Artificial Intelligence and the Future of Work
Congressional Testimony of Erik Brynjolfsson
September 24, 2019

Good afternoon, Chairwoman Johnson, Ranking Member Lucas, Chairwoman Stevens, Ranking Member Baird, and members of the Committee. Thank you for giving me this opportunity to summarize and share some of my research on the implications of AI for the economy. Addressing the opportunities created by AI is one of the most important challenges for the government, for business and for individuals over the coming decade. I'm gratified that this Committee is taking this challenge seriously. While I primarily focus on my own research for this testimony, I will also draw on work by my team at MIT IDE, work by the MIT Work of the Future initiative, the AI Index, many other researchers. These are my own views. I am not speaking for anyone else.

1776 was a remarkable year. The United States declared its independence, creating a new kind of nation. Adam Smith wrote the *Wealth of Nations*, laying the foundations for free enterprise, and James Watt introduced a superior steam engine, igniting the industrial revolution. Our nation, and the world, are immensely freer and wealthier than our ancestors because of these three milestones and the subsequent changes they set in motion.

Today, we are also at a crossroads of history. The people in this room will help us choose the path forward. I will begin my testimony by summarizing some key changes in the underlying technologies, then discuss the implications for work, productivity and the broader economy, and conclude with five policy recommendations.

The biggest drivers of economic growth are advances in technology, specifically general purpose technologies like the steam engine, electricity and computers. These technologies not only have important direct effects, but also enable myriad complementary innovations in technology, business processes and economic organization. The most important general purpose technology of our era is AI. Indeed, it may be the most general of all general purpose technologies because if we can create intelligent machines, we can use that intelligence to solve many other problems.

The most important advances in AI have been in the area called machine learning called deep neural networks or deep learning. Because of insights by researchers like Geoffrey Hinton, Yann LeCun and Yoshua Bengio, these techniques enable machines to learn from data dramatically more effectively than ever before. For instance, in 2010, the best algorithms could recognize and label images on the large Imagenet dataset with barely 70% accuracy. Today, using deep learning techniques, they are about 98% accurate, surpassing human level performance on the same dataset. Similarly, deep learning techniques enable voice recognition systems to understand spoken language well-enough to respond to simple questions or instructions. While they are far from perfect, we are in the midst of the remarkable 10-year period of history where we went from machines not understanding human speech, to machines and humans routinely talking to each other in natural language. Machines now outperform humans in a wide variety of tasks that only humans could do before, from choosing which ads to show when we read an article on the web, to recommending who to hire or lend money to, to reading our medical images and diagnosing our diseases.

The recent advances in machine learning are breath-taking and important. However, it is critical to understand that we are very far from *artificial general intelligence* that is, the kind of AI than spans the full range of human intelligence. Machines learning is now superhuman in many tasks that involving mapping a set of inputs into a set of outputs (e.g. images -> labels, voice recordings -> transcripts; clickstream data -> advertising recommendations; medical data -> diagnoses) but humans outperform machines in most other tasks and we will almost surely continue to do so for decades.

In particular, humans have a big edge in tasks involving creativity, interpersonal skills and emotional intelligence, and physical dexterity. This means we are not in danger of mass unemployment anytime soon. There is no shortage of work that needs to be done in our society that only humans can do. In work I've been doing with Tom Mitchell and Daniel Rock, we've mapped out, in some cases literally, where machine learning technologies will have the biggest impacts. The typical occupation consists of 20-30 distinct task, some of which are much easier for machine learning systems to do than others. Our research shows that few, if any, occupations will be fully automated by the new wave of technologies. At the same time, few, if any, will be unaffected. Instead, most will be transformed. For instance, the job of a typical radiologist consists of 26 distinct tasks, from reading medical images, to consulting with other physicians and experts, to advising and counselling patients. While machine learning has made impressive advances in reading medical images, it is of little use in most of the other tasks done by radiologists. We have used our techniques to predict which occupations will be most affected, as well as which industries, which geographic regions and even which individual firms.

Our research tells us that we face two urgent economic challenges: a lack of productivity growth and too much inequality.

Productivity is what determines the wealth of nations, the success of companies and the living standards of individuals. While advances in technology are the catalyst of productivity growth, that growth is not realized unless and until a cascade of complementary innovations are implemented. For instance, when American factories first electrified, there was negligible productivity growth for the first 30 years. It was only after the first generation of managers retired and a new generation replaced the old "group drive" organization of machinery, which was optimized for steam engines, with the new "unit drive" approach that enable assembly lines that we saw a doubling of productivity. Today, despite impressive improvements in AI, not to mention many other technologies, productivity growth has actually slowed down, from an average of over 2.4% per year between 1995-2005 to less than 1.3% per year since then. The bottleneck is not the technology – though faster advances certainly wouldn't hurt – but rather a lack of complementary process innovation, workforce reskilling and business dynamism. Simply plugging in new technologies without changing business organization and workforce skills is like paving the cow paths. It leaves the real benefits largely untapped. However, by making complementary investments, we can speed up productivity growth. In this way, the economic pie will be bigger, giving us trillions of dollars of additional resources to address challenges in healthcare, the environment, poverty, national security and overall economic well-being.

While productivity is important, it isn't everything. There is no economic law that says that everyone will benefit from technological advances or productivity growth. As the economic pie grows, it is possible for some people to be left behind, even as others benefit disproportionately. For the first two centuries since 1776, that was not the case. Most

Americans benefitted as we created an economic system that generated shared prosperity. But over the past several decades, the benefits of economic growth have been much more unequal. Not only has median income barely grown since the late 1990s, but other social indictors, have worsened. Deaths from despair, namely suicide, drug addiction and suicide, are skyrocketing, particularly among Americans with a high school education or less. And for the first time in history, average life expectance of Americans has begun to fall, again driving by worse mortality of less educated Americans. It's no coincidence that these are exactly the Americans who haven't shared in our economic growth, as technologies automate many of the tasks they once did. As a society, we haven't helped them develop the new skills needed to thrive in an increasingly technological economy, or updated our organizations to put their skills to effective use.

What does the future hold? That depends almost entirely on our choices, including the choices made in Congress.

My policy recommendations can be grouped into five key areas.

1. <u>Reinvent education.</u>
   This is not the first time America has faced a challenge from powerful new general purpose technologies. In the early 1800s, nearly 90% of Americans worked in agriculture, by the end of that century it was only 42%. The former farmers didn't simply become unemployed. Instead they were redeployed. They went into manufacturing and services, driving productivity and growth. A big reason that transition was successful was that America led the world in education, first via primary schools and later high schools. This created not only world-leading prosperity, but also one of most equal societies on the planet, with extensive upward mobility.

   Today, we need a similar commitment to education. It won't be enough to simply invest more in human capital, although we should surely do that. We must also reinvent education to focus on the types of skills that machines can't match. As noted above, these include creativity (in science, the arts, entrepreneurship and beyond) as well as interpersonal skills (leadership, teamwork, persuasion, caring, coaching, etc.). The skills needed are not just hard skills, like software coding and STEM, but also the softer skills, from the arts, to social work, to entrepreneurship. My experience is that both hard skills and soft skills can be nurtured by the right environment and curricula.

   This transformation can and must be done not only in K-12 schools, but also through an expanded commitment to vocational education, our colleges and universities, graduate education and life-long learning. Online education is also part of the solution, not simply via MOOCs, but also via embracing the "experiment and test" philosophy that enables so many technology firms to rapidly iterate and improve their offerings. The same philosophy needs to be brought to education.

2. <u>Rebalance capital and labor</u>
   As noted in the recent report by the MIT Work of the Future initiative, of which I'm a member, our tax code and other policies are heavily skewed toward capital at the

expense of labor. As the share of GDP that goes to labor continues to fall, we must create a more level playing field, particularly as AI starts to affect more and more of the labor force. This means taxing capital and labor at comparable rates, encouraging investments in human capital just as we do for physical capital, and updating corporate governance to recognized workers as stakeholders alongside stockholders. We can also expand the earned income tax credit to boost incomes for the working poor and use revenues from carbon taxes and other Pigouvian taxes to lower taxes on work and create a carbon dividend.

3. <u>Invest in US technology leadership</u>
The US has long been a leader not just in AI, but in a broad swath of technologies. That technological leadership is at serious risk because even as we have cut federal investment in R&D, other nations have boosted theirs. Data from the AI Index, where I serve on the steering committee, documents a host of metrics that show the falling share of research being done in the US. Federal science agencies, working with our leading universities and private industry, have a central role in maintaining and extending America's science and technology leadership in AI. In particular, my MIT colleagues Jon Gruber and Simon Johnson have put forth a compelling plan for *Jumpstarting America* that not only extends our pre-eminence but also shares the benefits from innovation more widely.

4. <u>Welcome High Skill Immigrants</u>
A vastly disproportionate of America's leaders in science and business are immigrants or the children of immigrants. This reflect the fact that the US has long been a magnet for talent and a place where that talent could flourish. Sadly, that strength is being severely undercut by our recent immigration policies. When I asked my students at MIT what was the most important message I should being to Washington regarding AI policy, they unanimously advised me to push for less restrictive immigration policies. Every international student I spoke to, whether undergraduate, graduate or post-doc, as well as most of my foreign-born faculty colleagues, had harrowing stories to tell of difficulties they have add with our immigration and visa process. These have prevented them from attending conferences, participating in research projects and in far too many cases, led them to move to Canada, Europe, India, China or other nations to continue their research, rather than the US. A more welcoming immigration policy, especially for top talent, would not only be a huge boost for the US, but also good for the world, since it would make it easier for the best minds to work together.

5. <u>Support Entrepreneurship</u>
While stories of technology-driven entrepreneurship are common in the media, the data tell a different story: as documented by John Haltiwanger, Steven Davis and many others, new business formation is down, fewer people are working in young firms, economic and geographic mobility is down and almost every measure of business dynamism has declined over the past 20 years. This has hindered new technologies from being translated into new products and service that benefit the economy. Boosting entrepreneurship will help reverse the stagnation of wages for the bottom half of the income distribution, particularly those groups who have been

most adversely affected by automation. This is not because everyone should become an entrepreneur or gig worker but because it's the core function of entrepreneurs to invent the new goods, services, companies and jobs that supplant the previous types of work that are being automated. Among the policies that can help with this is a reform of occupational licensing, decoupling of healthcare from employment, and direct investments in teaching entrepreneurship and boosting new business formation.

Artificial Intelligence is the most transformative technology of our era. It has begun to affect many specific tasks, but its biggest impacts are still ahead. AI creates enormous opportunities for boosting productivity. But the key to unlocking these benefits is not merely more or better technology investment, but also investment in the intangible complements, including new skills, new organizational processes and new business models. As powerful and pervasive as AI will be, we are not facing the imminent end of work or mass unemployment. Instead, we are witnessing a growing inequality and disruption as many tasks, disproportionately those done by lower wage workers, are affected by the technology.

With the right policies, we can harness the power of AI. With the right policies, particularly in reinventing education, rebalancing capital and labor, investing in US technological leadership, welcoming immigrants and boosting entrepreneurship we can create a economy that creates not only prosperity but shared prosperity. With the right polices, the next decade can be the best decade in US history since 1776.

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