Technological Unemployment and Socio-Economic Change: Historical Perspectives and the Future

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Abstract:

Since the time of the Classical economists, such as Malthus, Ricardo, then to Marx and Keynes, dozens of scholars have made predictions using economic theory about the future, and whether technology will someday displace all workers, often called "technological unemployment." The theory that is generally held is that "marginal productivity" essentially determines hiring and wages. Along with this, popular science fiction since the advent of the Space Age has created folklore over what robots and super computers might bring. As developed countries advance, we already see large changes in income inequality which may be due to the newest technological changes, leaving vast amounts of workers unskilled, and an elite class of experts in computer technologies. Some current leading minds, from Hawking, to Gates, to Musk, have weighed in on this reemerging subject, with dire warnings. How accurate are their concerns? Although predictions about the future are usually wrong, this paper uses economic theory, as well as past misconceptions about the future, and events that are transpiring today to conjecture about the many ways technology in general may affect socio-economic life in developed and developing countries in the coming years.

Keywords: technological unemployment, inequality, robots

Overview:

Since Classical economics, scholars have proposed whether technology displaces workers. Popular culture and scientists have weighed in. This paper applies theory and past misconceptions to how technology may affect socio-economic development ahead.

Introduction to Development

Many scholars over the years, but particularly since the late 18th and early 19th century, have outlined stages of development that human beings have and will pass through, in the course of economic development, but most lack economic theory and many rely on philosophy or simple ad hoc conjectures. In the Middle Ages, Thomas Hobbes, and Sir Thomas More envisioned futuristic utopia's of governments providing for every want, while slightly later Malthus predicted population problems due to limited resources, and Marx predicted revolution. All of these scholars failed to consider mediating factors that would assuage the specific fears

they were considering. Malthus was wrong because with fewer farms, less help was needed for child labor, which, combined with women being educated and less infant mortality, led to fewer births and a population slowdown. Malthus was also wrong about the advancement of technology of fertilizers. Karl Marx, on the other hand, was wrong because he failed to consider the powerful impact of unions and the rise of democracy.

At that time, farms were a breeding ground of learning, and produced engineers. Today, cities have produced lawyers and doctors, which in turned into a class of computer programmers. Looking ahead, some see a future of the Trekker economy, where all needs are met, while others see a future of doom. Resources in the future, just as in the past, will continue to be limited, as economics is in fact the science of scarcity, and there will indeed be clashes and conflicts, but overall, the future that will emerge will be somewhere in-between. It will indeed be very different from the present, but we should not fear it, just certain aspects of it that hopefully we will be able to remedy. There are two views of mankind: a positive one, or a pessimistic one; the leaving of halcyon days can be each sentimentally sad or imaginably exciting.

Methodology and the Difficulty of Predicting:

This paper will apply economic theory and philosophy from scientific outlooks and events that are transpiring today, to science fiction, as well as to past socio-economic misconceptions about the future, to speculate about the many ways technology in general may affect socio-economic life in developed and developing countries in the coming years. Will robots displace all workers? It hypothesizes about new, automated stages of development, the veracity of which can only be verified by the future itself.

Forecasting is difficult. To make forecasts, the ancients often relied on many items, from reading animal bones, to inhaling vapors at the Oracle at Delphi, to reading tea leaves. In *Superforecasting* (2015), Gardner and Tetlock write that it is actually easy in the short-term to predict the future, whereas other economists like Robert Shiller believe it is easier in the long-term, yet that some people have traits that other for better predicting than others (2000). Using a technique from Latvian-born British philosopher Sir Isaiah Berlin, they were able to define samples of groups as "hedgehogs," those who look at one or two ideas, and "foxes," those who look to many interrelated factors. The best predictors were the foxes. They continue that the best forecasters do not rely on statistics alone. They enjoy obtaining new information, revising

their predictions, and in using different sources with different outlooks. They are more interested in why they were wrong, afterwards, than if they were wrong. Some of the best predictors, historically, have been doctors such as turn-of-the-century gurus Archie Cochrane or Edgar Cayce, while today, the best ones are newspaper journalists or television pundits, probably because they make so many predictions they have fine-tuned their craft, probably due to their access to instantaneous information (The Economist 2015b).

Many economists, such as Janet Yellen, Chairwoman of the U.S. Federal Reserve, have commented on the extreme difficulty of economic predicting, even as the Federal Reserve receives weekly statistical information on the economy. Between 2007 and 2009, the OECD (the Organization for Economic Cooperation and Development), was off by an average of 2.6% GDP per year for the global economy (McMahon 2014). Predicting improved after the "Great Recession." In the U.S., forecasts vary between the executive Office of Management and Budget and the more realistic Congressional Budget Office. Economists tend to overlook the financial sector, they make political assumptions, and they are susceptible to group thinking. They also have rosier predictions, since positive signs are easier to identify than negative ones. However, they are not able to predict shocks, such as the 1970s oil crisis, the 2000 dot.com bubble, the U.S. mortgage crisis, or future predictions such as the coming dot.com bubble or terrorist attacks on the electric grid. Internationally, forecasters often take previous growth rates and simply add or subtract a small amount looking ahead. Economists also make rosier predictions to make themselves look better, as they are often advisors. Today, forecasters are using "nowcasting," involving more real-time data, and more "big data' such as banking and credit card transactions (McMahon 2014). They are also using more informal and anecdotal evidence from financial, business, and technology leaders (McMahon 2014).

Modern day economics teacher Roger A. Arnold adds that "People have difficulty predicting accurately because they don't have complete information' (Arnold 2005, 27). It is harder than "explaining," although previous explanations can be used to predict. Finally, statistical historian David Salsburg writes, in *The Lady Tasting Tea*, that it takes philosophers to make predictions, because they look at "the underlying assumptions behind our day-to-day cultural ideas and activities" (2001, 298). He continues, "[f]ew of us are even aware of them (the assumptions). [Philosophy] allows us to uncover these assumptions and examine their validity" (Salsburg 2001, 298). He tells the story that when he asked a class of students what underlying

assumptions of their world-view could seem preposterous to similar students in 500 years, "[t]hey could think of none" (Salsburg 2001, 299). Economists need to be "more humble" says economist Sebastian Barnes, or at least be willing to admit that they do not have all of the answers (McMahon 2014).

Literature Review:

Socio-Economic Development Theories and Technology

The concept of development takes us to that of socio-economic theories for the developing world, many of which include elements of technological change. The three main categories are modernization, dependency, and world systems theory. All three have roots in the end of colonialism following World War II. Modernization theory was the first to be conceived, and it was strongly linked to the Cold War, since both the Soviet Union and the United States were trying to entice states to join them. Dependency theory claimed that the West exploits developing countries, while World Systems Theory, propagated by Immanuel Wallerstein, argues that the globe can be divided into a core, a semi-periphery, and a periphery, in which technology is needed to advance, and that that world has consisted of two stages, from the 16th C. when economic growth took off, to 1945, and then 1945 to the present, since World War II changed virtually every aspect of the global system and order (So 1990, 176-193).

Modernization theory, the most popular of these three, is a complex synthesis of economic, political, sociological, and pyschocultural ideas, which posits a Western viewpoint that pre-development societies need to "modernize" in order to develop and copy the industrial world. It is not based on Gross Domestic Product. Instead, it focuses more on the differences between modern and traditional societies (Peet and Hartwick 2009, 123). According to Peet and Hartwick, "modernization" means to scholars: societies specializing in the division of labor, urbanization, geographic mobility, flexible labor markets, literacy and education. In political science, it means spreading of democracy and the weakening of elites who have held power "traditionally" (Peet and Hartwick 2009, 122). In totality, such ideas fomented during the 18th C. Enlightenment in Europe, when, according to Max Weber, the Calvinist idea of predestination began to lead people to focus on acquiring wealth rather than dedicating to their lives to religion in order to be saved in the next world. It also led to a newfound sense of individuality, and the idea that we are called to our chosen profession (Peet and Hartwick 2009, 109-111).

In the 1950s, western scholars shifted their attention, "suddenly," to the development of the Third World, looking to balance the Soviet Union under a comprehensive framework (Peet and Hartwick 2009, 116-123). Economist Bert Hoselitz argued that countries could only modernize economically if there is a change in the entrepreneurship. Innovations, he wrote, come from people who are different from the traditional mold, who exemplify the "the theory of social deviance" (Peet and Hartwick 2009, 124). He also theorized that cities generated new ideas, practices, and innovations, as opposed to rural areas, leading "the way forward," and changing power to the modern urban areas (Peet and Hartwick 2009, 124). One modernization theorist, David McClelland, argues that the West is special because it has entrepreneurs who have a "desire for achievement" (So 1990, 39).

According to political scientist Everett Hagen, technology and new products come only from advanced societies, and not traditional ones, because creativity there is stifled, but this could change if people felt a need for achievement. Similarly, psychologist David McClelland writes, "[e]ntrepreneurship comes from the need to achieve, and this can be advanced through "achievement motivation training," directed by retired business executives, which could lead to economic growth (Peet and Hartwick 2009, 125). Daniel Learner portrayed traditional versus modern societies as "village versus town, illiteracy versus enlightenment, resignation versus ambition, and piety versus excitement" (Peet and Hartwick 2009, 125). Another David, David H. Smith, claimed that the "enlightened modern" person included scientific thinking.

Walt Rostow, the most famous modernization theorist, held that societies travel through five stages of development, to finally reach modernity (So 1990, 29-33). Stages have been dealt with differently by various theories in numerous ways such as Marxism, which had hunter-gatherer societies, tribal agrarian societies, state societies, and then capitalism, followed by socialism (Peet and Hartwick 2009, 157-158). Walter Rostow's 1960 book offered a different version of the historical stages of growth, describing five phases. Traditional societies had "primitive" scientific views and uses of technologies, and religious beliefs oriented towards the natural environment. They were agricultural societies and there was little social mobility. Rostow includes aboriginal Australia and ancient China and Rome The second stage, "preconditions for take-off," was typified by 17th and 18th C. Europe where laborers began to use more machines, and countries began to trade internationally. This stage also involves the widespread concept of progress, national dignity, private profit, education, the use of banks,

investments, commerce, and manufacturing, yet with still traditional political and economic structures and values (Peet and Hartwick 2009, 126-127). The third stage, "Take-off," sets the conditions for economic growth, through the implementation of new technologies, as in railroads and factories, and with better methods of farming and industrial production. It is the most critical and difficult stage (Parr 2001, 4). Urbanization increases, the investment rises and entrepreneurs encourage class mobility (Peet and Harwick 2009, 127-128). The fourth stage, the "drive toward maturity," is characterized by increases to productivity which takes roughly sixty years past the take-off to transpire. Eventually, there is "sufficient entrepreneurship and technical skills to produce anything the society needs (Peet and Hartwick 2009, 128). Rostow was not indolent, and included twenty examples, from Argentina to Taiwan (Parr 2001, 4). The final stage, "high mass consumption," enables a society to produce consumer goods and services, income rises and "urban-skilled" office jobs become prevalent. Societies could then distribute money for social safety nets. The United States reached this stage in the 1920s and then solidified it following World War II. Europe and Japan reached it in the 1950s in the 1960s.

Rostow claimed that these stages were true for all societies, and his ideas became very popular in the 1960s, elements even being incorporated in President Kennedy's speeches, especially since Rostow played a role in shaping U.S. policy in Vietnam (Peet and Hartwick 2009, 128-129). Later on, Rostow was attacked for not providing explanations for the societal changes involved in his stages, but he did not because he reasoned that sociologists and anthropologists would provide them at a later date (Solivetti 2005, 722). Modernization theory was criticized later on for dismissing Third World traditions and values, it groups together unusual countries, and it did not address the harmful aspects of colonialism and multinational corporations. In the late 1970s, there was an attempted revival, which respected traditions, customs, and the impact of familism, stressing family at all costs.

In the 1990s, modernization returned, with the neoliberal ideas of economist Jeffrey Sachs and the Washington Consensus. Dependency theory became the primary paradigm amongst much development (Peet and Hartwick 2009, 134-137). In 2005, Sachs, who worked as a U.N. advisor and is currently the world's most well-known development economist wrote that poor countries can develop quickly if they can get a foot-hold on the ladder of economic development, an analogy that he frequently cited. Today, with the "Post Washington Census," we know there should be other goals than just high consumption, such as environmentalism,

women's rights, and social equality. Development should be focused on individual circumstances, not a one-size-fits-all blueprint (Peet and Hartwick 2009, 132-133).

Literature Review Continued- Forward Looking:

The Scientists:

Artificial Intelligence will, very well, bring forth a new age. Some scientists see a "Second Machine Age," following the Industrial Revolution, made possible by the connection of all people by a digital global network. According to economist Julian Simon "the main fuel to speed the world's progress is our stock of knowledge, and the brake is our lack of imagination" (Brynjolfsson and McAfee 2014, 4). Brynjolfsson and McAfee write that this will extend to developing countries (Brynjolfsson and McAfee 2014, 6). According to physicist Stephen Hawking, "Success in creating AI (Artificial Intelligence) would be the biggest event in human history." He continues, in his 2014 Op-Ed, "Unfortunately, it also might be the last, unless we learn to avoid the risk. In the near term, world countries are considering autonomous-weapon systems that can choose and eliminate targets" (Sainato 2015). In a 2014 BBC interview, he added that "humans, limited by biological evolution, couldn't compete and would be superseded by AI [Artificial Intelligence]" (Sainato 2015).

Still human beings have many advantages that computers do not. Elon Musk also caused controversy when in 2014 he stated that he believed that AI was our "biggest existential threat" and that "with artificial intelligence we're summoning the demon" (Markoff 2015). By 2015 Musk's view had not changed and he still has "concerns about the possibility that artificial intelligence could be used to create machines that might turn on humanity" (Markoff 2015). So paranoid or concerned over the rise of AI that Musk, Sam Altman, and other big names in the tech industry created a non-profit company, with about 1 billion US dollars in funding, called OpenAI whose "goal is to advance digital intelligence in the way that is most likely to benefit humanity as a whole, unconstrained by a need to generate financial return. Since our research is free from financial obligations, we can better focus on a positive human impact. We believe AI should be an extension of individual human wills and, in the spirit of liberty, as broadly and evenly distributed as possible" (OpenAI 2016). However others in the tech industry are also creating companies to looking into AI. Paul Allen, Microsoft's co-founder, also established a

non-profit Allen Institute for Artificial Intelligence, whose goal is "to contribute to humanity through high-impact A.I. research and engineering" (Markoff 2015).

Stephen Hawking's efforts to start a petition against Artificial Intelligence, mostly because of its militaristic capabilities, is reminiscent of a letter written in 1964 by social scientists to U.S. President Lyndon B. Johnson, warning that cybernation "requires progressively less human labor" (Brynjolfsson and McAfee 2015, 8). Their concerns were addressed in a 1987 National Academy of Sciences report that explained, "By reducing the costs of production… [and] price …, technological change frequently leads to increases in output demand [which] results in increased production, which requires more labor" (Brynjolfsson and McAfee 2015, 8). This cycle, still, assumes that production requires more labor, and that there is market demand, even with reduced prices from lower costs, which either way may not exist in all societies.

Despite these philosophical views, many economists, such as two from Northwestern University, have been leading out this long-standing debate, one, Robert Gordon, a 73 year old, pessimistic macroeconomist who sees little differences across his lifetimes, and another is 67 year old economic historian Joel Mokyr envisions new gene therapies and "miracle seeds" that grow without fertilizers. Mokyr sees "fast computing" as a device that will lead to more inventions (Aepel 2014, 1-3), which is debated in the social-sciences if one invention leads to more, or if there are equal or diminishing returns to innovation. Gordon sees period as of big breakthroughs as rare, most of which are behind us, such as the Internet and 1990s' growth rates.

Historically, in Great Britain, the standard of living doubled from 0-1570, it tripled from 1570-1875, and it tripled again much faster from 1875-1975. Despite this, the Enlightenment to the Industrial Revolution saw a decline in agriculture, which brought huge social changes. Mokyr points out that wages did not rise immediately since productivity only improved for a few industries, and Harvard economists Lawrence Katz and Robert Margo point out that manufacturing "hollowed out" (The Economist 2014). Harvard University economists Claudia Goldin and Lawrence Cast describe the social and political reforms that followed at the turn of the 20th C and education which eventually led to the middle class, and the "golden age" of the 1950s (The Economist 2014).

Today, most economists believe any type of productivity raises income, creating new demand, and new jobs (The Economist 2014). These economists include Tyler Cowen, who sees a moderate future due to energy improvements such a shale gas, and the Obama administration

economist Larry Summers, although he does see the decline of the middle class (Aepel 2014, 6). In one study, Summers found, of men from 25-54, only one in twenty was not working in the 1960s, compare to seven that will be the figure in 10 years. French economist Thomas Piketty has written about the top 1% "supermanagers" (The Economist 2014). The U.S. therefore needs policies aimed at the labor participation rate and the long-term unemployed. Over the past four decades, wages in the developing world have stagnated and even in egalitarian Sweden, inequality has risen (The Economist 2014). A British anthropologist, David Graeber, says that the "system" is providing "bull shit" jobs for many individuals (The Economist 2014), because "the ruling class has figured out that a happy and productive population with free time on their hands is a mortal danger…" (Campa 2014, 99). Still, economist Timothy Taylor says all of this pessimism has been heard before, and former Federal Reserve Chairperson Ben Bernanke notes that human's ability to innovate is "greater than at any time in history" (Aepel 2014, 6), which is a bold but debatable statement. Futuristic changes may or may not necessarily lead to growth in the way it is now tabulated (Aepel 2014, 6-7).

Other economists have revived the debate between progressives and "humanists," formerly known as the "Luddites," 19th C. European factory workers who threw their shoes at machines in disgust. In the movie *Star Trek: The Undiscovered Country,* Vulcan Valeris (played by Kim Catrall) said to Uhura and Chekov "Four hundred years ago, on the planet Earth, … workers whose lives were threatened by automation flung their wooden shoes, called sabots, into the machines to stop them. Hence the term 'sabotage'" (Dillard 1992, 50). Although some argue that sabots is not the entomology of the word for sabotage, it hardly matters. Conservative economists tend to disparage liberal economists who fear technology. At the time of the computer revolution, authors of a 1986 CATO Institute study cite a 1983 Upjohn Institute study saying that 50,000-1000,000 robots would replace the same number of workers by 1990. At the time, Russian-American economist Wassily Leontief, an input-output and trade economist, warned of coming income inequality. Still, most of the conservative CATO scholars argued that technology would benefit mankind, resulting in shorter workdays and workweeks, and fewer family members working, which it has done so, historically, they say. They saw, and perhaps still see, technology as only causing short-term unemployment, from "friction" alone. Still, some of their scholars make policy recommendations looking ahead, such as greater social safety nets to fight "capital hypermobility," provided by economist Barry Bluestone, and a better

government industrial policy, argued for by future President Bill Clinton's Labor Secretary Robert Reich (Mabry and Sharplin 1986, 1-2).

The more liberal scholars warn of the time of the "AI Revolution," or of "crossover points" where machines become smarter than humans. Some of these fears were lost with the attention placed on terrorism after 9/11/2001, but they are resurfacing with the spread of ISIL in the mid-East. The sociological aspect is pointed out by Harvard's Nicholas Carr and technology guru Jason Laurie who sees increasingly personal machines, but that the "real intelligence comes from human minds" (Larson 2015, 5). Carr warns that humans spend too much time online, distracting us from better pursuits. Matthew Crawford, author of *Shop Class as Soul Craft* (2010), discusses the virtue of working with one's own hands, and the drawbacks of losing oneself in digital distractions. Andrew Keen, a Silicon Valley entrepreneur, criticizes mankind's new, short-hand methods of writing, all which are now being analyzed for advertising promotions, as his *Cult of the Amateur* (2008) views mankind working like a bee-hive for robots' purposes. Humanists believe we will be lead away if we place tools alone above ourselves, and that the world remains ours to create (Larson 2015, 6-9).

The greatest fear amongst scientists seems not to be economic, but military. The U.S. military is currently researching new drones, South Korea is building a Super Egis II automatic turret, and Russia is building a Platform-M automatic combat machine. Artificial Intelligence weapons are low cost and easy to program, and they could be given lists of citizens' political persuasions, photos, and addresses, which could be used by terrorists, and these AI weapons could become as available as an Ak-47 is today. Stephen Hawking, Max Tegmark, Elon Musk, and many others have penned a "Future of Life" petition to ban AI weapons, following an unsuccessful United Nations meeting that was unproductive. The use of robots to fight wars, though, might save soldiers' lives, but the threat of using space satellites for warfare is disturbing. Astronomer and physicist Sri Martin Rees has warned of "dumb robots" going rogue or a network that develops a mind of its own, often depicted in Science Fiction (Musgrave and Roberts 2015, 1-3 & 5-7). Philosopher Huw Price of Cambridge, says humans should fear for their safety, if AI "escapes the constraints of biology" (Musgrave and Roberts 2015, 3). All is best summed up by Elon Musk, who says, "there should be some regulatory oversight, maybe at the national and international level, just to make sure we don't do something foolish" (Sainato 2015). Furthermore, Musk says we need to "just keep an eye on what's going on" (Sainato

2015). In other words, governments need to make sure there are safeguards that they cannot be reprogrammed or hacked into malevolently, whether for military of economic purposes (Musgrave and Roberts 2015, 5).

The Theory: Pure Economics on Technology

The history of the theory specific to technological advancement and "technological unemployment" dates to David Ricardo in the early 1800s. Ricardo spent a great deal of time pondering the effect of technology on labor, but claimed that works on it had never yielded any "certain or satisfactory results" (Ricardo 1962, 263). He initially agreed with a short excerpt that he read from Adam Smith's 1776 *The Wealth of Nations* which held that machinery helped provide for the division of labor, and bolstered economic growth by lowering the cost of goods. It also enabled the production of more goods, this authors might add, for it is the multiplication of the two which accounts for GDP, Gross Domestic Product, the total value of an economy. The division of labor does this by allowing for easier repetition, and as any student of Henry Ford's car factories knows, it saves the time in switching between tasks (Pressman 2014, 49).

Post-World War II micro- and macroeconomist J.R. Hicks analyzes Ricardo's writings, saying he had "candor and courage," in theorizing when there would become a point at which there would be so much fixed capital that saving would optimistically not be required, since, following all of the "pain and grief," there would be "further technical progress, [and] gain in productive power" (Hicks 1969, 154). The worker would become different than the proletariat, in that he or she was now "regularly" employed a group that "would soon be demanding in wider society" (Hicks 1969, 155).

But, Ricardo came across a pamphlet written by John Barton in 1817 which caused him to change his mind, and see a gloomier future, because capitalists would make higher profits by hiring fewer workers and investing more in machines (Pressman 2014, 49). Barton's main concern was how wages would impact population, marriages, and the poor, as economics was then known as the "moral sciences" (1817). He cites Smith as about the "multiplication of the people." This was occurring at the time with rapid population growth in North America, almost the opposite we see today, with the "youth bulges" in developing countries (Barton 1817, 4). He goes on to write that population growth is effected by wages and wealth, citing the feudal period in medieval Europe (Barton 1817, 67), which we know now is true, since wealth can actually

encourages female employment, which actually lower birth rates. Growth economists like Paul Romer would later suggest that the more people a country has, the more ideas, and thus technology, it will also have, but clearly some of these ideas have been disproven by history (Peet and Hartwick 2009, 55 & 61).

Barton's assumptions are important, for his machine productivity may be high, but his depreciation level is acceptable, compared to today, such as with computers or cell phones lasting perhaps five years. The small number of men needed to produce the machines are also too low, but his point on unemployment is nevertheless made. Barton ignores the ability of workers to move into other industries, which he should have known from Say, that "supply can create its own demand," but he does in fact address the agricultural industry, writing, "wherever the use of machinery, or the employment of horses could be substituted for manual labor, it would be done (cultivation with few hands); and … labourers would be thrown out of work" (Barton 1817, 24). He also does not consider that workers might move into new, entrepreneurial type activities, or activities improving the machine productivity. One of your authors had numerous great uncles, living in the early 20th C., who were of the profession known as "tool makers." However, the central question here becomes whether or not humans will be needed to improve machines or if machines will be able to improve themselves at a faster rate in the future.

Barton then engages in a long discussion progresses on population and concludes profits will be used by the employer for either themselves or fixed capital, and "fixed capital can never be converted into circulating capital (labor) (Barton 1817, 31)." This last line is interesting, because are not machines essentially being turned into a mechanical type of humans, thus even reinforcing his point? But, if wages are too low to afford machine-made goods, prices will not rise, your authors might add. After a long discussion of trade and population, he writes, "The best method that has been devised for alleviating the pressure of the present deficiency of work, is to raise subscriptions for employing the poor; in making roads, or in such other ways at least interfere with existing occupation" (Barton 1817, 69). This is eerily similar to President Obama's Keynesian economic policies. Might machines, computers, or robots, once superior to man, give humans unskilled tasks such as these to essentially employ us, and sustain us while we help them entrepreneurially to make small advancements?

In the mid-1800s, economics centered over utility, the amount of happiness one can attain from goods. Classical economics was followed, in the mid-to-late 1800s, by a neo-classical,

marginalist "revolution," which focused on micro-economics, and only future, additional costs matter. Led by such names as Jevons, Walras, and Marshall, it was the latter, Alfred Marshall, who helped turn "political-economy" into the new discipline of "economics," based on supply and demand curves. Marshall felt that population would continue to increase, and with it, the supply of unskilled labor, increasing the impact of "mechanization," both events of which would keep unskilled wages at a low, vicious cycle. What he neglected is that machine improvements require higher wages. Instead of advocating for a minimum wage or unions, Marshall advocated for families having fewer children, to decrease the supply of labor and raise wages, and also for greater education, and progressive taxation (Pressman 2014, 92).

During the extreme income inequality that followed, in America's Gilded Age, the first great American economist, John Bates Clark, conceived of a marginalist solution to the given socio-economic problem. In response to Marx's belief that firms would exploit workers, as well as journal Henry George's assertions about the power of the landowning class, Clark theorized the marginal productivity theory of distribution, defending capitalism in holding that each worker did, and should, receive in wages that which they contribute in marginal revenue to the company and society. Your author might add, here, that even the capitalists, or firm owners, would add a value to the firm through overall strategic decision making. Therefore, so long as the economy stayed freely competitive, distribution, which is economics' essence, would be fair, or else it would lead to social problems (Pressman 2014, 101-102). Pressman writes, "similarly, profits are justified by the contribution that capital equipment or machinery makes towards producing goods. These profits are not robbery; they are a return to capital" (Pressman 2014, 103). If marginal revenues should exceed marginal costs, firms would hire more employees with the surpluses, or invest in more machines. In what was called the "adding up problem," Clark theorized that total marginal productivities would equal the total value of all of the goods and services manufactured (Pressman 2014, 104).

The next major economists to comment on technology, at the turn of the century, were Eugen von Boehm-Bawerk and Knut Wicksell. From the conservative Austrian School, Eugen von Boehm-Bawerk described a roundabout production, touched upon by others, in which small parts are gradually manufactured and then combined and remanufactured to create more and more powerful machines. This could be true of robots, but they could become able to produce themselves, your author might add, except for doing some of the manual labor, but there could

be classes of manual robots designed for specific tasks. Pressman, quoting Boehm-Bawerk: "robots will get us even more goods than an automated assembly line, but in this case we have to first build the robots and then stock the plants with the robots" (Pressman 2014, 114). He writes, this "yields more goods over a longer period of time" (Pressman 2014, 114). Meanwhile, Wicksell was a major figure in the Stockholm School of thought, which advocates non-revolutionary equality. Wicksell held that payments would equal the value of all goods produced only if there are "constant returns to scale" (Pressman 2014, 104). If we double input, and output is less, then there are decreasing returns, if the output is equal, there are constant returns, and if the output is greater, there are increasing returns to scale. Whether or not robots will come to dominate, your authors might add, is if robots can keep expanding production with increasing returns based on their own advancement, not needing humans, whereby distribution based on marginal utility may not hold.

In the early 1900s, economics turned to finance, philosophy, and sociology. The eccentric Austrian Joseph Schumpeter theorized of different or phases that lead to recessions, cycles and waves that cause "creative destruction" or bursts of technological advancement. He also had historical stages and identified flaws in capitalism ahead that small firms would not be able to compete, that capitalism would stifle human inventiveness. Entrepreneurship and innovation are essential, echoing the French physiocrat Richard Cantillon, but could not be explained rationally, he reasoned. Amongst the robots, your authors note, cycles could lead to miss-estimation of demand, causing recessions. Schumpeter also held a view towards advertising, first written about by the German economists like Frederick Knies, and later by Joan Robinson and J.K. Galbraith, that it is needed to create new demand. The Italian Piero Sraffa, a neo-Ricardian who revived Ricardo's works, when discussing Say's law and the predominance of the supply side, wrote about the interdependence of the economy and that, all producers work together to create output, which then raises the question if robots come to work together in a complete institutional system? Technology inputs ultimately determines the relationship of prices of goods, he held (Pressman 2014, 150-157).

At the time of America's "Great Depression," British economist John Maynard Keynes ushered in a revolution that wages and prices may be slow to adjust, and require government intervention. Keynes held that employment is determined by interest rates and investment, and that these are determined by the liquidity and the amount of spent money. But, overproduction

could lead to excesses, and high unemployment, so Says was therefore wrong, at least in advanced societies. Keynes wrote "We are being afflicted with a new disease of which some readers may not yet have heard the name, but of which they will hear a great deal in the years to come- namely, technological unemployment. This means unemployment outrunning the pace at which can find new uses for labor" (Vardi 2015, 13). Keynes actually coined the phrase "technological unemployment" (The Economist 2014). But, Keynes envisioned a middle way between revolution and stagnation that would leave ..."[our] grandchildren a great deal richer than their grandparents" (The Economist 2014). He believed future employees would work only 15 hours per week. This may indeed be true today with the restructuring of developed economies towards part-time work, but this is largely institutional, and part-time wages are not high enough to maintain the same standard of living (The Economist 2014).

In the 1950s, statistics, sociology, and pro- and anti-Keynes forces emerged. Robert Solow, in the 1950s, argued that all growth is driven by new technologies, which most economists now agree with. Gunnar Myrdal wrote on discrimination and inequality lessening growth, and Simon Kuznets explained stages of inequality. J.R. Hicks attempted to expand upon Keynes, and along with Franco Modigliani, was able to create graphs (the IS-LM curve) combining the goods markets and money market, through interest rates. As Hicks also was a micro-economist, he elaborated on Marshall's works, and reasoned that capital machinery and labor could be substituted for each other, and the one with the less supply would earn higher wages. For this reason, Hicks thought, as Pressman writes, "workers should not necessarily oppose labor saving technical change since it could lead to higher wages" (Pressman 2014, 204). Of course, workers would have to be trained to use the machinery, which would cost more.

Hicks, in the lines of Keynes, believed in the power of investment, at the "marginal efficiency of capital," as well as the importance of the liquidity of money and the availability of banking funds. He writes how the age of geographic exploration was replaced by knowledge exploration; what will robots pursue? Machines became easier to make in the Industrial Revolution (Hicks 1969, 144-149). The effect on labor is "one to which economists (even the greatest economists) have given divergent answers" (Hicks 1969, 149), and then adds, "[n]ew technologies are bound to diminish the demands for some sorts of labour, and to increase the demands for others" (Hicks 1969, 149). He criticizes Keynes for looking too short-term, and pens, "'Inventions' will not be adopted unless they raise profits; higher profits means more

savings; a higher rate of saving means a higher rate of growth for the economy as a whole; and this, at least … over a fairly long period, …should imply a more rapid growth in the demand for labour" (Hicks 1969, 150-151). Savings, though, lower growth in the short-term due to the money multiplier, but can increase it in the long-term.

Meanwhile, Joan Robinson, a self-identified socialist who spent time mingling with communist world leaders, was a proponent of "Post-Keynesian" economics, that the world is so complex that no policies can work, nor any predictions be correct. Therefore, one cannot measure the profitability of capital, or the quantity of capital, and the theory of marginal productivity of distribution cannot hold. Robinson's main contention was along the lines of Piero Sraffa, that capital is a heterogeneous composition, and could not even be measured by a "chain index," because this would not account for technical change looking ahead. Even Paul Samuelson, a "New Keynesian," agreed with this, admitting that the neoclassical approach, or measuring the relationship between labor and capital based on their prices, was flawed. This is because it depends strongly on interest rate effects (the return to capital ahead), many of such theories being named after Knut Wicksell, and, the final demand of each good is different and depends on numerous inputs (Screpanti and Zamagni 1995, 400-403). She wrote economics should focus on the "real world" (Pressman 2014, 188-189).

The following years saw neo-institutional economists, who looked at economic structures and social mores. John Kenneth Galbraith wrote about power struggles between wealthy corporations, that have "technostructures" that rely on "technical virtuosity," much may come to dominate a futuristic world. He foresaw a world in-between central planning, which Austrian economist Frederick von Hayek railed against, and which can produce too many goods, and the market, which can produce too little (Pressman 2014, 212- 214). As trade took off, Paul Samuelson, modernity's people's economist, wrote about global marginal productivity, that free trade equalizes the "rewards" going to factors of production in varied countries, whether labor or capital. Wages for computer programmers will equalize internationally, per Clark's marginal productivity of distribution. This could impact the flow of capital and labor in the technological world of the future, provided that these inputs can flow freely across borders of countries of various degrees of development (Pressman 2014, 227). Dutch economist Jan Tinbergen said that income inequality is education catching up with technology, the "digital divide."

Modern scholars have weighed in as well, such as neo-liberal Jeffrey Sachs and L. Kotlikoff, saying: "What if machines are getting so smart, thanks to their microprocessor brains, that they no longer need unskilled labor to operate" (Vardi 2015, 10)? According to Noble Prize winner Paul Krugman: "a much darker picture of the effects of technology on labor is emerging", not just in America, but globally (Campa 2014, 88 & 89). He continued that "some of the victims of disruption will be workers who are currently considered highly skilled, and who invested a lot of time and money in acquiring those skills. For example…we're going to be seeing a lot of 'automation of knowledge work'" (Campa 2014, 88). Krugman, like Marx before, is critical of the "system," and favors a government policy that redistributes wealth, and "guarantees not just health care but a minimum income, too" (Campa 2014, 89). He also says: "Can innovation and progress really hurt large numbers of workers in general? The truth is that it can, and serious economists have been aware … for almost two centuries" (Vardi 2015, 10).

Other scholars differ. Harvard Universities Kenneth Rogoff has said, "Since the dawn of the industrial age, a recurrent fear has been that technological change will spawn mass unemployment. Neoclassical economists predicted that this would not happen because people would find other jobs, albeit possibly after a long period of painful adjustment. By and large, that prediction has proved to be correct" (Vardi 2015, 11). Even Albert Einstein, writing in 1949, wrote: "Technological progress frequently results in more unemployment rather that in easing of the burden of work for all….The result of these developments is an oligarchy of private capital, the enormous power of which cannot be effectively checked even by a democratically-organized political society" (Einstein 2009).

The central equation that can be developed from this theorizing, by your authors, is:

$$QP = Cw + Ew + (p)M + LwM + R(c) + Aw + Nw$$

Quantity of goods times their prices equals the sum of capitalists times their wage rate, employees times their wage rate, machine physical prices times the number of machines, machine laborers who make the machines times their wage rate and the number of machines they create, raw materials times their cost, machine "advancers" from research and development times their wage rate, and "entrepreneurs" who expand the business into new areas, times their wage rate.

The wage rate is, of course, different for each, depending on marginal productivity or skill level, which will depend on education and the costs of materials depends on their scarcity, the labor to obtain them, and their demand. The wage rate does not include savings, which would

be money that could go for further capital investments, essentially lowering growth in the present via the money multiplier effect, but increasing it in the future, especially since it adds a risk premium through investment. However, as economic theorists tell us, from Modigliani and Friedman, the wealthy tend to save more, and everyone tries to stretch-out their income over a lifetime.

At least some amount of competition will be needed to inspire and spur innovation, unless machines/robots are motivated by something else, such as the greater good. If marginal productivity holds, most rewards will end up going to (p)M, or other robots, so robots' motivations here are important, if they will care about advancing themselves as individuals, what economists call "utility." In essence, human beings will be paid either as capitalists (or government bureaucrats), helping to make institutional and strategic decisions; as menial employees; as "advancers" of robot technology (provided robots need us); or as "entrepreneurs."

Data (Part I): The Folklore and Future of Science

Science Fiction's Take:

What does Science Fiction tell us of this take over by artificial intelligence? Well, it depends on who you are reading or what movie you are watching? The *Back to the Future* movies, in vogue nostalgically because they presciently predicted the improvement of the Chicago Cubs baseball team, also foresaw the abundance of soda products, flat screen TVs, holograms, 3-D printers, hoverboards (real hoverboards), and flying or self-driving cars, but said little about the social features of the future.

In the majority of Science Fiction stories about artificial intelligence that go over to the "Dark Side" usually does not end well for the humans. As far back as 1942, AI's potential threat to humans has been on the minds of writers and this was clearly on the mind of Isaac Asimov when he wrote a short story and created the Three Laws of Robotics which state 1) A robot must not injure a human being or, through inaction, allow a human being to come to harm; 2) A robot must obey the orders given it by human beings expect where such orders would conflict with the First Law; and 3) A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws (Asimov 2008). As the years went on, both Asimov and others would modify and change these laws and Asimov even added a zero or forth law: a robot may not harm humanity, or, by its inaction, allow humanity to come to harm (Asimov 2008).

While well thought-out, we know from our movie going experience that these laws are not always followed.

In 1968 the film and book *2001: A Space Odyssey* (the book by Arthur C. Clark was developed concurrently with the Stanley Kubric film), HAL 9000 or HAL for short, the ship's computer: points out human error, seems to have emotions and an externalist crisis, reads the lips of the scientists, commits errors, lies, and eventually commits murder. Is he evil or just following orders?

Let's play Global Thermonuclear War! A few will recall those fabulously sassy words as David, played by young hacker Matthew Broderick, plays video games with a US military supercomputer who cannot tell the difference between reality and a simulation. Once again, he was just following his programming. In the various *Terminator* movies (5 films to date and one TV series) finds that on August 29, 1997 Judgement Day arrives when Skynet, a supercomputer intelligence defense network, becomes self-aware and decides to exterminate humanity by launching a nuclear attack on the USSR, which retaliates with its own nuclear attack on the US. Luckily, 1997 came and went with no computer takeover by Skynet, however humanity has been forced to witness further *Terminator* movies and various stages of undress by a former Governor of California.

WALL-E, the animated 2008 motion picture from Disney and Pixar found a lonely robot WALL-E stranded on an abandoned waste-covered Earth, slowly cleaning up the planet while he watches movies, falls in love with another robot named EVE, and has an adventure which saves robots and floating blobs of obesity that has become humanity. Both WALL-E and EVE show examples of free will, friendship, and emotions in the film. The film also shows the automatic autopilot, called AUTO, just following orders placed by the humans, to steal, stage a mutiny, and tries to kill WALL-E.

In the 2014 film *Interstellar*, two robots TARS and CASE lend a helping "hand" to the crew of the Endurance who leave the galaxy to find a potentially habitable planet and save mankind. TARS is shown in the film to have a humor rating, which is controllable by the astronauts.

In *Star Trek: The Motion Picture*, V'Ger a powerful alien cloud is destroying everything in its path and is headed straight for Earth. Eventually the crew of the Starship Enterprise realizes that it was none other than the little human spacecraft Voyager 6 (modeled off of NASA's

Voyager spacecraft Voyagers 1 and 2) and its return home after being rebuilt by alien robots to seek "something greater." As one would come to expect from *Star Trek*, other AI robots would soon followed, including the menacing evil Borg and the robot with a Pinocchio complex Data, from *Star Trek Next Generation*. While Data yearns to be human over the course of the series and movies, he comes to have an evil brother named Lore, create a child Lal, have issues with contractions, have an on-and-off switch which can be used against him, and go on trial to fight for his rights of self-determination and not be considered property of Starfleet. A book exploring the political-economic future based on the egalitarian society in Star Trek, *Trekonomics*, arrives on the market June, 2016. The question is if we will we become the "Borg," intertwined with technology so that our thought processes are connected, similarly explored in the young adult **"**Tripod Trilogy" by John Christopher.

Will we spend our time in virtual worlds like a Star Trek holodeck, which many people already do through intense video games, but with the benefit that holograms and sex robots will eliminate STDs and unwanted pregnancies? One can ask the smart-phone Siri if she believes in a higher power, and she will respond, "who am I to say," raising the question of religion in the future, and, if aliens are discovered, how this will be intertwined, and if we will be able to learn from each other. This also raises the question in movies such as *Blade Runner* and *Her*, about falling in love with cell phones or robots or operating systems.

So we learn from movies and science fiction's view that artificial intelligence is often evil, it questions its own existence, and it is often 'just following orders'. Are there deep seeded questions AI coming out or just easy plot devices to move the storylines along? Regardless of their use, this idea about robots turning evil has become deep seeded within our culture and one that is not going away anytime soon.

Data (Part II): Today's Scientists Outlook:

Diamond (2005) writes that the very way human beings used to live is often forgotten or left out of history. He remembers talking with the elders in his community, telling stories about the loudness of cities, with all of their horses and manual workers, and how this changed with the coming of cars. As most technical advancements follow wars, one can see that televisions following World War II, led to computers, then friendlier operating systems, and then eventually to smart phones. The current time is seeing the start of robots, as a University of Redding robot

named "Eugene Goostman," was able to fool bystanders that he was a human, until he struggled to answer several word-play questions (Musgrave and Roberts 2015, 3). Passers-by of the woods surrounding Boston Dynamics have reportedly seen a 6 foot tall, 320 pound human, supposedly known as "Atlas," running around, mimicking human behavior (Sainato 2015). The firm IBM is investing $1 billion dollars to make Watson, its supercomputer which won on *Jeopardy!* available commercially, while Google has bought out eight different robotics and machine-learning companies, and Facebook has employed AI expert Yann LeCun to create a special AI laboratory (Schatsky, Muraskin, and Gurumurthy 2014, 2). In the late 1990s, a Big Blue chess program was developed that eventually defeated world grandmasters. Between 2011 and May 2014, $2 billion dollars in private venture capital went towards "cognitive technology", and over 100 companies were merged or acquired by such oligopolies as Amazon, Apple, IBM, Facebook, and Google (Schatsky, Muraskin, and Gurumurthy 2014, 16).

Artificial Intelligence is expected to evolve over time, called the "AI effect," into doing whatever it cannot already do (Schatsky, Muraskin, and Gurumurthy 2014, 4). After conceived in the 1950s, by the early 1970s, supercomputers were started being used to solve calculus problems, perform physical actions, impersonate humans, and compose music, but they fell to wayside in the mid-1970s. A new initiative led by Japan in the 1980s spurred international competition, and led to such companies as Intellicorp, Symbolics, and Teknowledge, and by the end of that decade, half of the Fortune 500 companies were making investments. In the 1990s, "lower profile" work was devoted to replicating neural networks to produce "candidate solutions" to problems in part by "introducing random mutations" (Schatsky, Muraskin, and Gurumurthy 2014, 4-5).

Cloud-based services, which store data, can allow humans to collaborate, sometimes even unknowingly, by describing digital images, which allows image classification algorithms, or methods of solving problems, to learn, receive feedback, and improve. The algorithms continue to be advanced by humans, as many are "open source" or available to everyone, which may be one way we will mostly be connected. Computers are also advancing with cognitive technologies that were once thought only possible to be done by humans, such as identifying images. Whereas "machine vision" needed to identify parts in a factory is already established, "computer vision" of identifying humans is still being invested in (Schatsky, Muraskin, and

Gurumurthy 2014, 5-8). And quantum computers that run at very cold temperatures can calculate even more quickly.

Machine learning is a critical element to the advancement of AI. This occurs when machines do not need to follow programmed instructions, which happens once computers have "studied" enough data to be able to make better and better predictions given more data sets. It is useful for many jobs, and can lead to unemployment. It is currently a popular area of investment, compelling $1 billion dollars between 2011 and mid-2014, including a $400 million investment by Google to purchase the DeepMind company. This corresponds with language processing, which involves locating all of the names and places included in a document, extracting the main point, or identifying the terms and conditions to create readable contracts. They can also serve as "cobots" that share jobs with humans in factories, and techniques are being developed to recognize speech despite a plethora of accents, background noise, and homophones, words that sound that same but have different meanings, through the use of acoustic models. Other high-tech uses that are being developed are "optimization," which may be used to meet goals with limited resources, "planning and scheduling," which lays out procedures and actions, and "rules-based systems" that make inferences using information (Schatsky, Muraskin, and Gurumurthy 2014, 8-11).

Old methods, revered by traditional programmers, use a neural network for intelligence, begun in the 1950s using transistors to copy the design of human brains. Today, researchers are organizing computers' brains via hierarchical layers, which pass signals from one to the next, adding information as they go. These systems must be trained, though. Algorithms used to be very specific, needing "hints" from active programmers, and could not handle more data. Today, however, there is a "race" to create "unsupervised-learning" algorithms, which do not need humans. More physicists are being employed, to create artificial intelligence functions that companies believe can benefit their bottom lines (The Economist 2015a).

Employment-wise, computers can do jobs that involve consistency, objectivity, and attention (Kaplan 2015, 4). They are repetitive and tireless, except for depreciation, and can provide faster actions and decisions, better outcomes, greater efficiency, lower costs, greater scales of activity, and coming up with new features and new products (Schatsky, Muraskin, and Gurumurthy 2014, 12-13). A recent Oxford study of 700 different jobs found that 47% of them would be overtaken by computers within several decades (Kaplan 2015, 1). Most jobs held by

women will be safe, this study found, while jobs performed by men are in danger. "Male jobs" usually involve perception, manipulation, and physical exertion, while "female jobs" typically involve emotions and organization. Of the 3 million U.S. truck drivers, 95% are men, while of the 3 million secretaries, 95% are women and men compose 97% of the 25 million U.S. construction jobs, which have a 70% chance of being replace. Women represent 93% of nursing positions, a job that has 0.009% chance of being replaced (Kaplan 2015, 1-3). In a recent interview on CNN by Fareed Zakaria, Alec Ross, author of *The Industries of the Future*, predicts the advancements in hardware, material sciences, and life sciences, such that human's genetic code rather than computer code, will become the dominant industry, and that truck driving, which employs many men today, may be replaced (Zakaria 2016).

Artificial Intelligence can also be used in banking to detect fraud, in health care for transcribing notes dictated to physicians, analyzing medical images, understanding medical literature, and making diagnosis, pinpointing potential drugs in pharmaceutical research, drafting articles based on financial statements or sports outcomes, locating mineral deposits, diagnosing problems with mechanical equipment, crime surveying, vacuum cleaning or adjusting thermostats (Schatsky, Muraskin, and Gurumurthy 2014, 11-12). Other small uses of new technology can be anything from recognizing friends' faces in photos, to replicating human speech in apps, to recommending or delivering products to consumers, to serving as R2D2-like garbage collectors, to the more advanced, such as self-driving cars or robots in warehouses, and software that links jobs to job seekers (Brynjolfsson and McAfee 2014, 2). They can also perform tasks such window washing, controlling air traffic, or matching taxi drivers with trip inquiries (Kaplan 2015, 4). OrCam, an Israeli company, is developing technology to help the visually disabled, while some wheelchairs can now be controlled by human thoughts alone. Of course, the price is most likely very high (Brynjolfsson and McAfee 2014, 3). More advanced jobs include predicting the behavior of Islamic extremists (Sainato 2015), or serving as commodity traders, although, certain jobs need to be accompanied by a certain level of human respect (Kaplan 2015, 3).

The amount of improvement and commercialization is stunning. Google's voice recognition programs improved 84% accuracy in 2012 to 98% in 2014, while vision research improved by a factor of four. Facebook's DeepFace can now recognize faces with 97% accuracy, and IBM's Watson is now 2,400 times smarter than when it won on the Jeopardy!

However, the costs of technology, whether commercial or otherwise, is a large impediment to use, as David Autor, a Massachusetts Institute of Technology economist, notes in a 2013 paper, that while Japanese manufacturers use robots, Indian manufacturers rely on the developing world's cheap labor, a development divergence (The Economist 2014).

The Results:

The Automated Stages Ahead Based on Theory:

Many of the stages will overlap, and are broken down conveniently, so not all in each one will occur simultaneously. Technology in economics, from Solow to Romer to Lucas, refers to any tool that man can use to increase productivity. The term "robots" refers to advanced artificial intelligence in various forms, whether in machinery, computers, or other technology.

Over the next ten to fifteen years, the United States' economy, and those of most of the developed world, will continue to plod along at slow economy growth, due to its liquidity trap of a lack of profitable investment opportunities. Wild changes in saving, due to a finicky consumerism that rejects new high tech products in hopes of purchasing the next version, will keep corporations in a state of uncertainty, continuing to invest in consumer research as well as technical research and development to meet their specific demands and tastes, often coming to the market too late with their new products.

Political-economic gridlock in these countries will help to keep the debt as low as possible while the baby boom generations retires, after which there will be more job openings, many of which young employees will not be able to meet, resulting in re-schooling. The debt will be ameliorated by growth, but continue to grow, but which will be sustainable in the United States, due to its strong Federal Reserve central bank, but which many other countries will not have to maintain fiscal balance, resulting in numerous global bailouts. Eventually, this transitional period will be replaced by more dynamic leaders, who will be able to pass plans such as tax incentives for research, and the U.S. will return to stronger economic growth

1. Manufacturing

At first, computers and "robots" will take over most manufacturing jobs, since, in corporate decision making of how to invest and allocate productive resources, the marginal

revenues compared to marginal costs of humans versus machines will come to favor the machines. In other words, they will "provide more bang for the buck," in terms of productivity, as well. Car complies, from BMW to Tesla, create more of their cars with robots than with humans. Employees will, on the whole, switch to service type jobs, or jobs needed to make machines or robots, and growth will slow. The central question here is whether or not humans making machines is a more productive system than humans simply making products themselves with smaller manufacturing tools. Demographic pressures in the West will cause slow growth, but higher growth in other parts of the world, such that we will start the process or approaching economic convergence. The developing world will start off with more of the robots, because they are wealthier and can invest in the capital, but it will soon flow.

2. Services

Robots will take over support type jobs, and some services, although there are certain, creative type jobs, or jobs that require human interaction (like lawyering or marketing or writing evil robot screenplays), that they will not be able to fulfill. Computers will take over certain jobs like paralegals where databases can now be more easily used than time-consuming research. There may be some tasks that they still could not do without some direction and assistance, resulting in collaboration, such as military activity.

Despite this, robots will not be able to provide "discretion," or decision making at this point, as economists say, because they lack human imagination. There will be many advancements in medicine, such as with nanotechnology and genomics, people will live longer- they may have less stress from not working as much, or vice-versa for the class of manual workers, but modern diseases from obesity such as diabetes will increase in developed and developing countries. Then, the robots will eventually learn how to communicate and communicate with each other, and mimic human behavior, such that they will indeed be able to take over many of these jobs. By improving the productivity of services, they will help increase economic growth, thus defying Baumol's disease, the loss in productivity from service jobs. Humans will continue to be replaced by "services replaceable technology," and by robots that can perform "merging search capacities." Durkheim suggested that modern societies can become impersonal and dominated by institutions (Peet and Hartwick 2009, 104-106 & 113); whether the Internet and smart phones are causing this now is debatable, one hears stories of

children at camps not knowing how to play with one another, or professionals spending lunches not talking with their eating companions but checking their e-mail and we have all heard of the person too busy on their iPhone to notice the train or car and hence taken out of the genepool.

3. Support, some poor jobs

Robots will come to constitute the largest economic sector, and economic rule will be come to be by an elite super class of geeks, the smartest individuals able to make changes to, and essentially control, the robots. They will also control the profits. There still will be three classes, the highly skilled "geeks," a manual class, and a class of "domestic servants," (aka mostly government administrative workers). The shifting of human workers between jobs and sectors will cause large frictional as well as structural unemployment. Humans may still be able to afford their own, individual "robots" or "robot systems," connecting everything they need, and need to do, on gadgets, such that output will more closely meet our personal demand, but there will be economic swings due to the time it takes for robots to advance, and meet our constantly changing needs, which the Austrian economist Joseph Schumpeter called "creative destruction."

There will be an increased digital divide, with fewer people able to obtain a college education, similar to the "haves" and "have nots," with many humans performing menial jobs. The largest effected may be diverse ethnic groups in countries. As Putnam writes in *Our Kids*, education will become so expensive, resulting in certain wealthy families, and will result in societal change, of divided social classes, and people literally "bowling alone" or in smaller groups. If businesses pay for education in return for future profits, there will be moral hazard and adverse selection, and an obsession with money and not the arts, the special ones of which hopefully will not be lost. Humans and robots end up competing for many of the same jobs. Robots will have to rely on human institutions to start, or the entire economic system of how people make a living will have to be re-thought.

4. Embedded Collaboration

Human beings and robots will learn to work collaboratively, with humans still largely in charge, possibly with humans actually having robots embedded in the bodies, such as their minds, but not all people will go along with this. Money and the market will continue to exist, as people will still need to save for the future, as Boehm-Bawerk notes that a surplus of parts,

resources, and food enable greater time devoted to production, in any society. Bitcoins will be used by countries as reserve currency, along with many other currencies, such as the recently adopted Chinese yuan. Financing will be required for R&D in new robots, which will require a financial structure, but these investments can be risky, yet people will still save for the future. Being so connected, the "electronic herd," which Thomas Freidman wrote about, especially with regards to the markets, will cause group think to accelerate, resulting in wide financial and economic swings based upon human impulses reacting impulsively, combined with the increasing speed of technology and a resumption of globalization that had previously stalled.

Wages may not keep up with falling prices, if so much profits and investment are needed to improve the robots, whether done by humans, or by themselves. Computers continue to form a coordinated system at first, termed institutions, which humans have developed over thousands of years. Eventually, the highly skilled class will have difficulty keeping up with the robot intelligence, and this class virtually disappears by itself, but is replaced by a class of entrepreneurs and advancers. Employee entrepreneurs may need to work in teams to brainstorm ideas. Many entrepreneurial advancements and rewards are from "luck," resulting in a few "robber barons."

A greater variety of products will come to be bought and sold online. The domestic shipping industry will increase, but it will be replaced by drones or self-driving cars. Amazon warehouses are using more and more robots in "carefully coordinated harmony" (Knight 2015). A whole, competitive industry of robot making for robots will develop. Harvard Business School Professor Wily Shih, says that robots make it "easier to drop into factory and distribution settings, and easier to integrate with existing manual processes and workers" (Knight 2015). This market will contain steep barriers to entry, leading to patents, to oligopolies of competing robot firms, and then possible integrated monopolies with some innovation by smaller firms. There will be the need for robots to consolidate and merge to keep profits high so they can invest in either themselves (through other robots), if robots have feelings and care about their own mortality, or if they will invest in humans to help continually improve themselves (the robots). Larger firms will have more capital to invest in innovation, like Schumpeter writes, but they can become set in their ways and too focused on their primary "cash cow" products.

5. Domination/Oligopolies

Technology will cause so much income inequality that most of the lower classes will be able to do all lower class jobs with little training, thus, the division of labor written about by Adam Smith will be destroyed, and humans will no longer associate themselves by their occupation. But, the declining human intelligence and curiosity from the division of labor, occurring since the end of the Enlightenment and the start of the Industrial Revolution, may start to reverse. Robots, however, will still eventually greatly surpass human knowledge, and we will no longer be able to afford more advanced personal robots, nor pay for more embedded ones; thus, we will not "own" them. High capital will become a barrier to entry. It may be politically contentious at first as to whether to allow the robots to take over, since they will be superior, or whether to resist.

Having been programmed to produce the greatest output, in terms of an ordinal, ranking "values system," robots will internally struggle between providing output, simply acquiring advancements in knowledge, or becoming more human. Therefore, robots will see little need for humans except for performing menial jobs, or in improving the robots themselves in small ways, but since robots will become smarter than humans, they will essentially be able to improve themselves. Despite this, humans beings are incredibly manually dexterous, light weight, physically mobile, easy to reproduce, and numerous in population, which may be of great help in expanding the number of robots, if they need it since physical coordination might seem a problem, and if they are not able to do so themselves, despite a division of labor amongst their different kinds.

Humans will continue to demand more goods, especially entertainment products, since we are social beings, and robots will comply in supplying them, since they will use profits from consumer goods to improve themselves. However, most will be on the mass scale. Robots will not like diverting resources away from themselves, nevertheless, there may be room for small, human, entrepreneurial advancements, and robots will see no need in eliminating humans, so they will not eliminate human life. Some robots may begin to wonder who created them, but they do not harbor ill feelings, towards our "enslavement" of them, but some start to generate strong human-like emotions. With fewer advancements, economic growth may stall at times and there may be Keynesian overproduction. Even adults, who wish to earn more profits, which will continue to be an incentive, will spend most of their days being technologically educated, often with the robots trying to educate us.

6. Revolution/Conflict

Robots, having no ethical consciences at first, may not care how resources are distributed amongst humans, but from an economic standpoint, they may care about humans' potential to increase their (the robots') marginal productivity, thus providing carrot-and-stick rewards and incentives. Robots will have to decide to produce more robots or aid in the advancement and population of mankind. Market pressures will cause conflict between the robots and robot companies, and robots versus robots, over resources and possibly values, plus who should run the governments, until the robots learn to work together and create giant, linked supply chains, or monopolies, needed to generate larger profits. Robots will form, with humans, an integrated, institutional framework. This lack of societal diversification will increase the chances of malfunctions, viruses, or the threat that nation states may cut Internet connection cables of other states. Computers will form their own unions or governments, probably having the highest IQ machine as their leader. There will be competition between robots and workers, and unions of workers with similar skills obtained as avocations or simply based on one's genes or IQ (Intelligence Quotient). Humans may boycott goods or firms, especially solely "computer made" goods, or there may be outbreaks of computer viruses, which humans may be best at fixing. To prevent human and robot revolution, robots may let humans retain most political power.

7. Resolution

After the conflicts, humans and robots will learn to genuinely work together according to separate strengths, which will emerge based on a more different education system. Government, which will initially control many robots, will use some robots in part as public goods, available to everyone, as Adam Smith wrote about, which will cause some crowding out. At an advanced political point, there will be political divides over what public robots to build or invest in with public money. Social programs such as Welfare will greatly increase, but taxpayers will demur paying for all robots and large social funding, and some robots will demand independence from the government, as well.

When the robots took over the largest sectors of the economy, they left most of the government in place, to help maintain stability, and to help choose distribution methods to the masses, due to its large bureaucracy, as well as to fund technological change, as most private

investment will dry up since it will not simply be powerful enough to improve the robots or result in any kind of profitable return. Robots will still need profits from sold goods, as well as from government spending, so they give in, and robots will keep the human government, knowing that it invests in them. Consumer markets will remain virtually unchanged, especially for produce or agricultural products, but with greater output from increased productivity, and with lower prices for this very reason, unless the robots will need to charge more to make more profits to invest in their own advancement. Both the quality of high-tech products will have improved, and the quantity of diverse products, as well. In the entirety, hunger will disappear, but diseases will spread more as people live in cities.

8. Democracy remains

Democracy remains and does so as more people live in cities, which need active governments, and humans have more organized value systems. It becomes a question of whether robots should be allowed to vote, and which ones, but this is ultimately turned down. However, there will be shifting human political views between distribution based on marginal productivity, equality, or some combination of a base allocation combined with bonuses for coming up with productivity advancements, thus future, or potential, marginal productivity. This will results in deeper economic divisions, and greater shifts in policies between elections, than previously experienced in such countries like the United States, but will be more like Great Britain, in which labor and banking policies change dramatically with the administration. In this way, there will be continued, huge swings in inequality and distribution.

Central planning may be used to a degree, but it will not be the overall paradigm, since the fall of communism has discredited it, because human demand is constantly in flux. The decisions about how to reward and invest, though, will be largely political. As robots depreciate, there is a desired need for human occupation in jobs such as energy and rare minerals to continually improve and repair technology. Methods of distribution may result in new types of employment or societal discrimination, for which new laws will need to be written, that only humans can do.

With so much demand for education, there may be both schools run be robots, who will be smarter than humans, and secondary, less-competitive human ones as well. The marginal productivity of the robots must be greater than the combined total marginal productivity of the

people used to make the parts for them, so education will become so expensive, but paramount. Robots, too, constantly will need new training to keep up with market changes; one might say there is a diminishing marginal productivity, so they need education, too.

9. Global and Universal Threats

Asteroids, which may need to be shot down by missiles by developed countries working together, climate change, clean energy, nuclear weapons between an array of new, economically strong, Earth-based geo-political powers, and long-distance and commercial space travel, all which have been steadily increasing in importance, now become the largest concerns. Continued development will depend on the speed by which computers are able to improve themselves, aided by man. Humans will come in contact with numerous alien species, the majority of which will be peaceful. Ultimately, the universe ends from Einstein's "heat loss death of the universe," the loss of potential energy from the friction of the planets, causing the Earth to freeze, and humans, along with our robot and alien colleagues, transport ourselves into another, parallel universe. Or eventually our sun goes supernova and burns the Earth to a crisp (as seen in various science fictions shows from Doctor Who to Babylon 5).

Conclusion

The central question is if, and at what speed, can robots/computers learn, imagine, or improve by themselves? If they can, then they will no longer need humans for meaningful work, except perhaps for menial jobs that require our manual dexterity, a large population, light weightiness, physical durability, and mobility, and relative ease of replication. In essence, robots will be the humans, and humans will work for the robots, since the robots will be economically superior; more specifically, computers, if smarter than humans, will become our teachers and professors. If not, we can continue to work to improve them, through "entrepreneurial" and "advancement" tasks, going back to the equation presented, unless we work together creating synergies, the combination of actors, substances, or agencies to achieve an effect greater than that of which each is individually capable of. In economics, this depends on how humans use technology and how they are combined. Robots do not have a coordinated, institutional system, which will take centuries to develop, as it did for mankind.

With much time before any several large societal changes, mankind still has many policy options, provided technology turns out the way we think it will. Governments within individual countries could adopt "Basic Income Guarantees," or wages paid to all citizens in a border regardless of work, for consumption and not production, but this would have to be acceptable to the robots, as well. Of course, one must realize that welfare policies, without given work with production, can have inflationary pressures. To reduce the power of capitalists, government could provide each person a share of robotic corporations upon birth. Mankind could redistribute income through taxation, mandate human workers in industries, eliminate robotic workers if possible, find a way to pay for free education, or it could simply allow the market to make these decisions spontaneously via the "invisible hand" (Campa 2014, 86-101). Ricardo, as early as the 1800s, predicted that governments would not be politically able to ban technology, because it would make them internationally less competitive (Ricardo 1962, 271), still, writes Campa, each nation, developed or developing, may yet choose different policies, and, like him, we see "an intermediate scenario, between dystopia and utopia…, with variations from country to country, from people to people…" (Campa 2014, 101). Every country has its own culture, and therefore its own methods of development, which the modernization theorists ignored.

Ricardo wrote that, "machinery cannot be worked without the assistance of men, it cannot be made but with the contribution of their labor" (Ricardo 1962, 271). These points at this time are at the center of the question. Even if computers advance beyond mankind, the fear is that too much human-robot or human-human connectedness could hurt the human body, or give up control and independence. Much of the world, such as the underdeveloped, could be left behind, either unintentionally, because of the inability to buy computer goods, to use computer goods from the digital divide, or intentional refrain, like the Amish or other religious societies, like the Quakers and Shakers, or the 1800s transcendentalists, who prefer to be left alone. Recent writings between Alabama students and the imprisoned "Unabomber," Ted Kaczynski, who opposed technology, show how faddish society has become, susceptible to what Thomas Friedman called the "electronic herd," within a decade (Gattis 2016).

Regardless, economically it must be realized that if people end up losing their jobs, and hence no wages, they will not be able to afford goods, even at very low prices. Therefore, profitability, which goes for various types of investment as 1960s economist Hyman Minsky showed, will decline, unless the computers are able to make great advancements by themselves,

and if robots continue to help and provide for humans despite our comparative uselessness. Without working with robots, we would either have to craft a new way to live without machines, or a good part of them, or compete with them for resources and materials. However, it is questionable if machines would turn against humans, even in the long-term, depending on their morals that develop. With much more time devoted to education, from our own schools and from robots themselves, as well as physical advantages from the human body, and established socio-economic institutions, humans should still be able to contribute to various aspects of society and earn different degrees of employment.

This employment, in democratic countries, is, and will, in large part depend on individual's socio-economic career choices, which are not always motivated by wage incentives but also on values and interests. High-tech jobs will likely be respected, unlike the capitalists of the past. This will likely mean increased demand for education, and higher costs for the most prestigious schools, but gains from computer or online learning. Still, the technological advancements contributed by humans will need to be substantial, unless robots are able to advance themselves, since rudimentary, small changes will not contribute very much to growth. But either way, there will still be vicious economic and financial business cycle swings, or recessions and depressions, every time there is a new breakthrough, which humans have not been able to avoid historically, or in the future. Nevertheless, writes J.R. Hicks, the economist's economist, "A single improvement in technique, with suitable saving propensities (and no rise in wages) can convert a stationary into an expanding economy" (Hicks 1969, 171). He also writes, optimistically, "When we look at the matter in world terms, and consider what has been done, it [the expansion that is needed to accommodate a large population] looks far from impossible" (Hicks 1969, 158). Mankind also has many political-economic policy options available, which will have to be made within the presence of Artificial Intelligence. This will result in the greatest changes to the future, but can be left for further research. With human beings, though, the possibilities are endless; who can say what the future truly will bring?

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