT. J. TECH. L. & POL'Y 224 (2015) (providing a comprehensive discussion of a "telecommuting tax").

[139] *See* DAVID RATNER, FED. RESERVE BD., UNEMPLOYMENT INSURANCE EXPERIENCE RATING AND LABOR MARKET DYNAMICS 1 (2013), https://www.federalreserve.gov/pubs/feds/2013/201386/201386pap.pdf [https://perma.cc/T5W3-5YJD] ("The United States is the only OECD country to finance unemployment insurance (UI) through a tax system which penalizes layoffs. The original intent of this institution, known as 'experience rating,' was to apportion the costs of UI to the highest turnover firms and thereby stabilize employment. Experience rating can stabilize employment through a layoff cost. The layoff cost is levied when a firm lays off a worker and is assessed a higher tax rate in the future.").

[140] *See id.*

[141] *See generally* Michael Keen & Kai A. Konrad, *The Theory of International Tax Competition and Coordination*, *in* 5 HANDBOOK OF PUBLIC ECONOMICS 257 (Alan Auerbach et al. eds., 2013), http://gabriel-zucman.eu/files/teaching/KeenKonrad13.pdf [https://perma.cc/3VC5-HLN3] (exploring models that suggest a country might prefer to raise its tax rate in response to lower tax rates in other countries); *but see* Bret N. Bogenschneider, *Causation, Science & Taxation*, 10 ELON L. REV. (forthcoming, Spring 2018) ("The hypothesis that tax cuts cause economic growth is a central tenet of neoclassical economic theory. Yet, it is not clear why economists hold this belief, as empirical evidence of any posited causal relation is conspicuously absent. . . . The available evidence indicates to the contrary of the hypotheses that tax cuts cause economic growth is that higher ratios of taxation to gross domestic product are associated with higher rates of national economic growth in most countries.").

avoid the tax by reducing the number of employees upon the effective date of the law. Accordingly, a retroactive effective date for measurement of employment levels for the automation tax would be a practical necessity.

C. Grant Offsetting Tax Preferences for Human Workers

A third option is to attempt to grant offsetting tax preferences for firms that employ human workers for each category of tax benefit. To begin with wage taxation, the tax preference could entail a repeal of the employer contributions to the Social Security and Medicare systems. The result would be that both human and automated workers would be exempt for the employer in terms of wage taxes—not just automated workers. However, this would accelerate the insolvency of the Social Security system unless the resultant decrease in tax collections were otherwise offset.[142]

In terms of income taxation, an offsetting preference for human workers could be designed as an accelerated deduction for future wage compensation expense (i.e., the firm would get an accelerated tax deduction) to match the accelerated depreciation for automated workers. In terms of indirect taxation typically levied by the states, the contemplated offset would be for indirect taxes not typically levied on wage income. This would constitute an incentive for firms to employ human workers.

D. Levy of a Corporate Self-Employment Tax

A fourth option is to increase corporate level taxation for firms that produce outputs without using human labor. The additional taxes would be a substitute amount for Social Security and Medicare wage taxes avoided by the firm with automated labor.[143] In part, this is the corollary to the individual self-employment tax where a small-business owner is required to pay monies into the Social Security system approximating the Social Security taxes that would be paid on his or her own wages deemed to be paid to self. The corporate self-employment tax would be calculated as a substitute for what employment taxes would have been on the worker *and* employer if a human worker had continued to perform the work.[144] The corporate self-employment tax could be calculated based on a ratio of corporate profits to gross employee compensation expense. If the ratio exceeds an amount determined by the Treasury (in reference to industry standards), then backup

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[142] This would require a very significant offset. Federal Insurance Contributions and Self-Employment Insurance Contributions currently make up about 34.6% of net federal tax collections. Federal Insurance Contributions include both employee and employer payments to fund Social Security and Medicare. *See* I.R.S., *supra* note 122.

[143] MEISEL, *supra* note 32, at 222–23 ("Returning to the payroll tax analogy, companies that hire fewer people pay fewer payroll taxes. The payroll tax in the US helps fund social security, Medicare, and unemployment insurance. In Europe, payroll taxes are even higher than in the US.").

[144] *Id.* at 227 ("The automation tax might encourage companies to prefer productivity improvements achieved by using a combination of human and computer capabilities.").

withholding could apply on corporate profits. The gross amount of the automation tax could be designed to match the wage taxes avoided by the firm with automated workers.

William Meisel has similarly proposed an "automation tax" which he referred to in lay terms as a "payroll tax on computers."[145] This would be like the corporate self-employment tax described here. Meisel wrote:

> I propose that a national automation tax be based *on the ratio of a company's revenues (total sales) to their number of employees*. . . .[T]he automation tax should increase as a percentage as the revenue-per-employee [ratio] grows, making it more attractive to create jobs than to replace them with automation. . . . I prefer applying the percentage to revenues. . . . Profits can be manipulated with deductions and other accounting complexities much more than revenues.[146]

Meisel's "automation tax" differs from our proposed corporate self-employment tax in that the former uses a sales ratio as opposed to a profit ratio. A sales ratio may be unworkable in practice since the tax would prohibitively fall on firms with high sales but low profit margins, such as discounted retailers. Since automation often occurs in the high-tech industry among companies with high profit margins, it seems preferable that a viable "automation tax" using a ratio to employee expense should be premised on profits, not sales.

E. Increase the Corporate Tax Rate

A fifth option would be to significantly increase the corporate tax rate, with the intent of increasing the relative portion of the tax base borne by capital and decreasing that borne by labor. The counter-intuitive advantage of this approach is that higher corporate tax rates *increase* the relative value of tax deductions for marginal investment, where "marginal" investment refers to incremental investment made only because of the tax system.[147] As one of us has explained, "[t]he experienced tax attorney *always* counsels the client that marginal capital investment is tax *deductible*."[148] Thus, multinational firms may make capital investment into higher tax jurisdictions in lieu of tax haven jurisdictions to claim tax deductions of relatively higher value. In part for this reason, for smaller and growing firms that are reinvesting profits back into their businesses, the higher rate of corporate tax is not a major disincentive because ongoing tax deductions will substantially reduce the tax base regardless of the ultimate tax rate to be applied.

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[145] *Id.* at 220 ("If software is to take over many jobs, why not have an income tax on software? We could perhaps think of it as a payroll tax on computers.").

[146] *Id.* at 221–23.

[147] *See* Bret N. Bogenschneider, *The Tax Paradox of Capital Investment*, 33 J. TAX'N INV. 59, 74 (2015).

[148] *Id*. at 61 (second emphasis added).

The drawbacks to increasing the corporate tax rate are well-known and may be summarized as follows: First, the corporate tax rate might be a signal to firms about the tax climate of a jurisdiction, so higher tax rates could have a negative psychological effect on capital investment decision making.[149] Second, accelerated tax deductions would be a *stronger* automation incentive with a higher corporate tax rate as the deduction would have greater value. This means that an increase in the corporate tax rate should be taken in combination with our other proposals. Third, the increase in corporate tax rates would affect all firms, even those *not* engaged in worker automation. Hence, the increase in corporate tax rate option might be viewed as one version of zero-sum analysis, in which tax policy is designed not to allow a shift of the tax burden from capital to other taxpayers. Further, any increase in corporate tax rates may prompt firms to attempt to shift the tax incidence to workers or consumers.[150] Finally, increasing corporate tax rates may be politically unfeasible. As Meisel notes in an understated fashion, "[c]orporations might instinctively fight a corporate tax."[151]

F. Issues in Economic Efficiency Relevant to Automation Tax Policy Proposals

The tax policy analysis developed here comes from the perspective of average effective tax rates as opposed to solely marginal rates.[152] Any marginal tax rate methodology excludes an analysis of taxation relative to the overall share of the tax base. For example, technology and pharmaceutical companies often pay a very low average effective tax rate (e.g., less than 10%) but could also be correctly found to simultaneously have a high marginal effective tax rate (e.g., about 35%). A corporate taxpayer which pays very little tax relative to its level of taxable income could correctly describe its marginal tax rate as "high." Accordingly, the last dollar of income may nearly always be found to be taxed at a "high" marginal tax rate, even where the average effective tax rate is relatively low.[153]

Economic models of taxation are typically designed by modeling the hypothetical effects of changes in marginal tax rates.[154] Marginal tax rates

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[149] *Id.* at 60–61 ("Any income tax system is designed initially to favor *active* investors. This is because no matter how high the actual tax rate, it is levied only on what is referred to as 'taxable income.' Of course, 'taxable income' means the amount of profits less deductions. Every tax professional is aware of this feature of an income tax system and counsels the client accordingly.").

[150] *See* Kimberly Clausing, *In Search of Corporate Tax Incidence*, 65 TAX L. REV. 433, 468 (2012). Firms, however, behave as if they bear the incidence of corporate taxation.

[151] MEISEL, *supra* note 32, at 225.

[152] The calculation of a marginal tax rate is essentially the theoretical opposite of the calculation of taxation as a percentage of the share of the overall tax base.

[153] For example, a firm may have an overall tax rate of 20% on all of its earnings; however, with respect to a hypothetical decision of whether to earn incremental income, the marginal tax rate might be 35%.

[154] For a discussion of marginal tax rates in economic analysis, see David Madden, *The Poverty Effects of a 'Fat Tax' in Ireland*, 24 HEALTH ECON. 104, 106 (2015) ("The difficulties

again represent incremental changes to the statutory tax rate on the last dollar of income.[155] For example, a change in the statutory corporate tax rate from 35% to 30% would be reflected in economic models premised on marginal rate analysis. The trouble with this form of economic modeling is that its validity relies on the presumption that firm decisions are made based on tax effects on the marginal investment and not based on an average. This approach has major implications for tax policy design as tax cuts to the statutory rate are nearly certain to have a marginal effect even where the firm does not pay a high tax rate overall. Thus, business and investment decisions are presumed not to proceed at the average tax rate for all earned income, but only with respect to incremental tax changes relevant to marginal income.

Other economic modeling proceeds on a marginal effective tax rate basis (i.e., reflecting that corporate taxpayers do not pay the statutory rate). For example, the granting of an additional deduction for manufacturing activity to corporations could reduce the marginal effective tax rate on the last dollar of income from 30% to 27% where the statutory rate is 35%. By this method, the firm would be presumed to make an investment decision based on the average tax rate at the margin. Both approaches are distinguishable from analysis using simply an average effective tax rate, which for large corporations is now calculated at approximately 20% (including permanent deferrals) and trending downward.[156] However, for many tech companies, the effective tax rate is below 10%. At such very low average effective tax rates, it is not clear that economic analysis of marginal effects of tax cuts is a realistic method of tax policy analysis. By such methods, significant macroeconomic benefits can be posited where corporate effective tax rates are reduced from very low levels to even lower levels (e.g., from 2% to 1%), but where it is likely that factors other than marginal taxation are likely to drive firm investment decisions. Also, the positing of economic growth from marginal tax cuts does not consider the effect changes in the composition of the overall tax base, where the taxation of one factor is substantially reduced, namely capital, and the taxation of another factor is increased (or overall borrowing is increased). Further, multinational firms do not engage in tax avoidance planning to reduce income which they do not intend to earn.

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associated with non-marginal tax reforms have led a number of analysts to concentrate on marginal tax reforms. This approach has the advantage of not requiring estimates of individual demand and utility functions.") (internal citation omitted).

[155] The U.S. federal statutory corporate tax rate is thirty-five percent for corporate income in excess of ten million. *See* I.R.C. § 11 (2012). Various individual U.S. states also levy an incremental state-level corporate tax. *See generally* NICOLE KAEDING, TAX FOUND., STATE INCOME CORPORATE TAX RATES AND BRACKETS FOR 2016 (2016), https://files.taxfoundation.org/legacy/docs/TaxFoundation-FF497.pdf [https://perma.cc/J37Z-Y8X6].

[156] For effective tax rates on multinational firms including the delay in taxation of foreign earnings for U.S. multinationals, see generally Bret N. Bogenschneider, *The Effective Tax Rates of U.S. Firms with Permanent Deferral*, 145 TAX NOTES 1391 (2015).

In summary, notwithstanding that the statutory corporate tax rate, or marginal corporate effective tax rates, might be correctly described as "high" in the economic theory of taxation, such analysis is also subject to a relative or zero-sum form of analysis, where tax cuts for one party are transferred as tax increases to another party. The average effective tax rate on workers is relatively "high" where all types of taxation are taken into account.[157] The taxation of workers comprises the bulk of the tax base in the United States and that of most developed countries. As workers are substituted or replaced by automation, follow-on effects are possible not only from the direct reduction in the tax base, but also indirectly where the relative taxes are transferred to other workers in the economy.

Conclusion

Automation promises to be one of the great social challenges of our generation. It can benefit everyone, or it can benefit the select few at the expense of the many. Tax is a critical component of any automation policy. Existing tax policies both encourage automation and dramatically reduce the government's tax revenue. This means that attempts to craft policy solutions to deal with automation will be inadequate if they fail to take taxation into account. In this article, we have proposed a series of tax policy changes that could level the playing field for human workers. Whether these proposals are adopted may depend on whether policy makers are prepared to make politically challenging decisions about how to deal with automation.

[157] *See* Bogenschneider, *supra* note 27.