THE POLICY CHALLENGES OF AUTOMATION

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According to our analysis, making the AI revolution work for everyone will require systemic reforms, and the potential reinvention of social security, redistribution mechanisms, as well as education and skill development systems, to allow for repeated and viable professional transitions. Policy and regulatory frameworks will also need rebalancing to protect the most vulnerable from socio-economic exclusion, to prevent algorithmic discrimination and privacy abuses, to ensure control and accountability, as well as to avoid an exacerbation of wealth and opportunity inequalities.

INTRODUCTION

"Is this time different?" is the question that economists and experts worryingly argue over when they analyze the socio-economic impact of the AI revolution as compared with the other industrial revolutions of the 19th and 20th centuries. This Schumpeterian wave may prove to be a creative destruction raising incomes, enhancing quality of life for all and generating previously unimagined jobs to replace those that get automatized. Or it may turn out to be a destructive creation leading to mass unemployment, hollowing out of the middle class, and to abuses or loss of control over key decision-making processes. This depends on the velocity and magnitude of the development and diffusion of AI technologies, a point over which experts diverge widely. But technology is certainly not destiny and policy as well as institutional choices will matter greatly.

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A. ADAPTING SOCIAL SECURITY AND REDISTRIBUTIVE MECHANISMS

CREATIVE DESTRUCTION OR DESTRUCTIVE CREATION?

The most discussed set of policy challenges associated with the rise of AI refers to the impact of automation on jobs and inequalities, with some scholars positing the potential "hollowing out" of the middle classes. Experts agree that the automation wave fueled by AI will profoundly impact employment patterns and business processes. How is this time different from previous waves of technological disruption? Whether this "Schumpeterian wave" proves to be a *creative destruction* like those that have come before – resulting in higher average incomes and generating previously unimagined jobs to replace those that get automatized – or turns out to be a *destructive creation*, leading to mass unemployment, depends on the velocity of the development and diffusion of AI technologies over the coming decade. Here, there is significant uncertainty amongst scholars.

Along with President Obama's former Council of Economic Advisers Chairman, Jason Furman's, paper published in July 2016[1], and the White House report on *Artificial Intelligence, Automation and the Economy* published in December 2016[2], the McKinsey Global Institute report on *Harnessing Automation for a Future that Works*[3], released in January 2017, concluded that the fundamental shifts in the labor force caused by automation technologies would be "*of a scale not without precedent*.". In their 2014 book entitled *The Second Machine Age*, Eric Brynjolfsson and Andrew McAfee had on their part argued that we are facing an unprecedented inflection point between the first machine age, based on the automation of physical tasks through mechanization, and a second machine age, based on the automation of cognitive tasks through digital technologies[4].

Results of studies on the impact of job automation conducted over the past five years have differed quite radically in their assessment and projections: a report from the OECD published in June 2016[5] – focused on its 21 Member countries and centered around "tasks" as a unit of analysis – concluded that a modest average of 9 percent of tasks are automatable. There are predicted to be notable differences between different countries' trends[6]. The 2013 study of Frey and Osborne on the future of employment,[7] which focused on the broader concept of "occupations," had raised alarm bells with its conclusion that about 47 percent of jobs in the U.S. were susceptible to automation over the next two decades. Another report by Citibank,[8] building on the Frey and Osborne study as well as on data from the World Bank, focused on 50 countries and concluded that, on average in OECD countries, 50 percent of the jobs were susceptible to automation. This number was particularly high in India (69% susceptibility) and China (77% susceptibility). Analyzing more than 2,000 work activities across 800 occupations, McKinsey's most recent report concluded that "*about half the activities people are paid almost $15 trillion in wages to do in the global economy*

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1 Jason Furman, "Is this time different? The opportunities and challenges of artificial intelligence," remarks at AI Now: The Social and Economic Implications of Artificial Intelligence Technologies in the Near Term , conference in New York, July 7, 2016.

2 *Artificial intelligence, automation, and the economy*, Executive Office of the President, December 2016. https://obamawhitehouse.archives.gov/blog/2016/12/20/artificial-intelligence-automation-and-economy

3 James Manyika, Michael Chui, Mehdi Miremadi, Jacques Bughin, Katy George, Paul Willmott, and Martin Dewhurst, *Harnessing Automation for a Future that Works*, McKinsey Global Institute, January 2017 (p.97).

4 Erik Brynjolfsson and Andrew McAfee, *The second machine age: Work, progress, and prosperity in a time of brilliant technologies*, W. W. Norton & Company, 2014.

5 Melanie Arntz, Terry Gregory, and Ulrich Zierahn, *The risk of automation for jobs in OECD countries: A comparative analysis*, OECD Social, Employment and Migration working paper number 189, OECD, May 2016

6 For instance the share of automatable jobs is 6% in Korea vs. 12% in Austria.

7 Carl Benedikt Frey and Michael A. Osborne, *The future of employment: How susceptible are jobs to computerisation?*, Oxford Martin School, September 17, 2013.

8 *Technology at Work v2.0: The future is not what it used to be*, Citibank, January 2016.

> **"OUR ANALYSIS OF THE MOST RECENT LITERATURE POINTS TO THE LIKELY NEED FOR PROGRESSIVE TAX POLICIES TO REBALANCE THE LABOR TO CAPITAL SHIFT THAT IS LIKELY TO BE SEEN IN THE AI REVOLUTION, IN ORDER TO PROTECT THE MOST VULNERABLE FROM SOCIO-ECONOMIC EXCLUSION, AS WELL AS TO AVOID AN EXPLOSION IN INEQUALITIES OF WEALTH AND OPPORTUNITIES."**

have the potential to be automated. [...]. While less than 5 percent of all occupations can be automated entirely, about 60 percent of all occupations have at least 30 percent of constituent. More occupations will change than will be automated away."[9] The report also concluded that activities most exposed include "physical activities in highly structured and predictable environments, as well as the collection and processing of data."

Moving forward, it is paramount that more research is conducted to understand the factors of job automation at more a granular level, in particular across timeframes, sectors, wage levels, education levels, job types, and locations. Reports have hitherto mainly pointed to a continuation, if not an accentuation,[10] of the skill-biased displacement trend,[11] mitigated by the ability of AI and automation technologies to replace high-skill cognitive tasks which exhibit

high degree of routine.[12] Some low-skilled tasks requiring advanced hand-dexterity will also remain in demand, at least in the short term. Studies have also highlighted the loss of jobs for some workers in the short-run, but to a substantial degree the time-frame of displacement depends on institution-specific policy responses.

POLICY MATTERS: MAKING THE AI REVOLUTION WORK FOR EVERYONE

Societies' ability to shape the AI revolution into a *creative destruction* and diffuse its benefit to all mainly depends on how they collectively react to it. Technology is certainly not destiny, and policy as well as institutional choices will matter greatly. Our analysis of the most recent literature points to the likely need for progressive tax policies to rebalance the labor to capital shift that is likely to be seen in the AI revolution, in order to protect the most vulnerable from socio-economic exclusion, as well as to avoid an explosion in inequalities of wealth and opportunities. We believe, however that "taxing robots" per se[13] may not be the best option, and could be counterproductive if implemented narrowly, potentially slowing growth and triggering legal challenges.

Systemic policy responses will be required, including reform, and potential reinvention of, Social Security and redistributive tax. Education and skill development systems will also need reforming to enable for repeated and viable professional transitions. Given the difficulty in predicting areas of greater impact and to disaggregate AI-driven automation from other factors (e.g. other technological changes, globalization, reduction in market competition, workers' bargaining power, past public policy choices), policy responses will initially have to target the whole economy, until targeted strategies become more effective, and monitoring and evaluation practices have been designed.

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9 *Harnessing Automation for a Future that Works*, McKinsey Global Institute, January 2017 (p. vi). MGI scenarios suggest that half of today's work activities could be automated by 2055 or 20 years earlier or later depending on the various factors, in addition to other wider economic conditions.

10 It's what Erik Brynjolfsson and Andrew McAfee have called "super-star biased technological change" in their book *The Second Machine Age*. "*It's the fact that technologies can leverage and amplify the special talents, skill, or luck of the 1% or maybe even the 100th of 1% and replicate them across millions or billions of people. In those kinds of markets, you tend to have winner-take-all outcomes and a few people reap enormous benefits and all of us as consumers reap benefits as well, but there's a lot less need for people of just average or above-average skills*". http://www.businessinsider.com/erik-brynjolfsson-2014-1

11 For instance, the OECD 2016 study estimates that 44 percent of American workers with less than a high school degree hold jobs made up of highly-automatable tasks while 1 percent of people with a bachelor's degree or higher hold such a job. Melanie Arntz, Terry Gregory, and Ulrich Zierahn, *The risk of automation for jobs in OECD countries: A comparative analysis.* Ibid. See also *Artificial intelligence, automation, and the economy*, Executive Office of the President (p. 13 and 14)

12 *Harnessing Automation for a Future that Works*, McKinsey Global Institute, Ibid. Also see *Artificial intelligence, automation, and the economy*, White House Report. Ibid. (page 23).

13 In a very recent interview Bill Gates advocated for it as a way to slow down the pace of automation and fund professional transitions. See http://fortune.com/2017/02/25/bill-gates-robot-tax-automation-jobs/

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As large swathes of the workforce will be exposed to significant insecurity in the anticipated transition, the reform and enhancement of safety nets has often been suggested as a priority. However, raising minimum wages might paradoxically accelerate automation trends, if used indiscriminately. The opportunity to provide a Universal Basic Income (UBI)—in essence providing a regular, unconditional cash grant—which would revamp social welfare programs in a "post-secure-wage society" driven by automation, is now a feature of political agendas on the Left[14] and on the Right.[15], of course with different contours and degrees.

Economists are archly divided on the matter. Proponents, including Thomas Piketty,[16] see UBI as a way of simplifying the current bureaucratic system, and making it more efficient and fair. UBI is seen as a solution to address the looming automation wave, by favoring work as opposed to unemployment, which has been demonstrated to favor dangerous spirals of marginalization. Attacking mainly the "unconditionality" criteria, opponents[17] denounce an excessively radical and unrealistic approach to reforming existing safety nets. They argue that unconditionality could be counter-productive, resulting in increased, not decreased, income inequality. This camp also argues that UBI could potentially de-incentivize work which they also see as a pillar of social integration.

Interestingly, Finland recently announced a UBI experiment this year,[18] which should provide valuable evidence to move the debate forward. An experiment is also on the cards in the Netherlands though, interestingly, the mention of "universal income" has recently been abandoned[19]. In a 2016 referendum, Switzerland rejected, with a 77 percent majority, plans to deploy a monthly $2,555 universal income for all adults.[20]

Besides the UBI, a large variety of more moderate policy options are also on the table. These include strategies to tighten labor markets and pressure wages upward; and the possibility of strengthening workers' collective bargaining power, thus creating new and innovative ways to make workers' voices hear. Such policies aim to rebalance AI-driven concentration, which it is argued could lead to a monopolistic or oligopolistic market. Other available policy options seek a shift in scale rather than in nature of existing societal safety nets. They include the strengthening of existing unemployment insurance schemes to be more targeted or attuned to local environments, or to have their boundaries extended to include, for instance, people who decide on their own to quit their job[21] to pursue training or transition to entrepreneurship. Work-based reform options also include modernizing overtime, employment contracts, with work-sharing programs and temporary work-based training being encouraged[22].

Finally, to make the AI revolution work for everyone, policy-responses will have to find innovative ways to ensure that a more mobile and insecure workforce has fair access to credit as well as healthcare and retirement benefits. Such benefits have been hitherto largely dependent on employers' contributions, either directly or indirectly – with limited portability when people seek professional transitions, or choose to adapt their employment contracts (e.g. including part-time jobs and entrepreneurship). Challenges to existing employment practices will involve systemic policy change.

14 In the recent French Socialist Party primary elections held in January 2017, the large victory of Benoit Hamon has essentially been credited to his ability to bring the progressive deployment of a universal basic income as a his flagship measure. See also Andy Stern and Lee Kravitz, *Raising the Floor: How a Universal Basic Income Can Renew Our Economy and Rebuild the American Dream*, June 2016.

15 Charles Murray, "A guaranteed income for every American", WSJ, June 2016. https://www.wsj.com/articles/a-guaranteed-income-for-every-american-1464969586 ; See also Matt Zwolinsky, « The Libertarian Case for Basic Income », December 2013. https://www.libertarianism.org/columns/libertarian-case-basic-income

16 Provided UBI targets low wages. See « Pour un revenu universel crédible et audacieux », Le Monde, 25 Janvier 2017. http://piketty.blog.lemonde.fr/2017/01/25/pour-un-revenu-universel-credible-et-ambitieux/

17 Jason Furman, "Is this time different? The opportunities and challenges of artificial intelligence," remarks at AI Now: The Social and Economic Implications of Artificial Intelligence Technologies in the Near Term, conference in New York, July 7, 2016.

18 in which 2,000 unemployed people between the ages of 25 and 58 will receive a guaranteed sum – a "basic income" – of €560 a month for two years whether or not they find work. See Sonia Soda, "Is Finland's basic universal income a solution to automation, fewer jobs and lower wages?", Guardian, February 2017. https://www.theguardian.com/society/2017/feb/19/basic-income-finland-low-wages-fewer-jobs?CMP=share_btn_tw

> **"BESIDES THE UBI, A LARGE VARIETY OF MORE MODERATE POLICY OPTIONS ARE ALSO ON THE TABLE. THESE INCLUDE STRATEGIES TO TIGHTEN LABOR MARKETS AND PRESSURE WAGES UPWARD; AND THE POSSIBILITY OF STRENGTHENING WORKERS' COLLECTIVE BARGAINING POWER. OTHER AVAILABLE POLICY OPTIONS INCLUDE THE STRENGTHENING OF EXISTING UNEMPLOYMENT INSURANCE SCHEMES, MODERNIZING OVERTIME, EMPLOYMENT CONTRACTS, ENCOURAGING WORK-SHARING PROGRAMS AND TEMPORARY WORK-BASED TRAINING."**

19 Deployed in 20 Dutch municipalities, the experiment will allow small groups of benefit claimants to be paid $825 a month while continuing to earning what they make from work. See Daniel Boffey, "Dutch city plans to pay citizens a 'basic income', and Greens say it could work in the UK", Guadian, December 2016. https://www.theguardian.com/world/2015/dec/26/dutch-city-utrecht-basic-income-uk-greens

20 See http://www.bbc.com/news/world-europe-36454060

21 That's what French presidential candidate Emmanuel Macron has proposed for instance. See https://www.contrepoints.org/2016/11/13/271472-macron-veut-autoriser-chomage-aux-salaries-demissionnent

22 A more detailed description can be found in the White House report *Artificial intelligence, automation, and the economy*, Executive Office of the President. Ibid. (p. 34-40).

B. THE CASE FOR 21ST CENTURY EDUCATION AND SKILL DEVELOPMENT SYSTEMS

REINVENTING ACTIVE LABOR MARKET PROGRAMS

As we have written above, the wave of automation caused by the AI revolution will displace a very large amount of jobs across domains and value chains. The U.S. "automated vehicle" case study analyzed in the White House 2016 report on *Artificial intelligence, Automation, and the Economy* is emblematic of what's at stake: 2.2 to 3.1 million existing part- and full-time U.S. jobs are exposed[23] over the next two decades, though the timeline remains uncertain. In particular, between 1.3 and 1.7 million heavy truck drivers are threatened. And this is not trivial, for the profession has symbolized in the collective imaginary the manifestation of the American dream of empowerment, liberty and social ascension whereby less-educated people could make it into the middle class[24].

The automation wave calls at least for higher investment and probably the need to reinvent active labor market programs in the coming decades[25]. Such investment should logically be funded by fiscal policies targeting the capital. The 2016 White House report on *Artificial intelligence, Automation, and the Economy* gave an interesting order of magnitude applied to the case of the U.S.: "*increasing funding for job training in the U.S. by six-fold—which would match spending as a percentage of GDP to Germany, but still leave the U.S. far behind other European countries—would enable retraining of an additional 2.5 million people per year*"[26].

AI and other digital technologies offer real potential to innovate new approaches to job-search assistance, placement and hiring processes in the age of personalized services. The efficiency of matching labor supply and demand can be tremendously enhanced by the rise of multi-sided platforms and predictive analytics. The case of platforms such as *LinkedIn* for instance with its 470 million registered users is interesting as an evolution in hiring practices. Tailored counseling and integrated re-training programs also represent promising grounds for innovation.

This, however, won't be enough. A lot will have to be done to create fair and effective life-long skill development/training infrastructure and mechanisms capable of empowering millions of people to viably transition jobs, sectors and potentially geographies – that, too, several times in a lifetime. A lot will also have to be done to address differential geographic impacts which exacerbate income and wealth disparities. Effectively enabling the workforce to be more mobile –both physically, legally and virtually- will be crucial. And this implies of course systemic policy approaches which encompass housing, transportation, licensing, taxes and, crucially in the age of AI, broadband access -especially in rural areas.

To lay solid foundations for this profound transformation, we need more research in at least three complementary areas: first, to devise mechanisms of dynamic mapping of tasks and occupations at risks of automation and associated employment volumes. This mapping of the workforce supply is needed at the macro but also crucially at the micro levels where labor market programs are deployed. Integrated with that, we also need more granular and dynamic mapping of the future jobs/tasks, workplace-structures, associated work-habits, and skill-base spurred by the AI revolution. This mapping of the demand side will be key to innovate, align and synchronize skill development and training programs with future requirements in anticipation, that too on the right timescales. And finally, we need more policy research on the dynamics of professional transitions in different labor market conditions.

To maximize intended impact, create necessary space for trial-and-errors strategies, and to scale up solutions that work, we recommend implementing robust data-driven evidence-based approaches. These approaches should be based on experiments and centered on outcomes in terms of employment but also in terms of earnings. We also recommend exploring new forms of people-public-private partnerships involving civil society as well as new outcome-oriented financial mechanisms such as Social Impact Bonds for instance which could help scale up successful innovations.

A REVOLUTION IN EDUCATION?

Understanding components and drivers of AI-labor complementarity and navigating that evolving understanding nimbly to transform primary, secondary and professional education will be capital in the coming decades. Because of the large impact of the rise of AI on economies and societies, this implies of course for all countries - almost as a sovereignty imperative, the need to invest in developing AI-related workforce. It is needed to support advances in the field of fundamental research, in the engineering, and of course in the applications, business and socio-political aspects. And the field is by definition interdisciplinary with expanding confines towards biology, cognitive and brain science. Because of the central role of data in developing and training machine learning algorithms, boundaries between fundamental research, applied research, engineering

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23 Though the figures exclude new types of jobs that may be developed in the industry. See *Artificial intelligence, automation, and the economy*, Executive Office of the President. Ibid. (p. 15-17)

24 Sean Kilcarr, "Defining the American Dream for trucking ... and the nation, too", *Fleetowner*, April 2017

25 OECD member countries outside of the U.S. spent, on average, 0.6 percent of GDP on active labor market policies in 2014. The U.S. spent just 0.1 percent of GDP, less than half of what it did 30 years ago. OECD, "Labour market programmes: expenditure and participants", *OECD Employment and Labour Market Statistics* (database), 2016. http://stats.oecd.org/viewhtml.aspx?datasetcode=LMPEXP&lang=en#

26 This assumes $6,000 per person training/reemployment cost, and an increase in Workforce Innovation and Opportunity Act funding from today's $3B to $18B, to match Germany's spending as a fraction of GDP, with all new funding spent on training. See *Artificial intelligence, automation, and the economy*, Executive Office of the President. Ibid. (p. 33).

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and higher education are likely to blur[27]. We are already seeing a trend whereby fundamental research in AI is shifting away from universities and government laboratories to the biggest technology companies. Academics worry about what they call a "brain drain"[28] which could damage the quality of public research and education down-the-line.

In the *2016 Economic Report of the President*[29], the White House summarized: "*college- and career-ready skills in math, reading, computer science, and critical thinking are likely to be among the factors in helping workers successfully navigate through unpredictable changes in the future labor market*".

Basic literacy and math will more than ever represent the crucial foundation of employability, especially with the accentuation of skill-based job displacement; as will be the quality of early-education since "catching up" will become more difficult; or the need to generalize access to secondary education which should include proven alternatives such as apprenticeship, creative and vocational training[30]. Diversifying and enhancing STEM curriculum beyond computer science to include computational thinking, data science, creativity, innovation and entrepreneurship also appears to be a required evolution.

But beyond that, education will need to change more profoundly and attract the required talent to develop and diffuse innovatively new pedagogies; including centered on emotional intelligence as well as tapping into the power of personalized learning and affective computing. Innovative public-private-partnership should also be explored to favor the emergence of the most effective learning environments and to incentivize good quality investment at scale. But policy-makers will probably retain a key role to ensure innovation diffusion to most, if not all.

As the "online-to-in-person" learning continuum grows more mature, the contours of teachers' role are also very likely to evolve: from that of content providers towards that of content curators, educators, coaches and mentors able to guide learners along personalized path adapted to labor market needs. Crucially, civic education will also need to evolve to equip future citizens with data and AI literacy as well as adequate understanding of trends and stakes, including related to the governance of AI and other emerging technosciences. As we have seen in this study, the serious ethical and political choices abound regarding how societies will decide to collectively embrace the rise of AI. Forging consensus will not be easy, especially considering how the rise of income, wealth, geographic and opportunity disparities may unravel the social fabric both in developed and in emerging countries.

27 The case of Yann LeCun is emblematic. A pioneer in machine learning, computer vision, mobile robotics and computational neuroscience with a long career in academia in France and in the U.S., he joined Facebook as Director of AI Research in 2013 while retaining his position of Professorship at New York University, and simultaneously starting a research partnership between Facebook and New York University's Center for Data Science. He also convinced Mark Zuckerberg to let him run Facebook AI Research operations from New York City creating a dedicated lab there a few blocks from NYU in addition to the laboratories in Menlo Park CA and London. See https://www.facebook.com/yann.lecun/posts/10151728212367143

28 Richard Waters, "AI academic warns on brain drain to tech groups", *Financial Times*, November 2016. https://www.ft.com/content/298e2ac0-b010-11e6-a37c-f4a01f1b0fa1

29 The White House, Economic Report of the President 2016, Chapter 4.

30 Research in the U.S. suggests that apprenticeship fetches a significant premium at a given skill level—as much as $300,000 over a lifetime. Debbie Reed, et al. An Effectiveness Assessment and Cost-Benefit Analysis of Registered Apprenticeship in 10 States. Mathematica Policy Research, 2012.