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# What Impact will Automation have on the 21<sup>st</sup> Century Economy?

## Introduction

In this research paper, we investigate the impact that automation will have on the twenty-first century economy. Technological progress has expanded, and will continue to expand, the scope of work that can be performed by machines. We broadly define automation as the process by which computers or machines substitute for human labor. To examine how automation relates to unemployment, we focus on the substitution of capital for labor for the explicit purpose of decreasing labor costs.

First, in section I we discuss how firms make the decision to automate and explain why the trend toward automation is likely to continue into the twenty-first century. Then, informed by economic theory, in section II we explain how markets will likely react to automation. After exploring how a free-market can be expected to respond, in section III we address potential government interventions that might be used in an attempt to mitigate the perceived negative effects of automation. We conclude in section IV

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with an analysis of how the next wave of automation will change the economic landscape.

## I. What is Causing Automation?

Firms automate when the cost of performing a given task with human labor exceeds that of performing the same job using a machine. Specifically, profit maximizers will automate a process when the marginal expected benefit of doing so is greater than the marginal expected costs. We assume that this figure is positive when labor outlays are reduced by more than it costs to automate. To the extent that specific benefits and costs can be reasonably estimated, firms will include them in their calculation of net benefit. Qualitative considerations that are difficult to quantify will be considered after calculating net benefit. For example, a grocery store that is thinking about installing self-checkout machines would also include expected savings on employment lawsuits in their calculation.<sup>1</sup> However, it might be impractical to esti-

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<sup>1</sup>In similar manner, while machines sometimes break down, they do not talk back to their bosses, do not hassle customers, engage in sexual harassment against them, do not need coffee breaks, never leave work early, etc.

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mate lost sales from customers who would rather patronize businesses that employ human cashiers. In this situation, management would decide to automate only when the expected net benefit is high enough to compensate them for the risk of losing certain customers. When firms must decide between competing strategies to achieve the same end, they tend to increase spending on whichever medium has a higher marginal effect, and make reductions on the alternative (Froeb *et al.*, 2016, p. 42). Automation is a strategy and, in order to explain why it is happening, we must examine the costs and benefits associated with it.

Public policies that increase the cost of labor, like minimum wage laws and other regulations, escalate the pace of automation. For example, in an interview with *Business Insider* on March 16, 2016, the CEO of Carl's Jr. and Hardee's, Andy Puzder, referenced rising minimum wages and said that he would like to open a restaurant where "you never see a person." Puzder also explained that machines "... never take a vacation, they never show up late, there's never a slip-and-fall, or an age, sex, or race discrimination case" (Taylor, 2016). If the cost of replacing a low skilled employee is only slightly greater than the cost of employing them, then one should expect a minimum wage hike to result in their replacement. Although increases in the minimum wage could trigger the automation of certain low-skilled jobs, this trend seems almost inevitable<sup>2</sup> as computers

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<sup>2</sup>But not quite. If there were no minimum wage law at all, and unskilled workers could be paid \$2 or \$3 per hour, they might long stay more than competitive with new machinery. This sounds cruel, to be sure, but, that \$2 or \$3 per hour is infinitely higher than the zero per hour due to this legislation.

become more capable and affordable.<sup>3</sup>

As MIT professors Erik Brynjolfsson and Andrew McAfee point out in their book *The Second Machine Age*: "... there's never been a worse time to be a worker with only 'ordinary' skills and abilities to offer, because computers, robots, and other digital technologies are acquiring these skills and abilities at an extraordinary rate" (Brynjolfsson and McAfee, 2014, p. 10). The exponential growth in the amount of computing power that can be purchased for a given amount of money has come to be known as "Moore's Law." This is based on Gordon Moore's prediction in 1965 that "the complexity for minimum component costs has increased at a rate of roughly a factor of two per year ... there is no reason to believe it will not remain nearly constant for at least ten years" (Moore, 1965). It turns out that Moore was too conservative in limiting his forecast to just one decade; in fact, "Moore's law has proved remarkably prescient for almost half a century" (Brynjolfsson and McAfee, 2014, p. 40). The compounding effects of exponential growth have resulted in the rapid advancements in technol-

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<sup>3</sup>For more on the unemployment effects of this pernicious legislation, see Becker (1995), Block (2001), Block and Barnett (2002), Boudreaux (2016), Burkhauser, Couch and Wittenburg (1996), Caplan (2013a, 2013b), Cappelli and Block (2012), Deere, Murphy and Welch (1995), Gallaway and Adie (1995), Hanke (2014), Hazlitt (1946), Howland (2013), Klein and Dompe (2007), Landsburg (2004), McCaffrey (2014), McCormick and Block (2000), Mercer (2015), Murphy (2015), Neumark (2015), Neumark and Wascher (1992, 1995), North (2014), Powell (2013), Rothbard (1988), Rustici (1985), Sohr and Block (1997), Sowell (1995), Vedder and Gallaway (2001), Vuk (2006), Ward (2016), Wenzel (2013) and Williams (1982).

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ogy that will drive automation in the 21<sup>st</sup> century economy. The likelihood that a firm will automate will continue to increase as technological progress improves the functionality of computers and machines, while simultaneously making them cheaper.

As managerial economics tells us, “the art of business consists of identifying assets in low-valued uses and devising ways to profitably move them to higher-valued ones” (Froeb *et al.*, 2016, p. 19). To the extent that a company can redirect spending from employment to automation and generate more value, we should expect them to do so. Profit maximizing firms use their resources efficiently to provide consumers with goods and services. As it becomes more efficient to acquire, implement and maintain machines instead of paying wages to employees, companies will do exactly that.

## II. How Markets React to Automation.

Automation is “... merely a new name for continued technological advance and further progress in labor-saving equipment” (Hazlitt, 1946, p. 53). To the extent that a technological advancement enables us to produce more with the same amount of labor, the proverbial economic pie will increase. The concern is that the size of each individual’s slice will not increase equally, and that some people’s slice might even shrink as the pie grows. To examine whether or not this concern is warranted, we must carefully consider how the market will react as technology enables firms and individuals to economize on labor.

When managers decide to replace human labor with a new technology, they will decrease their workforce to improve

efficiency. This initial loss of employment will first be offset by the fact that people were employed in the creation of the new technology; however, this offset can be arbitrarily low, depending on the nature of the new breakthroughs. The effects following the firm’s decision to automate will likely result in sufficient increases in employment to offset the initial loss of jobs. When automation works as planned, the first firms to engage in this practice will be able to deliver their product or service at a lower cost than their competition. This ability is a competitive advantage that will enable them to earn a positive economic profit. Regardless of how the firm’s owners spend this profit, they will generate economic activity that will increase employment. In the long-run, competition will erode the excess profit by pushing down the price. As it falls, consumers will have more money to spend on other goods, thereby increasing employment wherever they allocate this spending. In examining the central question at hand, one should remember Henry Hazlitt’s advice that “the art of economics consists in looking not merely at the immediate but at the longer effects of any act ...” (Hazlitt, 1946, p. 17).

The first firm to successfully automate will exploit this advantage over its competition to increase profit. Assuming that demand is elastic, the profit-maximizing firm will increase sales by lowering its price until marginal cost equals marginal revenue (Froeb *et al.*, 2016, p. 41). The owners will either invest or consume the extra profit generated by automation.<sup>4</sup> Assuming that they in-

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<sup>4</sup>Suppose that, instead, they stick these funds under their mattresses. Then the real balance effect will come into play. Their act of hoarding will increase the value of everyone else’s

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vest in or purchase from businesses that employ people, they will indirectly stimulate employment as they spend the extra profit. As this innovative firm expands, its competitors will adopt the new technology to maintain market share and remain profitable. The industry-wide trend toward automation will increase employment for the makers of the new technology and will result in lower prices for consumers. The customers of the newly automated firms will have more money to spend, which will lead to increased employment wherever they choose to allocate their spending. Clearly, automation cannot be said, by default, to increase overall unemployment.<sup>5</sup> The specific workers that are displaced by automation are freed up to employ themselves in a different capacity where they can continue to fulfill consumer demand.

The more difficult it is for the workers who are replaced by machines to re-employ themselves productively, the more they will suffer from automation. However, we cannot forget about the

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money; this, in turn, will create more jobs.

<sup>5</sup>Back in the 1960's, Yale Brozen wrote: "Amateur social scientists such as Norbert Wiener (a professional mathematician) predicted, in 1949, that we faced a decade or more of ruin and despair" from the wholesale unemployment which would occur in the 1950's. Cybernation and automation were going to abolish jobs at an unprecedented rate. The prediction was reaffirmed by a parade of witnesses in the mid-1950's before a congressional committee investigating automation. Yet, the decade or more of ruin and despair from the unemployment that was going to be caused by automation appears to have been postponed by at least 17 years. Nevertheless, we still have doom criers who say that this consequence of automation will be appearing in the near future" (Brozen, 1966).

people who find gainful employment as a result of the increased consumption and investment made possible by this process. Furthermore, we must also consider that technological advancements that make automation possible can create entirely new jobs. To illustrate this point with an example, touch-screen technology can be used to replace fast-food cashiers but many more people are employed making retail tablets and smart phones using the same technology. The net change in the quantity of jobs and workers ability to respond to the changing labor market will determine the effect that automation has on unemployment and living standards.<sup>6</sup> New uses for labor may come from existing industries where demand increases due to the economies generated by automation, or from new industries that are made possible by advancements in technology.

The type of work that will be in higher demand as technology advances will

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<sup>6</sup>To the extent that displaced workers cannot find a way to employ themselves, they may suffer from what Keynes called *technological unemployment*, which he defined as "unemployment due to our discovery of means of economizing the use of labor outrunning the pace at which we can find new uses for labor" (Keynes, 1930). But this is an economic fallacy. As long as we have not achieved post-scarcity, as long as people want more than they already have, there will be employment opportunities for all those whose marginal revenue productivity is greater than zero—i.e., pretty much all of us, apart from those who are severely mentally handicapped, children, and the very elderly. For a critique of Keynes, see Anderson (2009), Cochran and Glahe (1999), Dempster (1999), Garrison (1985, 1992), Hammond (2012), Hazlitt (1959, 1983), Hoppe (1992), Hutt (1979), Murphy (2008), Ritenour (2000), Rostan (2010), Rothbard (1992) and Skousen (1992).

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likely be of a different nature than that demanded at present. For example, “skill-biased technical change has increased the relative demand for highly educated workers while reducing demand for less educated workers” (Brynjolfsson and McAfee, 2014, p. 147). As far back as 1881, Alfred Marshall claimed that “as civilization advances the relative importance of mental to manual labor changes. Every year mental labor becomes more important and manual labor less important” (Marshall, 1881, p. 9). If new technology complements the abilities of intelligent workers, while substituting for the less intelligent, then the value it generates may accrue unevenly to those with greater intellect. However, we cannot assume that “mental workers” will, on net, be relatively better off than “physical workers.” There is a principle in robotics known as “Moravec’s paradox” that basically states that “high level reasoning requires very little computation, but low-level sensorimotor skills require enormous computational resources” (Brynjolfsson and McAfee, 2014, p. 27). This has led some, such as cognitive scientist Steven Pinker, to claim that “it will be the stock analysts and petrochemical engineers and parole board members who are in danger of being replaced by machines. The gardeners, receptionists, and cooks are secure in their jobs for decades to come” (Pinker, 1994, p. 191). Workers throughout the economy will need to respond to technological change and find new areas of employment as machines take over their jobs.

Human beings cannot instantaneously acquire new skills and find employment opportunities as they lose their comparative advantage to machines. Displaced workers need time to react, retrain and re-employ themselves productively. During this time, their earnings will decrease,

perhaps to zero. As such, the amount of forewarning that workers have about the changes to come is of crucial importance.

Rapid transitions to automation brought on by policy changes, such as minimum wage hikes, could result in mass unemployment as swathes of people suddenly find themselves unemployed and competing for all too few similar jobs. As technology enables firms to automate certain employment positions, falling wages will signal the decrease in demand, giving workers an incentive to pursue alternative opportunities and time to react. As with any market change, whether due to technology or consumer preferences, there will be winners and losers.<sup>7</sup>

One cannot say for sure how the growing economic pie will be split up or whether it will cause more or less inequality than presently exists. If gardeners are harder to replace than stock analysts, then we should expect the wage gap between them to shrink. The fact that the pie is growing is a reason to celebrate. The presumption, as a wealth of experience bears out, is that living standards will continue to rise for people at all levels of the socio-economic ladder.

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<sup>7</sup>Strictly speaking, however, there cannot be any such thing as a loser in the market place from a technical point of view. Yes, horse-trainers, whip makers, blacksmiths, in the thousands, lost their jobs with the advent of the “horseless carriage.” But, they are not losers *in the marketplace*. Their problem is that they no longer have skills necessary to enter into that arena. They must retrain, and be able to do something else that enables them once again to enter into the marketplace. Once they do, they cannot “lose,” at least not in the *ex ante* sense.

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### III. Our Expectations for the Future.

As technology enables companies to profitably substitute computers and machines for human effort, we fully expect them to continue down this path. However, we do not expect automation, in a free-market, to result in mass unemployment or inequality. Self-interested people who expect to be replaced by machines will oppose automation and call for the government to intervene. There will be others who will, for financial or ideological reasons, argue for wealth redistribution and entitlement programs to mitigate the supposed harmful effects of automation. Although it is impossible to predict what will happen as companies that have historically provided jobs continue to automate, there is no question that people will continue to generate wealth by exchanging value in the market.

The variety and amount of things that people want is not fixed and will continue to grow. As machines substitute for labor, prices will fall and consumers' real incomes will rise and enable them to increase spending on things that they could not previously afford. The average person would not object to his grocery bill falling enough for him to include massages, vacations and other luxuries in the monthly budget. Companies will respond to the increased demand for these luxury goods and services by employing more people. For some workers, the income effect of an increase in real wages will be greater than the substitution effect, which will result in them working fewer hours and spending more time on leisure (Rahman, 2013). As certain people decide to work less, some companies may need to hire more labor to maintain production at the optimal level. Of course, those being replaced by technology will have less income in the short-run, which tends to

decrease demand. Since automation is disruptive<sup>8</sup> and the market will need time to react, it is important to note that automation will not occur simultaneously in all sectors of the economy.

When people lose their old jobs and compete for new ones, labor market supply increases and equilibrium wages decrease. As wages fall and labor becomes cheaper, the expected net benefit from automating will decrease. Since business owners risk their own money when they decide to automate, they have the strongest incentive to consider all available information before making a final decision. Entrepreneurs will not make the large, upfront investment needed for new plant and equipment unless they expect sufficient demand in the future—which hardly correlates with mass unemployment. If automation ever starts to cause mass unemployment and the associated decreases in demand, then business owners would be drawn by Adam Smith's "invisible hand" in the direction of hiring workers at lower wages instead of investing in more of the same. Technology will enable companies to slowly replace certain workers with machines; as this happens, wages in these occupations will fall. Meanwhile, incentivized by lower wages they will tend to be brought onto the payroll once again. There is an ongoing equilibration process taking place that will ensure no vast unemployment.

Perhaps the era of relying on big companies to provide full-time jobs and paychecks is coming to an end. The internet is a valuable and productive resource that is widely available for people to use as self-employed entrepreneurs. The average person can access free Wi-Fi

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<sup>8</sup>In the sense of "creative destruction" (Schumpeter, 1934).

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hotspots and use the internet as a productive business tool for self-employment. Widespread internet access and social networks have enabled ordinary people to showcase their products and services and connect with potential customers. In the mobile internet age, the transaction costs associated with connecting producers and consumers are low and the “freelancer economy” is growing. One commentator has claimed that at the beginning of 2016 there were “53 million freelancers in America ... [and] ... by 2020, 50 % of the U.S. workforce will be freelancers [in some capacity]” (Rashid, 2016). Those who want to compete as entrepreneurs will have to overcome the obstacle of acquiring business skills. Luckily, technology also makes education cheaper and solutions such as the London Business School’s *Business Bridge Initiative* are available to offer “high-quality business education at low cost on a global scale” (Chandy, 2013). Micro-entrepreneur platforms like Airbnb, Uber and Etsy enable ordinary citizens to generate and capture value by providing vacation rentals, car services and custom goods, respectively. As businesses automate certain jobs they will find themselves in competition with a growing army of increasingly nimble entrepreneurs offering goods and services in the market place.

As Henry Hazlitt so succinctly warned us in *Economics in One Lesson*, “among the most viable of all economic delusions is the belief that machines on net balance create unemployment” (Hazlitt, 1946, p. 49). This proposition is partly behind Paul Krugman’s claim (in his *New York Times* article “Robots and Robber Barons”) that “innovation and progress [can] really hurt large numbers of workers, maybe even workers in general” (Krugman, 2012). Fears related to automation are being used to advocate the

expansion of entitlement and wealth redistribution programs, the most radical of which is the Basic Income Guarantee. In June 2016, the citizens of Switzerland voted in a nationwide referendum on the introduction of a basic income that would pay each adult resident an unconditional income of \$2,555 a month. “Supporters point[ed] to the fact that 21<sup>st</sup> Century work is increasingly automated, with more and more traditional jobs, in factories, retail, finance and accounting being done by machines” (Foulkes, 2016). Programs like this expand the social safety net, and “the more that the safety net pays for not working, the less reason people in low-wage jobs have to keep their job and the less reason unemployed people have to accept a low-wage job. In this way, the safety net raises wages, to which employers respond by hiring less” (Mulligan, 2012, p. 97). As such, the push for entitlement programs to deal with the perceived negative effects of automation could result in a more rapid transition toward automation than is socially optimal.<sup>9</sup>

#### IV. Conclusion.

Automation will continue to increase the amount of goods and services that we can produce with our limited time and resources. Individuals who are replaced by machines will be freed up to provide value in other areas of the economy. As production costs decrease, competition will lower prices and real incomes will rise so that people can afford both more consumption and leisure. Internet-based platforms will increase the number of people

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<sup>9</sup>Murray (2006) also calls for a guaranteed annual income, courtesy of the government. For a devastating critique, see Gordon (2006).

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who can succeed as self-employed entrepreneurs by providing goods and services directly to consumers rather than working for big companies. People will use technology to generate value with their skills and property in new and innovative ways. Labor-saving devices free human beings up to do what they do best and enable them to do it profitably. Nobody can say for sure what impact automation will have on wealth inequality, but policies that attempt to force equality by interfering in markets will likely have negative, unintended consequences.

Suppose, just suppose, that the Chicken Littles of “the sky is falling” philosophy were correct, and automation would occur to such a degree that human labor was no longer necessary for the creation of goods and services.<sup>10</sup> Would this be an unmitigated disaster? No. After all, the reason we have jobs in the first place is because of scarcity. If ever this is no longer the case, then jobs will be unnecessary.

We can do no better than to end this essay with these brilliant words: “... the spectre of ‘technological unemployment’ has been with us at least since the early days of the Industrial Revolution, when benighted workers smashed machines which came to create jobs for them and raise their standards of living immeasurably above the subsistence level. Despite all manner of refutation, it recurs continually, the latest manifestation being the fashionable view that the current chronic unemployment during a recovery is caused by ‘too much’ increase in productivity (when it is really caused by excessive union wage rates). It is about time

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<sup>10</sup>Yes, we are now entering the world of “Star Trek” and other science fiction scenarios, but bear with us.

that this absurd notion of technological unemployment be laid to rest once and for all. Who was displaced by the steam shovel? How many millions of ditch diggers are now out of work because of it? Where are the billions of unemployed that are supposed to have been caused by the replacement of the human pack animal by the wagon and the truck? Where are they, if the doctrine of technological unemployment is correct? Where are the millions of unemployed resulting from the Industrial Revolution—when the truth is the other way round, that thousands of beggars had nothing to do until the Industrial Revolution rescued them!” (Rothbard (1959, pp. 105-06).

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