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MACHINES, ARTIFICIAL INTELLIGENCE, AND THE WORKFORCE: RECOVERING AND READYING OUR ECONOMY FOR THE FUTURE

HEARING

BEFORE THE

COMMITTEE ON THE BUDGET
HOUSE OF REPRESENTATIVES

ONE HUNDRED SIXTEENTH CONGRESS

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MACHINES, ARTIFICIAL INTELLIGENCE, AND THE WORKFORCE: RECOVERING AND READYING OUR ECONOMY FOR THE FUTURE

THURSDAY, SEPTEMBER 10, 2020

HOUSE OF REPRESENTATIVES,
COMMITTEE ON THE BUDGET,
Washington, D.C.

The Committee met, pursuant to notice, at 1:04 p.m., via Webex, Hon. John A. Yarmuth [Chairman of the Committee] presiding.

Present: Representatives Yarmuth, Boyle, Schakowsky, Kildee, Panetta, Morelle, Scott, Jackson Lee, Sires, Khanna; Womack, Woodall, Johnson, Flores, Hern, Burchett, and Jacobs.

Chairman YARMUTH. This hearing will come to order. Good afternoon and welcome to the Budget Committee's hearing on Machines, Artificial Intelligence, and the Workforce: Recovering and Readying Our Economy for the Future.

Before we begin, I want to welcome the newest Member of the Budget Committee, Chris Jacobs. Welcome, Chris. Before coming to Congress, Chris was a New York State Senator, and the Committee is happy to have you here.

Mr. JACOBS. Thank you.

Chairman YARMUTH. Now before I welcome our witnesses, I will go over a few housekeeping matters.

At the outset, I ask unanimous consent that the Chair be authorized to declare a recess at any time to address technical difficulties that may arise with such remote proceedings.

Without objection, so ordered.

As a reminder, we are holding this hearing virtually in compliance with the regulations for committee proceedings pursuant to House Resolution 965. First consistent with regulations, the Chair, or staff designated by the Chair, may mute participants' microphones when they are not under recognition for the purpose of eliminating inadvertent background noise.

Members are responsible for unmuting themselves when they seek recognition or when they are recognized for their five minutes. We are not permitted to unmute Members unless they explicitly request assistance. If I notice that you have not unmuted yourself, I will ask you if you would like the staff to unmute you. If you indicate approval by nodding, staff will unmute your microphone. They will not unmute you under any other circumstances.

Second, Members must have their cameras on throughout this proceeding and must be visible on screen in order to be recognized. As a reminder, Members may not participate in more than one

committee proceeding simultaneously. For those Members not wanting to wear a mask, the House rules provide a way to participate remotely from your office without being physically present in the hearing room.

Now, I will introduce our witnesses.

This afternoon we will be hearing from Dr. Susan Athey, Economics of Technology Professor at Stanford Graduate School of Business, and Associate Director at the Stanford Institute for Human Centered Artificial Intelligence.

Dr. Daron Acemoglu, Institute Professor of Economics at the Massachusetts Institute of Technology.

Dr. Darrell West, Vice President and Director of Governance Studies at the Brookings Institution.

And Dr. Jason Matheny, Director for the Center For Security and Emerging Technology at Georgetown University and Commissioner for the National Security Commission on Artificial Intelligence, who I might add has just informed me he is from Louisville, Kentucky, so we are especially glad to have him here with us.

Thank you all for being with us today.

I will now yield myself five minutes for an opening statement.

This year Labor Day felt different than previous years. While most of us still honored our workers and celebrated their vital contributions to our nation, especially our frontline workers, we also recognize the hardships faced by millions of laid off Americans and their families struggling to get by amid global pandemic and the worst economic downturn since the Great Depression.

Yet these twin crises have amplified problems that existed long before the coronavirus: devastating healthcare inequities, the loss of stable well-paying jobs, and stagnating wages. While our economy has slowed, exacerbating these underlying issues, technological change has marched on creating even more challenges.

As we look to the future artificial intelligence, or AI, has significant potential to disrupt the world. It presents opportunities to improve lives, livelihoods, productivity, and equality. However, it also poses serious risks of large scale economic changes.

Today's hearing will help us ground our thinking in facts and better prepare for this impending economic transition.

Like the arrival of the steam engine, electricity, and computers, AI will reshape a broad swath of industries and jobs. However, history shows us that while technological advancements can create new jobs that increase productivity and growth, these benefits have been paired with the elimination of old jobs and increased inequality as some workers are left behind.

Today we are losing jobs because the administration's failed response to the pandemic and economic crisis, but as the economy eventually recovers, workers may find it difficult to get their job back as companies replace jobs with new AI enabled automation.

So while advancements in AI technologies could create more opportunities for workers with advanced education or specialized skills, workers without these skills could see fewer opportunities in the near future, and it is low and middle waged jobs that are most at risk.

Since the mid–1980's, but prior to the pandemic, 88 percent of middle skilled job losses associated with the automation of routine

tasks took place within 12 months of a recession. Absent concerted efforts to foster inclusive recovery, AI and automation could exacerbate income inequality, widen racial and gender income gaps, and push more people into poverty when we eventually emerge from this recession.

There is already a large and persistent racial wealth gap in America. And since Black and Latino Americans are over represented in occupations at high risk for automation, they are disproportionately at risk of job and wage losses. Additionally, there are 40 percent more women than men who work in occupations at high risk for automation.

The Organization for Economic Cooperation and Development estimates that AI and automation could eliminate upwards of 14 percent of today's jobs and disrupt an additional 32 percent.

Current AI technologies have also raised concerns around replicating human biases and discrimination in algorithms. Given the range of AI applications emerging in employment, housing, healthcare, financial services, and criminal justice, improved transparency and oversight are needed to ensure AI tools do not replicate or expand discriminatory practices.

Just like previous technological breakthroughs, AI will broadly impact the federal budget. Along with IT modernization, AI can directly improve the efficiency and effectiveness of government operations leading to savings.

With the industry set to generate additional economic activity of up to $13 trillion worldwide by 2030, Federal R&D investments will remain essential to U.S. leadership and competitiveness in AI technology. However, the benefits will only be available to all Americans if paired with strategic investments to support our workforce through this impending evolution.

The pandemic and economic crisis have already shown that income security and related programs are crucial for supporting Americans during challenging times. The shifting job landscape expected with widespread AI implementation could further demonstrate this need. This will require strong federal investments and social programs and affordable healthcare, childcare, and housing, as well as new approaches for retraining and upskilling our workforce.

IBM estimates that between 2019 and 2022, more than 120 million workers in the world's 12 largest economies may need to be retrained and reskilled as a result of AI-enabled automation. If we fail to plan ahead, the underlying problems illuminated by the pandemic and recession will continue to create barriers to success for American workers.

We have a responsibility to get Americans through the COVID crisis, but we also must address the long-term economic challenges we know are coming. These issues are complicated and nuanced, but that is why we are here today. With the help of our expert witnesses, we can begin to chart a path forward that leads to inclusive economic growth, broad social benefits, and a better prepared workforce.

I look forward to learning more about the magnitude of the potential changes to our economy and job market and the federal policies that will be needed in response.

I now yield five minutes to the Ranking Member, Mr. Womack, of Arkansas.

[The prepared statement of Chairman Yarmuth follows:]

Chairman John A. Yarmuth
Hearing on Machines, Artificial Intelligence, & the Workforce:
Recovering & Readying Our Economy for the Future
Opening Statement
September 10, 2020

This year, Labor Day felt very different than previous years. While most of us still honored our workers and celebrated their vital contributions to our nation – especially our frontline workers – we also recognized the hardships faced by millions of laid-off Americans and their families, struggling to get by amid a global pandemic and the worst economic downturn since the Great Depression.

Yet these twin crises have amplified problems that existed long before the coronavirus: devastating health care inequities, the loss of stable, well-paying jobs, and stagnating wages. While our economy has slowed – exacerbating these underlying issues – technological change has marched on, creating even more challenges.

As we look to the future, artificial intelligence (or AI) has significant potential to disrupt the world. It presents opportunities to improve lives, livelihoods, productivity, and equality. However, it also poses serious risks of large-scale economic changes. Today's hearing will help us ground our thinking in facts and better prepare for this impending economic transition.

Like the arrival of the steam engine, electricity, and computers, AI will reshape a broad swath of industries and jobs. However, history shows us that while technological advancements can create new jobs and increase productivity and growth, these benefits have been paired with the elimination of old jobs and increased inequality as some workers are left behind.

Today we are losing jobs because of the Administration's failed response to the pandemic and economic crisis. But as the economy eventually recovers, workers may find it difficult to get their job back as companies replace jobs with new AI-enabled automation. So, while advancements in AI technologies could create more opportunities for workers with advanced education or specialized skills, workers without these skills could see fewer opportunities in the near future. And it's low- and middle-wage jobs that are most at risk.

Since the mid-1980s, but prior to the pandemic, 88 percent of middle-skill job losses – associated with the automation of routine tasks – took place within 12 months of a recession. Absent concerted efforts to foster an inclusive recovery, AI and automation could exacerbate income inequality, widen racial and gender income gaps, and push more people into poverty when we eventually emerge from this recession. There is already a large and persistent racial wealth gap in America, and, since Black and Latino Americans are overrepresented in occupations at high risk for automation, they are disproportionately at risk of job and wage losses. Additionally, there are 40 percent more women than men who work in occupations at high risk for automation. The Organisation for Economic Co-operation and Development (OECD) estimates that AI and automation could eliminate upwards of 14 percent of today's jobs and disrupt an additional 32 percent.

Current AI technologies have also raised concerns around replicating human biases and discrimination in algorithms. Given the range of AI applications emerging in employment, housing, health care, financial

services, and criminal justice, improved transparency and oversight are needed to ensure AI tools do not replicate or expand discriminatory practices.

Just like previous technological breakthroughs, AI will broadly impact the federal budget. Along with IT modernization, AI can directly improve the efficiency and effectiveness of government operations, leading to savings. With the industry set to generate additional economic activity of up to $13 trillion worldwide by 2030, federal R&D investments will remain essential to U.S. leadership and competitiveness in AI technology. However, the benefits will only be available to all Americans if paired with strategic investments to support our workforce through this impending evolution.

The pandemic and economic crisis have already shown that income security and related programs are crucial for supporting Americans during challenging times. The shifting job landscape expected with widespread AI implementation further demonstrates this need. This will require strong federal investments in social programs, in affordable health care, child care, and housing, as well as new approaches for retraining and upskilling our workforce. IBM estimates that between 2019 and 2022, more than 120 million workers in the world's 12 largest economies may need to be retrained and reskilled as a result of AI-enabled automation.

If we fail to plan ahead, the underlying problems illuminated by the pandemic and recession will continue to create barriers to success for American workers. We have a responsibility to get Americans through the COVID crises, but we also must address the long-term economic challenges we know are coming.

These issues are complicated and nuanced, but that's why we are here today. With the help of our expert witnesses, we can begin to chart a path forward that leads to inclusive economic growth, broad societal benefits, and a better-prepared workforce. I look forward to learning more about the magnitude of the potential changes to our economy and job market, and the federal policies that will be needed in response.

Mr. WOMACK. And I thank the Chairman for holding this hearing and my thanks to the witnesses who will be with us today.

I would like to also add my bit of welcome to Chris Jacobs, the newest Member of the Committee, native of Buffalo, New York. Long history of public service, Erie County clerk, state Senator now joining us as a Member of Congress. This isn't his first tour of duty at the Capitol. He began his career working for former Congressman and Buffalo Bill quarterback Jack Kemp.

Chris, welcome to the Budget Committee. To your wife and daughter, Martina and Anna, thank you for allowing your husband and father to continue his public service career by spending time in Washington with all of us. Chris, we welcome you to the Committee.

We are here to talk about AI capabilities, both current and future, and the impacts on the economy and the federal budget. It is a critical technology to be sure that will benefit the lives of many Americans and touch nearly every sector of the U.S. economy. While it will likely change the way many jobs are performed as technological advances have for many decades, we must harness the capabilities of AI to help drive our economy and society forward.

Congress has to ensure that its actions do not stifle innovation, rather government should work in partnership with the private sector to move our country forward in AI research and development.

By making strategic federal investments in AI R&D, Washington can help unleash America's pioneering and entrepreneurial spirit. It also means creating a regulatory environment that supports, not hinders, private industry by allowing technological advancements to flourish in a safe, trustworthy, and effective way. Congress should also move to encourage more American high-tech manufacturing in general.

The U.S. currently relies on countries located in geopolitical hot spots for many critical components and as the coronavirus pandemic has shown with medical supplies, we need to ensure we have reliable, secure, and diverse supply chains for vital materials.

Now while this is an interesting, important topic, it should not be the reason why the Budget Committee is convening this afternoon, in my strong opinion.

The dire fiscal outlook—notably the recent deficit and debt projections—and the discussion on how to tackle these challenges should be the focus of today's Committee meeting. Last week the Congressional Budget Office released its budget outlook update, and let me tell you the findings are incredibly sobering, but not surprising.

We did not do our job when this pandemic—before the pandemic hit. This Committee is charged with writing a budget to put our country on a responsible fiscal path, but we failed in that duty. Once COVID hit, we were obligated to respond to the crisis. For those of you who don't know, let me summarize where our nation stands fiscally. And let me just warn you, it isn't good.

The deficit for fiscal 2020 is protected to be $3.3 trillion, more than triple the previous year's deficit and by far the highest in American history. Every single year for the next 10 years, CBO is

projecting that annual deficits will exceed a trillion dollars and total $13 trillion over this period.

The public debt is projected to be larger than the size of the entire economy by next year, that is 104 percent of GDP, and will continue to increase to more than $33 trillion by fiscal 2030. That is 109 percent of projected GDP. Once again, CBO confirmed the driver of the fiscal problem, federal spending, particularly mandatory spending.

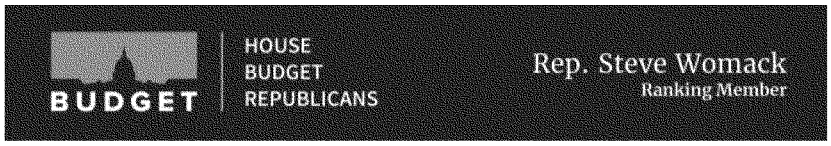
Mandatory spending, including interest payments on the debt is expected to account for 75 percent of total federal spending by 2030. And I don't need to be the guy to tell you, you already know. That is squeezing resources for many discretionary priorities. The job of this Committee is to write a budget resolution that sets a fiscal path for the government to follow. We didn't write one. We don't have one. Instead of considering a budget resolution, we are talking about artificial intelligence, which is, as I mentioned before, while an interesting topic and an important topic, it is not the mandate of this Committee.

The Democrat majority has neglected to do a budget resolution for the past two years. CBO's projections illustrate the necessity for the Democrat majority to do its job—write and pass a budget resolution that provides a responsible, fiscal framework to correct this current, fiscal trajectory.

With that, I look forward to hearing from our witnesses, and always look forward to the discussion. Thank you, Mr. Chairman.

I will yield back the balance of my time.

[The prepared statement of Steve Womack follows:]



Ranking Member Steve Womack (R-AR-3) Opening Statement

Hearing: *"Machines, Artificial Intelligence, & the Workforce: Recovering & Readying Our Economy for the Future"*

September 10, 2020

(Remarks as Prepared for Delivery)

Thank you, Chairman Yarmuth, for holding this hearing, and thank you to our witnesses for joining us today.

I would like to welcome one more person – Representative Chris Jacobs, the newest member of the Committee. A native of Buffalo, New York, Chris has a long history of public service – as Erie County Clerk, a state senator, and now joining us as a Member of Congress. This isn't his first tour of duty in the Capitol. He began his career working for former Congressman - and Buffalo Bills quarterback - Jack Kemp. Chris – welcome to the Budget Committee. And to your wife and daughter, Martina and Anna, thank you for allowing your husband and father to continue his public service career by spending time in Washington. Chris, welcome.

We are here today to talk about artificial intelligence (AI) capabilities – both current and future – and the impacts on the economy and federal budget.

AI is a critical technology that will benefit the lives of many Americans, and touch nearly every sector of the U.S. economy. While it will likely change the way many jobs are performed, as technological advances have for many decades, we must harness the capabilities of AI to help drive our economy and society forward. Congress must ensure that its actions do not stifle innovation. Rather, government should work in partnership with the private sector to move our country forward in AI research and development (R&D).

By making strategic federal investments in AI R&D, Washington can help unleash America's pioneering and entrepreneurial spirit. This also means creating a regulatory environment that supports – not hinders – private industry by allowing technological advancements to flourish in a safe, trustworthy, and effective way.

Congress should also move to encourage more American high-tech manufacturing in general. The U.S. currently relies on countries located in geopolitical hotspots for many critical components, and as the coronavirus pandemic has shown with medical supplies, we need to ensure we have reliable, secure, and diverse supply chains for vital materials.

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surprising. We did not do our job before the pandemic hit. This Committee is charged with writing a budget to put our country on a responsible fiscal path. We failed that duty. Once COVID-19 hit, we were obligated to respond to the crisis. For those of you who don't know, let me summarize where our nation stands fiscally. It isn't good.

The deficit for fiscal year 2020 is projected to be $3.3 trillion, more than triple the previous year's deficit and by far the highest in American history. Every single year, for the next 10 years, CBO is projecting that annual deficits will exceed one trillion dollars and total $13 trillion over the period. The public debt is projected to be larger than the size of the entire economy by next year (104 percent of GDP) and will continue to increase to more than $33 trillion by fiscal year 2030 (109 percent of GDP). Once again, CBO confirmed the driver of the fiscal problem: federal spending, particularly mandatory spending. Mandatory spending, including interest payments on the federal debt, is expected to account for 75 percent of total federal spending by 2030, squeezing out resources for important discretionary priorities, including investments in AI.

The job of this Committee is to write a budget resolution that sets a fiscal path for the government to follow. We didn't write one; we don't have one. Instead of considering a budget resolution, we are talking about artificial intelligence, which, as I mentioned before, while an interesting topic, is not the mandate for this Committee. The Democrat Majority has neglected to do a budget resolution for the past two years. CBO's projections illustrate the necessity for the Democrat Majority to do its job: write and pass a budget resolution that provides a responsible fiscal framework to correct the current trajectory.

With that, I look forward to hearing from our witnesses, and I look forward to today's discussion. Thank you, Mr. Chairman. I yield back.

Mr. WOMACK. Chairman, you'll need to unmute, I think.

Chairman YARMUTH. Thank you. Should be up to that by now.

In the interest of time, once again, if any additional Member has an opening statement, you may submit those statements electronically to the Clerk for the record.

Once again, I want to thank our witnesses for being here this afternoon. The Committee has received your written statements and they will be made a part of the formal hearing record. Each of you will have five minutes to give your oral remarks. As a reminder, please unmute your microphone before speaking.

I now introduce and yield five minutes to Dr. Susan Athey. Please unmute your mike and begin when you are ready.

STATEMENTS OF SUSAN ATHEY, PH.D., ECONOMICS OF TECHNOLOGY PROFESSOR, STANFORD GRADUATE SCHOOL OF BUSINESS, AND ASSOCIATE DIRECTOR, STANFORD INSTITUTE FOR HUMAN-CENTERED ARTIFICIAL INTELLIGENCE (HAI); DARON ACEMOGLU, PH.D., INSTITUTE PROFESSOR OF ECONOMICS, MASSACHUSETTS INSTITUTE OF TECHNOLOGY; DARRELL WEST, PH.D., VICE PRESIDENT AND DIRECTOR OF GOVERNANCE STUDIES, BROOKINGS INSTITUTION; JASON MATHENY, PH.D., FOUNDING DIRECTOR, CENTER FOR SECURITY AND EMERGING TECHNOLOGY AT GEORGETOWN UNIVERSITY, AND COMMISSIONER, NATIONAL SECURITY COMMISSION ON ARTIFICIAL INTELLIGENCE

STATEMENT OF SUSAN ATHEY, PH.D.

Dr. ATHEY. Hello, Chairman Yarmuth, Ranking Member Womack, and Members of the Committee. Thank you so much for inviting me to speak today.

Artificial intelligence seems to inspire extreme views. Some focus on a future where robots take all the jobs, while others point out that so far its effects on the economy are barely detectable. My own view is that AI has enormous positive potential for society and for the efficiency and finances of government, and that governments and universities have a crucial role to play in ensuring that the potential is realized.

AI, of course, also creates challenges, contributing to an era where workers transition more frequently and require more reskilling throughout their careers. So we need to ensure that our institutions are prepared to meet this reality, especially in light of the many fiscal and labor market challenges created by an aging population and workforce. But when R&D is directed at technology that augments human workers and support citizens in their lives and health, we may be able to expand the circumstances in which people engage in rewarding work while experiencing a high-quality of life in areas with a more moderate cost of living.

Some of the most promising areas where technology can be part of the solution include education, training, remote work, medicine, and government services. In each case, digital technology powered by AI can be used to make services cheaper to provide, higher quality, more tailored to the individual need, and substantially more accessible and convenient.

The accessibility matters particularly to people with limited time, like working people with caregiving responsibilities and especially rural residents who face a dual burden of high transportation costs and insufficient density to support specialized services and job opportunities in their local communities.

One reason the potential is so great for these problems is that digitization and the adoption of AI can lead to low marginal cost scalable and thus more efficient services.

Digitization and AI are inextricably linked to measurement and optimization, which naturally improves the accountability and effectiveness of the organizations who adopt them, including the government. In addition, general trends that have led to the rapid diffusion of AI relate to the lowered fixed cost in time required to adopt it.

One trend is just a digitization of everything from consumer interactions to supply chains. That creation of data is what powers and makes possible AI to be an optimization. The way IT is implemented has also changed. Cloud computing allows companies to rent computing as they need it rather than buy allowing infrastructure to be shared across firms and that reduces cost.

Software as a service lets companies subscribe to services and purchase the best products use case by use case and that software as a service then can also make available AI and machine learning innovation without firms having to do that R&D themselves.

Finally, we have seen a big expansion of open source software and, in general, data management analytics tools are widely available. They are shared across firms and across academia, and thus diffuse very quickly. The latest machine learning algorithms are typically free. For example, for my class we used algorithms that we downloaded that were trained using Facebook's image data setting computing infrastructure allowing the students to move on to the analytics on top of the image recognition.

The reason that firms are willing to share those types of algorithms is that it is customer relationships and data, as well as know-how to optimize the algorithms at large scale that give companies their competitive advantage.

And the general purpose technologies in algorithms have actually been fairly widely available. That means the cost of developing services is reduced as these general purpose innovation from academia and for-profit organizations can be repurposed by entrepreneurs, governments, and social impact organizations.

Now an important precursor to a policy discussion is demystifying the technology. In practice, rather than sort of general intelligence, most of what we have seen in the past 15 years can be thought of as more automation on steroids. For software, automation is like following prespecified rules without real-time human direction, but the latest innovations have concerned implementing automation using decision rules that are learned from past data using machine learning.

And a common example of machine learning and algorithm might take as input a digital photo and output a guess of what animal is in the photo.

Traditionally, analysts had to do a lot of manual work to customize the statistical models so the models were simplified, but

modern machine learning allows the analyst to just feed in raw data and the algorithm does a lot of work to determine what is important for the task. This makes things general purpose, but the fact that they are general purpose also means they are black boxed and sometimes even the engineers building them don't understand them. Thus we need a lot more research and best practices to make sure that this technology is implemented safely and without unintended consequences.

Just to close, machine learning is diffusing across the economy use case by use case, but in most cases, this has led to an incremental innovation and incremental changes over time rather than sudden shifts.

So I look forward to continuing the discussion in the question and answer. Thank you.

[The prepared statement of Susan Athey follows:]

Susan Athey

The Economics of Technology Professor, Stanford Graduate School of Business

Written Testimony

House Committee on the Budget

Hearing on Machines, Artificial Intelligence, & the Workforce: Recovering & Readying Our Economy for the Future

September 10, 2020

Chairman Yarmuth, Ranking Member Womack and Members of the Committee,

Thank you for inviting me to speak today. Artificial intelligence (AI) seems to inspire extreme views among policy analysts: some focus on a future where robots take all the jobs, while others argue that its effect will be no different than previous rounds of technological innovation. My own view is that AI has enormous positive potential that should not be ignored, and that governments and universities have a crucial role to play in ensuring that the potential is realized. At the same time, it will create some challenges, contributing to an era where workers transition more frequently and require more ongoing training and reskilling throughout their careers. If we invest carefully in making technology and innovation part of the solution, AI can achieve its potential and even contribute to addressing a variety of societal and fiscal challenges that loom before us.

An important precursor to a policy discussion about AI is a grounding in the technology, including a clear framework for understanding what it can and cannot do. Once AI is demystified, it is easier to assess its potential for impact, both positive and negative, as well as to interpret the data we have so far about how it affects the economy.

Artificial Intelligence, Automation and Software

Ideally, artificial intelligence refers to intelligent machines, where by "intelligent" we mean truly smart, for example capable of reasoning. In practice, most of what we've seen in the past fifteen years, and what I believe we will continue to see in the near future, can be better

thought of as "automation on steroids." Thinking in terms of automation can guide the discussion in a more realistic direction, and also helps remind us of the limitations of AI.

Traditional automation in turn refers to physical machines or software that follow pre-specified rules or routines for interacting with its environment without real-time human direction.

One kind of automation that has expanded dramatically over the last few decades consists of a set of rules conceived of and written by humans, and executed by software. An automated telephone system that requires you to choose from a series of menus is a simple example of this; these systems evolved from phones, to websites, and more recently to chatbots. However, more complex systems have also been programmed using human-specified rules; some of the earliest self-driving cars encoded in software a set of scenarios and correct responses. Many educational technology applications that advertise their ability adapt to the level of the student simply specify what the next learning exercise should be as a function ofthe student's answers to previous questions using a large decision tree created manually by human experts (Golub Capital Social Impact Lab, 2020).

Although most people wouldn't consider a phone menu either inspiring or enjoyable, over time, automation through websites and apps have created substantial customer value and saved consumers large amounts of time and money. Being able to check a bank balance quickly on the go can prevent an overdraft fee; and when airlines finally adopted technology to pull up your flight information based on your mobile phone number, it made it much faster to make last-minute changes to a travel itinerary. Although it can be frustrating to deal with pre-specified menus when you have a non-standard request, a well-designed automated system can allow consumers to get their needs met quickly, and on their own time, which may be especially important for people working long hours or for working parents. As more and more services digitize, we expect that a larger share of services directly provided by government or indirectly funded by government will be accessed through automated systems.

This automation, while not sexy, can have an impact on employment. As more people have mobile phones and learn to use bank mobile apps for more and more functions, there is less need for a bank branch or call center with human beings available to answer questions. Indeed, Totty (2020) documented that bank teller employment declined by 26% in the last decade, from 600,000 jobs in 2010 to about 442,000 in 2019, while the Bureau of Labor Statistics projects a further decline of 15 percent between 2019 and 2029 (BLS, 2019). Numerous analysts have predicted large declines in financial services employment in the near future, including not just front-line workers but also back-office workers whose jobs involve relatively routine information processing (Kelly, 2019).

This type of automation has increased substantially over the last decade, but much of the change is not directly due to advances in artificial intelligence. Instead, in my view the most impactful changes have resulted from an expansion of digitization of interactions and recording of digital data.

As firms interact with customers digitally, use software to manage supply chains, GPS to track locations, and have digital recordings of many processes, it becomes natural for them to use software to manage the data. There is an evolution through the steps of digitization, using software to automate and process data, to more sophisticated optimization of digital processes and machine learning from data. Although sometimes firms take several steps simultaneously, it is more common to evolve slowly through these steps.

Alongside digitization, some other important trends include the rise of cloud-based services (where according to analysts the global cloud computing market increased from under $1 billion to several hundred billion dollars annually over a single decade, and today provides services to the vast majority of businesses.) The U.S. leads the world in both supply of cloud computing services and in adoption (IDC, 2019). Software as a service replaced the need for company-owned computers and specialized software to do things like manage email, customer databases, and call centers.

Even technology firms often adopt "software as a service" solutions for many purposes rather than building their own applications. This can be efficient, as software development is done once by a specialized team of developers and then used across many organizations. It is also increasingly common for different software products to interact and share data through application programming interfaces (APIs), allowing for more of a "plug and play" environment and enabling firms to take advantage of the best software for each need. This in turn makes it easier for firms to enter in both the technology and non-technology sectors, as they can purchase the products they need off-the-shelf and scale their usage as they grow. This can reduce costs associated with functions ranging from email to human resources to accounting to marketing and sales; it can also position governments and firms to more easily take advantage of innovations in AI.

Artificial Intelligence and Machine Learning

The largest innovations in AI in the past decade have concerned automation using decision rules learned from data, rather than human-specified rules. This is called machine learning. For an educational application, machine learning might be used to learn what types of reading material to recommend to a student based on past reading. With machine learning, an algorithm takes data as input and performs tasks such as prediction and classification.

For example, an analyst building a machine learning algorithm might feed in "training data" consisting of digital files that represent photos together with the corresponding labels for the photos such as "cat" and "dog." Once trained, the algorithm will take as input an unlabelled photo and output its best guess of the label (that is, its guess of whether the photo is a cat or a dog). Or, an algorithm might take in data about patients in a hospital from their electronic medical records, and output a predicted probability of death for each patient or the predicted

number of days each patient will stay, predictions that can be important in a time of scarce hospital capacity, as in the COVID-19 pandemic.

Scientists and industry practitioners have built models like this for many decades, for applications like predicting the probability that a consumer will repay a loan. However, traditionally, the analyst had to do a lot of work to determine which variables were most important, and models were often overly simplified. Recent advances in machine learning allow the analyst to just feed in raw data, and the algorithm does a lot of the work to make sense of the data. In other words, the newer tools figure out what is important from the data, and then use the important factors to make predictions. This allows the same general purpose tools to be used across a wide range of applications. These tools work best when there is plenty of data, as well as a stable environment, so that the model's performance in the future is well approximated by how well it performs on a set of held out "test data" that is hidden from the analyst when building the model.

The fact that the algorithms take over a lot of the work of refining statistical models implies that algorithms can be very "general purpose," meaning that the same general approaches can be applied to a wide range of settings (see, e.g. Agarwal, Gans, and Goldfarb (2018) or Brynjolfsson, Rock, and Syverson (2020) for further discussion of this). For this reason, we have seen a rapid diffusion of machine learning across industries and applications.

At the same time, the fact that the algorithms are general purpose and emerge from data also create weaknesses. For example, the models can be difficult to interpret and understand without substantial additional effort and analysis; they are "black boxes" that translate input into output, making it challenging for even the engineers who build them to identify potential weaknesses. The goal of training is for the algorithms to perform well on average, but predictions may be poor for some realizations of input data, which can be a problem for individual decisions with certain characteristics, but further can create more widespread difficulties if the world changes in a way that makes the realizations of certain characteristics more likely. For example, unemployment or business failure may become more likely in sectors that previously did not experience it. In general, machine learning might make predictions based on relationships that are not stable in the long run. For example, factors that predict loan default may be different during the COVID-19 pandemic than at other times. In an image classification application, cats may be associated with indoor photographs, so that an algorithm bases its classification of a photo as showing a cat versus a dog using the background of the photo rather than characteristics of the animals, where characteristics of the animals themselves are more likely to remain constant across different countries, cultures, and environments for photo sharing.

It may be difficult for the engineers that build machine learning models to even understand the extent to which their models are fragile or unstable, let alone address the problems or prevent them. Well-documented examples where image classification failed for humans with darker skin highlight the pitfalls; once identified, many technology firms addressed

the particular problems that had been pointed out, but other problems likely remain to be identified and fixed. This remains an active and important area of research in both academia and industry.

For related reasons, off-the-shelf machine learning models are often not suitable for learning about cause and effect. A small research community focuses on addressing such challenges, and indeed much of my own research focuses on how to adapt machine learning to make it more useful for scientific discovery (Athey, 2017), disentangling cause and effect (Athey, 2018; Athey and Imbens, 2019), and to make prediction more stable and reliable (Chipman, 2018; Kuang et al, 2018; Kuang et al, 2020); but the most commonly applied algorithms in practice suffer from challenges that come with the territory of black-box, general purpose machine learning.

In spite of their limitations, there are many advantages of general purpose algorithms, and the general purpose nature of machine learning is complementary with the trends of digitization, cloud computing, and open source software. There has been a dramatic increase in the availability of open source software that provides tools to manage and analyze large datasets, as well as software to implement machine learning algorithms. Although it might at first seem surprising, large technology firms have put a large number of software packages and algorithms into the public domain, including algorithms that have been trained on their own large datasets. Even a few years ago, an engineer might need to spend a lot of time to train an algorithm that classifies images, but now it is possible to use off the shelf algorithms that companies like Facebook have trained on their large datasets of pictures. That frees engineers to focus on other parts of the problem, and can make it easier for academics to do research as well as for other AI firms to enter.

For example, as a university researcher I can store terabytes of data in public cloud infrastructure for research projects, and for just hundreds or thousands of dollars, I can analyze it in ways that would have only been possible inside large corporations a decade ago. Tools exist now that manage a lot of the work for distributing workloads and optimizing performance for statistical algorithms, and I can just focus on the analytic questions without worrying so much about the computational issues. My students can use publicly available image classifiers developed by Facebook to detect objects in images. Anyone from a student to a startup to a large company can use the technology. It is easy to experiment or prototype new models. What is often scarce is not the know-how or the infrastructure, but the data or the user base.

On the other hand, some of the most computationally intensive and cutting-edge applications of AI can be too expensive for startups or university researchers to carry out due to large computing needs, or they may require the types of data only available within large technology firms. For that reason, certain types of AI research have been challenging to carry out in academia, reducing the pace of publicly available innovation in those areas (see Lazer et al, 2020 for further discussion of policy issues around access to data and infrastructure for social

science research). Some have called for a greater investment in public infrastructure for AI to support research and innovation (Etchemendy and Li, 2020).

Overall, digitization has decreased the costs of implementing AI, which reinforces the advancement of practical applications of AI and facilitates the diffusion of AI across industries and applications. Cloud infrastructure has made it easier for companies to enter and compete providing software as a service. In turn, companies providing software as a service invest in research and development, over time adding features including those powered by machine learning, thus making the benefits of machine learning available more broadly. As long as markets are competitive, a lot of those benefits accrue to the businesses and consumers who use the products. Of course, and this is a topic for another day, market power can sometimes be a concern, particularly in situations where a single firm controls access to a large group of consumers and/or their data. However, in many cases, consumers have seen the quality and convenience of digitally-delivered services rise or the costs fall as a result of all of this innovation, as digital services often have low marginal cost of delivery. This potential is what captures the imagination of AI optimists. However, there are also many unintended consequences of all of this innovation that require careful attention, as I will discuss further below.

Artificial intelligence and the generation of novel creations

An even more recent set of advances in artificial intelligence concerns algorithms that are used to create original digital objects, such as stories, art, photographs or music. It is easy to see why an observer might get the impression that AI is truly intelligent when we see a computer create an original digital image that looks like a photograph of real human. Some of the photo filters my children enjoy on their smartphones are another example of this technology, where the apps produce an image of a person that is altered to look younger or older. This type of creation is often the result of what is known as a "generative adversarial network" or GAN (Goodfellow et al, 2014). This type of AI solves a very challenging problem; it is much easier for an algorithm to distinguish between images of cats and dogs than to create an original image of a cat. Telling images of cats and dogs apart might boil down to understanding the shape of cat ears, nose, and eyes separately, without needing to specify how they relate to one another within an image; but creating a believable photograph of a cat requires generating ears, nose and eyes that make sense together in terms of proportions, locations relative to one another in the image, colors, and shadows.

GANs work by combining two distinct, dueling algorithms, the generator and the discriminator, where the discriminator has access to a dataset of objects that are labelled as real. The generator algorithm creates fake objects, and while the discriminator builds a model that classifies objects as real and fake based on a dataset of including the generator's fake objects and those that it knows are real. The algorithms battle amongst themselves. The one that creates

fake objects keeps trying to make objects that trick the latest model built by the discriminator, and the discriminator keeps trying to find different ways to distinguish real from fake. The fact that the discriminator is automated (rather than a human judge) means that the generator can try a very large number of different options, and eventually it can find something that looks good in the sense that the discriminator can't distinguish it from something fake. But much like the example you've heard that a monkey would eventually write a classic novel if it typed long enough, the algorithm creating fake stuff is not smart, it just did a lot of trial and error against a computerized judge.

GANs already have a wide array of applications (Alqahtani et al, 2019; Brownlee, 2019), and we may expect more to be introduced, as they have only gained widespread use in the last few years. GANs can be useful when it is helpful to have lots of options to select from, but it is important that the objects are original or distinct. They can generate designs for images, fabrics, music, cartoons, email subject lines, etc. that are likely to be pleasing, but typically when applied, humans screen the generated options in a second step. GANs can also can make variants of existing objects with desired characteristics, e.g. a handbag with a specified shape decorated in a certain color or style, and GANs can also convert text to an image.

In scientific applications, GANs can be used to generate fake datasets for replication of studies, to test algorithms, or to protect privacy of, e.g., health data. Constraints can be added to the GAN, so that a GAN can be trained to generate objects that have desired scientific properties. They have been used for generating potential chemical or biological compounds with useful properties, for example candidate drug compounds that might deserve further research (Schmelzer, 2019).

GANs can be problematic as well. They can be used for "deep fakes," where convincing videos or images appear to show politicians or celebrities in a negative light, as well as to generate fake comments or social media posts, creating discord and anger among citizens. They can create fake identities that can be used for financial crimes or fraud as well. The fact that GANs can produce a large number of unique fakes make them particularly useful for applications where an actor repeatedly attempts to get past anti-fraud systems or algorithms designed to screen out robots from review systems and social media.

As impressive as GANs may be, there is a big gap between being able to, say, help a customer with a non-standard request and being able to spit out sentences that mimic human sentences. The technology doesn't think or reason, it just mimics patterns.

Artificial Intelligence and Autonomy

Autonomy, whereby an algorithm governs behavior of software or hardware in reaction to a changing environment, is another key concept in artificial intelligence. A robot that navigates obstacles to deliver an object is called autonomous; and recent advances have improved the ability of autonomous agents to learn decision rules. A type of algorithm known as

reinforcement learning is designed to solve a problem like winning a board game or climbing over a wall. The algorithms actively experiment, and learn by trial and error. They break a problem down into a set of "states of the world," e.g. the location of chess pieces on a game board, or what objects are perceived by a robot in a hallway. The algorithm then considers what states it can move to from the current state, and either moves to the best option, or experiments among alternatives to learn more about what the value is of being in different states.

Reinforcement learning generally requires a lot of training in a setting where mistakes are not too dangerous, for example when a computer can play billions of games of chess against other computers in order to learn what works. As impressive as it sounds, reinforcement learning still relies heavily on pattern recognition; it isn't developing theories of the world. The core ideas behind reinforcement learning have been around a long time, but its performance has advanced dramatically in large part because of improvements in machine learning that help the algorithm automatically learn ways to effectively simplify the state space. The algorithms learn simpler representations of the possible positions of chess pieces; just as chess students learn a point system to determine how good their position is in a game, the algorithms assign scores to different positions and suggest game moves that optimize the scores. The AI accomplishments are especially impressive when there are billions of billions of possible configurations of a game board, since human brains can't remember that much information, but fundamentally the algorithms are still just adding up wins and losses using a scoring system learned from many replications of the game. Algorithms created in this way might perform arbitrarily badly if something small changes about the environment, and they are only as good as the data they have seen in the past, whether through simulated game play, their own experiments in previous games, or data from past games played by humans. Thus, they still may not do well in never-experienced environments.

Artificial Intelligence Applications and Impact

We have seen that the most commonly used categories of AI either implement human-created decision rules, or make use of pattern recognition to derive predictions or decision rules. Despite the inherent limitations of these categories of AI, some awe-inspiring accomplishments have emerged; yet, it is important not to conclude from the accomplishments to date that some sort of general intelligence will follow quickly. As discussed above, pattern recognition has limitations, particularly performance in changing circumstances.

Machine learning and AI have had especially widespread adoption for applications when it is possible to update the model more quickly than the environment changes, and when prediction and classification tasks play an important role (Agrawal, Gans, and Goldfarb, 2018). Examples of applications include digitizing input from people, including handwritten forms and voice recognition. Image classification has many applications across industries ranging from finance (e.g. images for insurance claims) to medicine (diagnosis). For example, AI has been

used in medical imaging, detecting diseases or anomalies with specialist-level accuracy in some cases (Ruamviboonsuk et al., 2019). It is also used to predict the likelihood of a chemical reaction (Hao, 2020).

Machine learning and AI can be particularly useful in a setting where, in the absence of AI, human workers would need to make decisions in limited time. Although in principle, a human worker could make a better decision than an algorithm with sufficient investment of time, they might not have enough time to gather and absorb all of the relevant data in practice. An example is resume screening, where often a human screener might only briefly scan a resume before deciding if it should be prioritized for further consideration. The screener might not know all relevant information about the quality of the secondary or university school attended by the applicant, and they might not be familiar with the skills required for work at a particular firm in the worker's employment history. In contrast, an algorithm might be trained on thousands of resumes, and can quickly process a large set of characteristics of the individual. Of course, it is important to consider issues of bias that can arise when using algorithms in this way; careful attention to training data and active investment in expanding the pool of workers who advance to higher levels of the interview process are examples of approaches that may mitigate these issues.

A related application is in automation of worker screening for qualifications and availability. Alain Dehaze, CEO of Adecco, recently reported that his firm quickly recruited 16,000 workers in Europe using a purely digital process during the COVID-19 pandemic (Michaels, 2020).

AI is also used to prioritize resource allocation according to the risk posed by an individual or entity. It has been used in a variety of government applications, including the allocation of health inspectors to restaurants or home visits by child protective services workers (Schwartz et al, 2017). AI has also been used to help judges make bail decisions (Kleinberg et al, 2018). In principle, they can improve decision quality, accountability, and equity, as they replace rapid decisions by humans who may not have the time to consider all relevant information. However, it should also be obvious that these types of applications require great care to implement fairly and effectively (Glaberson, 2019), and more work is needed both by academics and regulators to ensure that implementations of these algorithms follow best practices and are evaluated for unintended consequences.

Applications of reinforcement learning include digital marketing, where reinforcement learning is commonly used to figure out which of many email subject lines or headlines work best to attract consumer clicks; and autonomous drones, robots, and delivery vehicles.

More broadly, according to McKinsey's 2019 AI impact survey across hundreds of firms, AI had been adopted in nearly every industry by 2018. Retail is growing most quickly, with 60 percent of respondents from retail reported that their companies have embedded at least one AI capability in one or more functions or business units, a 35-percentage-point increase from the 2018 survey (Cam et al., 2019). Funding of AI startups in the U.S. spans a wide range of industries. AI startups received $19.8B of investment in 2019, with top focus areas including

Data Tools (8.1% of all startups); Medical Technology (5.3%); Fashion and Retail Technology (4.7%); Text Analytics (4.7%), and Chatbots (3.9%) (Perrault et. al 2019, p. 92).

Impact on the Efficiency and Accessibility of Service Delivery

The impacts of automation and AI arise not just in terms of the cost of providing services, but also in the costs of receiving services. In particular, individuals seeking services like health and education often bear substantial costs in terms of transportation and time, which translate into lost income, outlays for child care, or lost sleep. For those with full-time jobs or caregiving responsibilities, it can be extremely frustrating and create economic hardship to waste time in waiting rooms, lines, or traveling in order to access services.

Providing services digitally allows people to access services when it is convenient, avoiding the need to take time off of work or obtain child care. Otherwise unused blocks of time can be used to accomplish tasks such as filling out forms or acquiring job-relevant skills, and a parent might engage in these activities while children are sleeping to avoid the need for child care. Citizens may be more satisfied with digital services in many cases, and lower income consumers in particular can benefit from improved access (Kuziemski, M., & Misuraca, G., 2020). For example, Medicaid patients may experience long travel times or waits to access health care, while providing access to telehealth has shown promising results in pilot studies (Koehn, 2016), and the widespread adoption of telehealth during COVID has opened up new possibilities to expand this access while simultaneously reducing costs. Access to high-quality medical care in rural areas is another important application.

In contrast, the lack of ability to reach consumers digitally can interfere with efficient provision of services. For example, poor IT infrastructure hampered state governments in their efforts to provide COVID relief to individuals quickly, and it limited the scope of early programs to deal with the pandemic (Bollag and Wilner, 2020). Even where digital provision was enabled, as in telemedicine, concerns remain about inequality of access (Weigel et al, 2020; Anderson and Kumar, 2017). This type of infrastructure and access must be addressed for governments to be able to take the next step and optimize service provision using artificial intelligence.

It is perhaps more straightforward to assess the potential for efficiency benefits in terms of reducing the cost of providing services through digitization and automation, which (after technology is developed) reduces the number of government workers needed to provide a service. This reduction in employment is obviously a challenge for the affected workers, but it increases the efficiency of government. In some cases, government funds can be reallocated to provide additional services in areas where it is harder for automation to substitute for human workers, as in the area of education or child care.

A number of studies have attempted to assess the state of digitization as well as the efficiency gains that are possible for governments (see, e.g. analyses of the degree of digitization of government services in the US (OECD, 2019); the extent of potential efficiency and cost

savings (Eggers et al, 2017); citizen preferences and satisfaction with government services (BCG, 2018); the use of AI in government services in developing countries (Lauron and Stamboel, 2018)). Deloitte estimates that automation of federal government employee tasks could save between 96.7 million and 1.2 billion hours annually, with potential savings between $3.3 billion and $41.1 billion (Eggers et al, 2017). Categories of potential benefits include reducing the labor cost of providing government services and avoiding corruption.

There are some challenges to undertaking large-scale digitization programs. First, the infrastructure underlying digitization has the feature of requiring up front investments that pay off over years, which can be difficult for companies, let alone governments, to manage well, especially in an environment of changing technology. There are large risks for governments undertaking large IT projects, although there are also substantial risks of retaining antiquated systems, as described in testimony before this committee in July (Gerton, 2019). It is also important to remain attentive to inequality in IT skills, access and adoption that make for an uneven playing field when it comes to accessing digital services (Anderson and Kumar, 2017).

Impact on Productivity and Measurement Challenges

Like many previous technologies, it is hard to isolate the impact of AI in productivity numbers. Despite impressive improvements in AI, not to mention many other technologies, productivity growth has actually slowed down in the last fifteen years, from an average of over 2.4% per year between 1995-2005 to less than 1.3% per year since then (Brynjolfsson, Rock and Syverson, 2019). That is to say, the data appears to rule out very large productivity gains from AI or digitization in general. One explanation is that realizing the potential of new technologies "requires large intangible investments and a fundamental rethinking of the organization of production itself. Firms must create new business processes, develop managerial experience, train workers, patch software, and build other intangibles. This raises productivity measurement issues because intangible investments are not readily tallied on a balance sheet or in the national accounts." (Brynjolfsson, Rock and Syverson, 2020, p.2) In addition, all of the investments required to achieve the full potential of AI may be characterized by up front investments whose benefits take many years to realize, making it more difficult to isolate the impact.

Opportunities

Several types of opportunities stand out where AI can be an important part of the solution to societal challenges. A first area is finance. The financial services sector is on the front line of employment impacts from AI, but there are also a wide range of opportunities for technology to improve access to services and to reduce costs to the point that more low-income consumers can be served. However, challenges remain, in part because the regulatory framework for our financial system is designed around regulating processes followed by human workers, not regulating algorithms and automated systems. Many financial regulators lack experience and expertise in AI, and the existing regulatory structure is not designed to handle situations where

algorithms have a small but positive chance of making mistakes. Cost-benefit analysis is not the primary framework used by regulators to evaluate AI projects, and firms slow their investment in the face of regulatory uncertainty. Financial technology has the potential to be very progressive, reducing costs of serving low-income consumers and small businesses, providing opportunities for new startups, and introducing competition. Automation can ensure compliance and avoid a role for human biases, while well-designed algorithms can avoid introducing new forms of bias. A regulatory framework needs to address the benefits as well as the risks of new technology and innovation. Of course, risks are real, as AI can be used to automate the creation of exploitive or manipulative marketing as well as financial crimes (FINRA, 2020).

A second area where AI can be quite impactful is in the area of education and training. The COVID-19 pandemic dramatically accelerated adoption of a wide range of educational technology applications (Gilchrist, 2020), ranging from preschool applications like Khan Kids or IntellectoKids (Kotlov, 2020) to upskilling programs. Companies like Coursera expanded their free offerings and partnered with governments to allow unemployed workers to acquire new skills, such as basic technical skills identified by employers (Training Industry, 2020). The United States could do more to study the impact of such programs, and if effective, scale up access to a larger group of unemployed Americans.

Many educational technology companies are in a relatively early stage of growth. However, with the new, larger user bases they have attracted during the pandemic, companies have the opportunity to introduce more automation and artificial intelligence into the learning process, personalizing educational experiences, adapting to the student, and also potentially innovating in certification and interview practice (as artificial intelligence can be used evaluate students or create interactive scenarios for students to practice their skills). Given its outsized impact on society, it will be important to continue to nurture the industry providing education and training digitally, and to consider complementary investments that reduce frictions for workers in job transitions.

More generally, the changes brought by AI will contribute to increasing rates of worker transitions between jobs. As automation changes the organization of work, some jobs are likely to be eliminated, and newly created jobs may require different skills. If, as in the case of call centers, a large number of jobs in a single category is eliminated in a short period of time, workers may need to transition to a different type of work. The use of cloud computing and software as a service may lead to a variety of employers in the same industry automating processes at the same time, making the transitions more challenging for affected workers. A variety of frictions might interfere with their ability to transition.

Simon (2020) reviews research on labor market frictions, and finds that many causes of frictions are related to individuals needing to adapt by (1) learning new skills or (2) moving to new geographies with better opportunities. There is potential for AI and digitization more generally to provide solutions to both of these frictions, (1) by providing convenient, accessible, enticing and personalized education and training solutions, (2) reducing the importance of

geography by providing remote work opportunities, and (3) improving worker access to information and support in order to guide workers to better decisions and reduce the risk associated with transitions.

A variety of evidence (Chen et al, 2019) also points to the importance of flexibility of schedules for many workers, particularly workers who need to balance school or caregiving responsibilities with work. Remote work and technology-related work may lend themselves to flexibility, and the new approaches to work developed during the COVID-19 pandemic may enable more such flexibility. Other policies that complement worker flexibility may also become important, for example policies that facilitate continuous access to health care while workers combine retraining and part time work.

Artificial Intelligence for Worker Safety and Monitoring

Another category of application of AI concerns monitoring the activities and experiences of workers. Although the primary motivation for the introduction of AI might be worker safety or regulatory compliance, there are a number of potential unintended consequences.

First, consider some of the ways in which AI can be used to monitor workers. Worker communication is increasingly digital, as it takes place through email, company-sponsored chat platforms, or over digital conferencing systems. A variety of companies provide services designed to translate conference calls into written notes, and it is straightforward to use machine learning to learn to create risk scores for written communication. The relevant type of risk to be predicted may vary by industry, but, for example, AI is already being productively deployed to monitor communication within financial services companies to ensure compliance with regulations, such as prohibitions on insider trading or other illegal activities (IBM and Chartis Research, 2018; FINRA, 2020). Indeed, the term "regtech" has been coined for technology that helps firms comply with regulations, something that ultimately will be important to consider when thinking about cost-benefit analysis from regulations. Some regulations may become easier and cheaper to comply with and enforce in the digital era, especially when compliance processes can be automated and included in software as a service provided to firms in a given industry. On the other hand, compliance failures may occur at a larger scale when many firms use the same software.

It is also relatively straightforward for an employer to create a training dataset for a machine learning algorithm based on video or audio recordings of employee interactions with customers. A sample of video or audio can be watched and manually scored by human judges to create a labelled training dataset. After training, an algorithm can be applied to all video, creating a "predicted customer satisfaction score" for every minute of every recorded interaction. This allows large-scale, low-cost scoring of workers. Another application would be safety violations. Video can be labelled, or assembly line accidents or errors can be used as "labels" in training datasets for algorithms designed to identify undesirable actions by workers. Once trained, the algorithms can be applied to all recorded video, and those video segments that

received poor scores could be manually reviewed to assess whether the incident was, in fact, an example of undesirable employee behavior. This dramatically increases the efficiency of worker monitoring by focusing human time on the portions of video most likely to be associated with problems.

A related example concerns safety for fleets of drivers. A variety of companies sell software that is installed on the mobile phones of drivers, where drivers are required to use the software during working hours. The software uses the telemetry from the phone to identify whether the driver was speeding, or whether the other safety violations took place. Drivers with poor safety can be assigned to safety courses, or if necessary, terminated.

Similar algorithms could in principle be used in governments to ensure that government workers provide proper service, follow rules, and don't take bribes, similar to the use of body cameras for police. This type of application is in an earlier stage, but there have been some promising case studies in recent years (Aarvik, 2019).

However, as a society we will need to consider the broader implications and substantial risks that arise alongside the large scale monitoring of workers. A variety of problems might emerge, ranging from bias, as might occur if algorithms perform poorly on women, shorter people, or people with darker skin; to the potential that the existence of all of this tracking can create fodder for blackmail or extortion. It is hard to imagine that nothing embarrassing ever happens if you are constantly monitored as a worker or as a citizen. Privacy and security of data is already important to individuals in their leisure time, but it takes on different considerations in the workplace.

A final issue worth considering when AI is used to augment humans in the workforce is the extent to which reliance on AI reduces human attentiveness. Just as humans might "fall asleep at the wheel" when using an autopilot feature in a car, workers may fail to gain experience in certain types of tasks when the tasks are automated, or they may be insufficiently incentivized to pay attention and gather information when AI is introduced to assist them with tasks. Thus, it is important for firms and governments to consider the way in which AI changes both the information and incentives for workers when it is introduced into organizations and decision processes (Athey, Bryan, and Gans, 2020).

Additional Policy Considerations

A common mistake in thinking about AI is to focus on the harm to a small group of people, without considering the benefits that accrue to many. Many AI applications can be progressive, because automation and digital provision of services reduce marginal cost. On the other hand, technical change is taking place in a context where the costs of essentials such as housing and health care are rising faster than wages, and some of the consumer products and services made available through technology are consumed by wealthier individuals. It is thus important to consider overall effects as well as the context in which the innovation occurs.

AI raises a variety of additional opportunities and challenges for our economy. One is a misalignment of incentives by firms in the type of research and development that is prioritized. Firms have incentives to invest in cost reduction, but don't consider broader societal consequences; thus, they may be more likely to invest in labor-replacing technology. Research that helps explore labor augmenting technology may receive insufficient investment by the private sector. The Stanford Institute for Human-Centered Artificial Intelligence, where I am associate director, is attempting to prioritize research on labor-augmenting technology, but much more investment in this type of research and development would be beneficial and more aligned with societal objectives.

Another set of considerations concerns the geographic distribution of research, entrepreneurship, and investment. Historically, the United States has been a leader in AI innovation, but there is no guarantee that will continue without support for universities as well as high-skilled immigration. Given that some parts of the AI industry are prone to concentration due to scale economies, it can be important that the U.S. retains its leadership position in innovation if the U.S. hopes to be the home of the world's leading companies in the future. Furthermore, there is no guarantee that jobs created by AI will have broad geographic distribution within the U.S. For example, Bloom et al. (2019) suggests that between 1990 and 2007, large multinational firms offshored their production while creating new service-sector jobs. However, the lost jobs were in the U.S. heartland, while the new service jobs were created in high-education areas along the coasts, and were therefore taken up by very different people. Despite this shift in the location of jobs, geographic mobility has not been a widespread way of adjusting to the shock (Autor, Dorn, and Hanson, 2013; Autor et al., 2014).

Gruber and Johnson (2019) argue that universities, especially those with large medical centers, can anchor cities that are large enough to grow and create jobs, and that research and development investment (including investment funded by the government) can be effective at spurring the innovation that drives this growth. With high cost of living and congestion in the existing tech centers, together with tech firms embracing remote work, there may be opportunities for timely investments in these locations that contribute to their success, expanding the set of geographies where firms open offices with AI jobs. Technology companies consider the size of the engineering workforce as well as the opportunities to hire from universities when locating new satellite offices, and it has been common for veterans of larger technology companies to start new ventures after gaining experience, which can seed new communities of entrepreneurs outside the traditional technology hubs.

A further set of challenges facing the U.S. is related to demographics. Overall, our working population is aging. Several countries, including the United States, may face fiscal challenges due to demographics unless they increase either the birth rate or immigration. Varian (2018) did analysis to suggest that using the most aggressive estimates for the impact of automation, we are still more likely to face a worker shortage than surplus in the coming decades. He points out that it may be hard to predict the future impact of AI, but we have a lot

of certainty about how many 40 year olds there will be in 20 years, and our population is very likely to be much older. According to the Congressional Budget Office, the federal government spent about one-third of its budget on seniors in 2005 (Congressional Budget Office, 2019, pp. 12-14). By last year, the share grew to 40 percent, or $1.5 trillion. The share is forecast to rise to half of all non-interest spending, or $3 trillion, by 2029. This amounts to spending 10 percent of the nation's Gross Domestic Product on older adults.

Countries with aging workforces tend to invest more in automation. To mitigate demographic challenges, we may want to consider investments in research and development that supports the efficient provision of services to older populations, perhaps assisted by technology to make services safer and more affordable. In addition, AI can be used to augment older workers, making it possible for older workers to have second careers without compromising their health. For example, robots can help workers with challenging physical tasks, while AI can assist with tasks that traditionally required memory or attention to detail, as it can warn of anomalies and monitor performance in real time. This removes some of the more challenging components of work, allowing older workers to focus on activities that emphasize human interaction and provide fulfillment and stimulation.

Conclusions

As AI is adopted through government and the economy, it will be important for governments to keep a close eye on the myriad challenges raised by AI. Some of them have been raised in my testimony today, including bias, privacy, security, investment risk, reliability and fragility of machine learning models, and the need for thoughtful regulation that includes cost-benefit analysis. Other challenges, such as concerns about market power of large firms who have unique access to data, are important, but beyond the scope of this testimony.

In the coming decades, as AI plays a larger and larger role in our economy and in the provision of government services, transitions will be the new normal for workers. It will be important for governments to address the challenges faced by workers, and also to make the necessary investments to ensure that AI fulfills its potential as part of the solution. Since digitally provided services have low marginal cost of delivery, AI is well positioned to contribute to providing scalable and effective education, training, and access to government-provided and government-funded services.

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Chairman YARMUTH. Thank you for your testimony.

I now recognize Dr. Acemoglu for five minutes. Please unmute and the floor is yours.

STATEMENT OF DARON ACEMOGLU, PH.D.

Dr. ACEMOGLU. Chairman Yarmuth, Ranking Member Womack, and Members of the Committee, thank you for inviting me to testify on this important subject.

The U.S. economy today and U.S. workers are suffering from what I view as excessive automation. The extent of automation is excessive in that it is not leading to sufficient productivity growth, creating new tasks for humans or increasing wages.

Automation, the substitution of machines and algorithms for tasks previously performed by labor, is nothing new. It has often been an engine of economic growth, but in the past, for example, during the year of the mechanization of agriculture, it was part of a broad technology portfolio and its potentially negative effects on labor were counterbalanced by other technologies. Not today.

Recent advances in AI and machine learning are not responsible for these trends. In fact, AI, a broad technological platform with great promise, can be used for helping human productivity in creating new human tasks. But it could exacerbate the same trends if we use it just for automation.

The COVID–19 pandemic will also contribute to this predicament as there are now more reasons for employers to look for ways of substituting machines for workers and recent evidence suggests that they are already doing so.

Excessive automation has already been a major drag for the U.S. economy. Private sector spending on workers, which increased steadily and rapidly almost every year in the four decades following World War II, has been essentially stagnant over the last 20 years. The decline in the share of labor in national income, the stagnation of middle class wages, and a huge increase in inequality are all connected to our recent unbalanced technology portfolio prioritizing automation and not much else.

Excessive automation is not an inexorable development. It is a result of choices and we can make different choices. While there is no consensus on exactly what brought us to this state, we know of a number of factors that have encouraged greater automation. Chief among these has been the transformation in the technology strategies of leading companies.

American and world technology is shaped by the decisions of a handful of very large and very successful tech companies with tiny workforces and business models centered on the substitution of algorithms for humans.

There is, of course, nothing wrong with successful companies pushing their vision, but when this becomes the only game in town, we have to watch out. Past technological successes have often been fueled by a diversity of perspectives and approaches. The dominance of the paradigm of a handful of companies has been exacerbated by the dwindling support of the U.S. Government for fundamental research. The transformative technologies over the 20th century, such as antibiotics, sensors, modern engines, and the internet have the fingerprints of the government all over them. The

government funded and purchased these technologies and often set the agenda, but no longer.

Last but not least, government policies encouraging automation excessively through its tax code. The U.S. tax system has always treated capital more favorably than labor. My own research estimates that over the last 40 years, via payroll and federal income taxes, labor has paid an effective tax rate of over 25 percent.

Even 20 years ago, capital was taxed more lightly, with equipment and software facing tax rates around 15 percent. This differential has significantly widened with tax cuts on high incomes, the shifts of many businesses to S-Corporation status that are exempt from corporate income taxes, and very generous depreciation allowances.

Software and equipment are now taxed at about 5 percent, and in some cases corporations can get a net subsidy when they invest in capital. This generates a powerful motive for excessive automation. One result of this has been the disappearance of good jobs, especially for workers without postgraduate degrees or very specialized skills.

The only way to alter this technology is to redirect technological change. That will require changes in federal policy. A first step would be to correct the asymmetric taxation of capital and labor. This would go a long way, but is not sufficient by itself.

A second step is to re-evaluate the role of big tech companies in our lives, including in the direction of technology. This, of course, goes beyond debates about automation and AI as it relates to the issue of limiting the size and dominance of big tech.

These measures can be strengthened with government R&D policies specifically targeting technologies that help human productivity and increase labor demand. Research policies that target specific classes of technologies are rightly controversial. They may be particularly challenging in the context of choosing between automation and human-friendly technologies since identifying these is nontrivial.

Nevertheless, I would like to end my comments by emphasizing that such policies have been adopted and have had successes in the past. Four decades ago, renewable energy was prohibitively expensive and the basic know-how for green technology was lacking. Today, renewables already make up 19 percent of energy consumption in Europe and 11 percent in the United States, and have costs in the ballpark of fossil fuel based energy. This has been achieved thanks to a redirection of technological change away from a singular focus on fossil fuels toward greater efforts for advances in renewables.

In the U.S., the primary driver of this redirection has been the government subsidies to green technologies, as well as the changing norms of consumers in society. The same can be done for the balance between automation and human-friendly technologies.

Thank you.

[The prepared statement of Daron Acemoglu follows:]

Daron Acemoglu

Institute Professor, MIT

Written Testimony

House Committee on the Budget

Hearing on Machines, Artificial Intelligence, & the Workforce: Recovering & Readying Our Economy for the Future

September 10, 2020

Chairman Yarmuth, Ranking Member Womack and Members of the Committee,

Thank you for inviting me to testify today on this important subject. Today, the U.S. economy— and U.S. workers — are suffering from what I view as excessive automation. The extent of automation is excessive in that it is not leading to increased productivity, creating new tasks for humans or increasing wages.

Automation — the substitution of machines and algorithms for tasks previously performed by labor — is nothing new. Ever since the weaving and spinning machines that fueled British Industrial Revolution, automation has often been an engine of economic growth. However, in the past it was part of a broad technology portfolio, and its potentially negative effects on labor were counterbalanced by other technologies boosting human productivity and employment opportunities. Not today.

Recent advances in AI and machine learning are not responsible for these trends. In fact, AI, a broad technological platform with diverse applications and great promise, can be used for helping human productivity and creating new human tasks and competencies in education, health care, engineering, manufacturing and elsewhere. But it could exacerbate the same trends if we use it exclusively for automation.

The COVID-19 pandemic will also contribute to this predicament as there are now more reasons for employers to look for ways of substituting machines for workers, and recent evidence suggests that they are already doing so.[1]

Excessive automation has had major costs for the U.S. economy. One aspect of this can be seen in Figure 1, which plots private sector spending on workers (the private sector wage bill) normalized by population. The left panel shows that private sector wage bill increased, on average, about 2.5% faster than population in the four decades following World War II. This meant over 2% real wage growth for the majority of the U.S. workforce during these years. This growth (and resulting wealth) was very broadly shared. The real wages of all demographic groups (by education, gender and race) grew more or less in tandem, and if anything, overall inequality contracted.

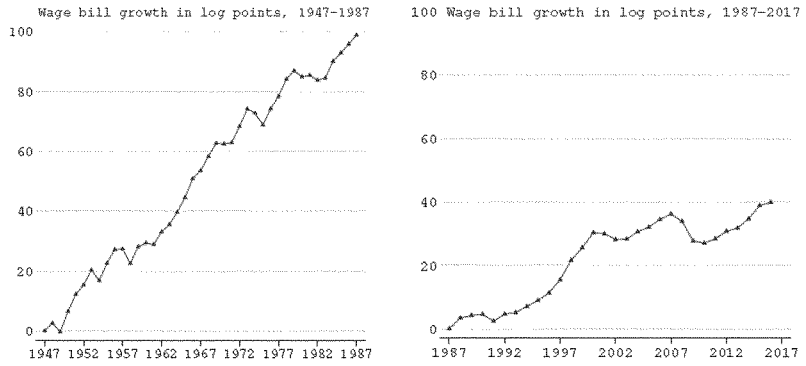


Figure 1: Evolution of US Labor Demand. From Acemoglu, Daron and Pascual Restrepo (2019) "Automation and New Tasks: How Technology Changes Labor Demand." *Journal of Economic Perspectives*, 33(2): 3--30.

[1] See https://assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/ey-capital-confidence-barometer/pdfs/22/ey-22nd-global-capital-confidence-barometer-march-2020.pdf, https://www.nytimes.com/2020/04/10/business/coronavirus-workplace-automation.html and Alex Chernoff and Casey Warman (2020) "COVID-19 and Implications for Automation" NBER working paper.

The right panel of the figure shows a very different picture after the mid-1980s: slower growth of private sector spending on labor, and subsequently, almost no growth from the late 1990s onwards. This drying up of labor demand in the U.S. economy has many causes, but it is fundamentally related to the changing nature of technology. From the mid-1980s onwards, there is faster automation and automation-related displacement of workers from U.S. industry, and much less rapid introduction of other technologies that would increase human productivity and opportunities. [2]

The adoption of industrial robots, a typical example of automation technologies, illustrates these implications. Robots have raised productivity in many parts of modern manufacturing. But their impact on labor has been more mixed. Local communities where businesses have adopted more robots have experienced employment and wage declines (relative to the rest of the U.S.).[3] While robots impacted a relatively narrow segment of the US workforce (manufacturing workers specialized in production tasks), the substitution of algorithms and software for white-collar tasks probably had even more sweeping consequences.

The next phase of automation, relying on AI and AI-powered machines, such as self-driving cars, can be even more disruptive, especially if it is not accompanied with other types of more human-friendly technologies.

The imbalance of technology may also be partly responsible for the disappointing productivity performance of the American economy. Despite the bewildering array of new

[2] Acemoglu, Daron and Pascual Restrepo (2019) "Automation and New Tasks: How Technology Changes Labor Demand." *Journal of Economic Perspectives*, 33(2): 3--30.
[3] Acemoglu, Daron, and Pascual Restrepo (2020) "Robots and jobs: Evidence from US labor markets." *Journal of Political Economy* 128(6): 2188-2244.

machines and algorithms all around us, productivity growth in the U.S. economy has much lower rates of productivity growth over the last 20 years than during the decades that followed World War II.[4] Even though information and communication technology (ICT) has advanced rapidly and is used in every sector of the economy, industries that use ICT more intensively have not performed better in terms of productivity, output or employment growth.[5] The reasons for slow productivity growth over the last two decades are not well understood. But one contributing factor appears to be that many automation technologies, such as self-checkout kiosks or automated customer service, are not generating much productivity growth.

The implications of our recent unbalanced technological portfolio and the resulting slowdown in private sector labor demand are widespread and include: the sizable decline in the share of labor in national income (driven partly by the reduced role of labor in the production process); the stagnation of middle-class wages and the huge increase in inequality, which has also meant large declines in the real wages of low-education men.[6]

Excessive automation is not an inexorable development. It is a result of choices of researchers who have focused on automation applications at the expense of other uses of technologies and companies that have built their business models on automation and reducing labor costs rather than broad-based productivity increases. We can make different choices.

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[4] Gordon, Robert J. *The Rise and Fall of American Growth: The US Standard of Living Since the Civil War*. Princeton University Press, Princeton, NJ, 2017.

[5] Acemoglu, Daron, David Autor, David Dorn, Gordon H. Hanson and Brendan Price (2014) "Return of the Solow Paradox? IT, Productivity, and Employment in US Manufacturing" *American Economic Review*, 104(5), 394-99.

[6] Acemoglu, Daron and David Autor (2011) "Skills, Tasks and Technologies: Implications for Employment and Earnings." *Handbook of Labor Economics*, 4: 1043--1171, and Acemoglu, Daron and Pascual Restrepo (2019) "Automation and New Tasks: How Technology Changes Labor Demand." *Journal of Economic Perspectives*, 33(2): 3--30.

While there is no consensus on exactly what brought us to this perilous state, we know of a number of factors that have pushed the economy towards greater automation.

Chief among these has been the transformation in the corporate strategies of leading companies in the U.S. American and world technology is shaped by the decisions of a handful of very large and very successful tech companies, with tiny workforces and a business model built on automation.[7] Big tech companies are responsible for more than two out of every three dollars spent globally on AI and their vision, centered on the substitution of algorithms for humans, influences not only their own spending but also what other companies prioritize and the aspirations and focus of hundreds of thousands of young students and researchers specializing in computer and data sciences.[8] There is of course nothing wrong with successful companies pushing their vision, but when this becomes the only game in town, we must be on guard. Past technological successes have more often than not been fueled by a diversity of perspectives and approaches, and if we lose this diversity, we will also risk losing our technological edge.

The dominance of the paradigm of a handful of companies has been exacerbated by the dwindling support the US government is providing for fundamental research. The transformative technologies of the 20th century, such as antibiotics, sensors, modern engines, and the Internet, have the fingerprints of the government all over them.[9] The government funded and purchased these technologies and often set the research agenda. This is no longer the case.[10]

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[7] Acemoglu, Daron, and Pascual Restrepo (2020) "The Wrong Kind Of AI? Artificial Intelligence and The Future Of Labour Demand." *Cambridge Journal of Regions, Economy and Society* 13.1: 25-35.
[8] Artificial Intelligence: The Next Digital Frontier? McKinsey & Company.
[9] Lerner, Josh. *Boulevard of Broken Dreams: Why Public Efforts to Boost Entrepreneurship and Venture Capital Have Failed and What to Do about It.* Princeton University Press, New York, 2009, and Mazzucato, Mariana. *The Entrepreneurial State: Debunking Public Versus Private Sector Myths.* Public Affairs, New York, 2015.
[10] Gruber, Johnson, and Simon Johnson. *Jump-Starting America: How Breakthrough Science Can Revive Economic Growth and the American Dream.* Public Affairs, New York, NY, 2019.

Last but not least, government policy is encouraging automation excessively, especially through its tax code. The U.S. tax system has always treated capital more favorably than labor, encouraging firms to substitute machines for workers, even when workers may be more productive. As Figure 2 shows, over the last 40 years, via payroll and federal income taxes, labor pays an effective tax rate of over 25%. Even twenty years ago, capital was taxed more lightly, with equipment and software facing tax rates around 15%. This differential has widened even more with tax cuts on high incomes, the shift of many businesses to S-Corporation status making them exempt from corporate income taxes, and very generous depreciation allowances. As a result of these changes, software and equipment are taxed close to zero now and in some cases, corporations can get a net subsidy when they invest in capital. This generates a powerful motive for excessive automation.



Figure 2: Evolution of effective taxes in the U.S. From Acemoglu, Daron, Andrea Manera and Pascual Restrepo (2020) "Does the US Tax Code Favor Automation" *Brookings Papers on Economic Activity*.

A critical consequence of these trends has been the disappearance of good jobs, the lifeblood of the American workforce.[11] Today it has become exceedingly difficult for workers without post-graduate degrees or very specialized skills to obtain jobs with decent wages, prospects for promotions and wage growth, and a reasonable amount of job security. The only way to change this trajectory is to redirect technological change. That will require changes in federal policy.

[11] Acemoglu, Daron (2001) "Good Jobs Versus Bad Jobs" *Journal of Labor Economics*, 19(1): 1-21.

A first step would be to correct the differential taxation of capital and labor. This would go a long way but is not sufficient by itself. A second step is to reevaluate the role of big tech companies in our lives, including in the direction of technology. This of course goes beyond debates about automation and AI, as it relates to the issue of limiting the size and the dominance of big tech companies.

These measures can be strengthened with government R&D policies specifically targeting technologies that help human productivity and increase labor demand. Research policies that target specific classes of technologies are controversial and difficult. They may be particularly challenging in the context of choosing between automation and human-friendly technologies, since identifying these may be nontrivial. Nevertheless, I would like to end my comments by emphasizing that such policies have been adopted and have had successes in the past.

Four decades ago renewable energy was prohibitively expensive and the basic know-how for green technologies was lacking. Today renewables already make up 19% of energy consumption in Europe and 11% in the U.S., and have costs in the same ballpark as fossil-fuel based energy.[12] This has been achieved thanks to a redirection of technological change away from a singular focus on fossil fuels towards greater efforts for advances in renewables. In the U.S. the primary driver of this redirection has been government subsidies to green technologies, as well as the changing norms of consumers in society.

[12] Renewable Power Generation Costs in 2018, International Renewable Energy Agency; Global renewable energy consumption, Our World in Data. See also https://www.lazard.com/perspective/lcoe2019/; https://irena.org/publications/2020/Jun/Renewable-Power-Costs-in-2019; https://www.sciencedirect.com/science/article/abs/pii/S1364032111003492?via%3Dihub

The same can be done for the balance between automation and human-friendly technologies, but as in the case of climate change, change must start with a broader societal recognition that our technology choices have become highly unbalanced, with myriad adverse social consequences, and with a clear commitment by the federal government to redress some of these imbalances.

Chairman YARMUTH. Thank you very much for your testimony. I now recognize Dr. West for five minutes.

STATEMENT OF DARRELL WEST, PH.D.

Dr. WEST. Chairman Yarmuth, Ranking Member Womack, and Members of the Committee, thanks for the opportunity to testify. I am coauthor with Brookings' president, John Allen, of a new AI book entitled, "Turning Point: Policymaking in the Era of Artificial Intelligence." And I also am the co-editor of the Brookings technology policy blog Tech Tank and coproducer of the Tech Tank Podcast.

In my testimony, I am going to argue that artificial intelligence is one of the transformative technologies of our time and likely to have major ramifications for the workforce. AI is being deployed in a number of different sectors, and its usage will accelerate in coming years. Its development is going to necessitate rethinking our policies in the areas of budgeting, infrastructure, healthcare, education, workforce development, and economic development.

As AI and other emerging technologies become widely deployed, there are several possible ramifications for the workforce—job loss, job dislocation, job redefinition, job mismatch, and job churn.

For example, there could be job losses in entry level positions as firms automate routine tasks. There can be geographical dislocations as positions migrate to urban population centers and there can be job churn as people move from company to company.

In an economy where benefits are tied to full-time employment, any increase in job churn will create instability in people's ability to maintain income and benefits.

Most of the issues noted above have grown worse with the advent of COVID–19. The pandemic has revealed stark inequities in access to online education, telemedicine, and opportunities for remote work. As an illustration, African Americans are far less likely than Whites to access online educational resources, but far more likely to suffer from the coronavirus.

It is hard to estimate the precise impact of technology innovation on the federal budget because there is so many ramifications for government revenues and expenses. But one thing that appears clear is we are going to need greater investment by both the private and the public sectors.

One area is digital infrastructure. Right now there are around 18 million Americans who lack sufficient access to the internet. You need an online connection to apply for many jobs. A number of people do not have the connectivity required for online education, telemedicine, and remote work. So it is vital that we close that gap so that all can benefit from the digital economy.

The emerging economy presents challenges with respect to ensuring health and retirement benefits. Any increases in unemployment or people having part-time jobs will create some hardships. In today's digital world, workers need benefit portability to survive a turbulent working environment.

Organizations need to shorten their vesting periods for people to become eligible for company retirement contributions. Right now many organizations do not vest employees until they have worked at the firm for one or two years, and if there is increased jobless-

ness, lengthy vesting periods will lead to shortfalls in retirement income.

In the world of rapid change it is imperative that people engage in lifelong learning. The traditional model in which people focused their learning on the years before age 25 and then get a job and devote little attention to education thereafter is becoming obsolete. In the contemporary world, people can expect to see whole sectors disrupted and they will need to develop additional skills. The type of work that people do at age 30 is going to be very different from what they will be doing at ages 40, 50, and 60.

One possibility to encourage continuing education is through the establishment of lifelong learning accounts. They would be analogous to individual retirement accounts or state government-run 529 college savings plans, but the owners of the account could draw on that account to finance online learning, certificate programs, or job retraining expenses.

As America deploys AI and moves to a digital economy, its two coasts have fared much better economically than the heartland. According to research by my Brookings colleague, senior fellow Mark Moro, only about 15 percent of American counties generate 64 percent of GDP. Far too many parts of the United States are being left behind. One way to address this is through regional innovation districts. These are public-private partnerships that boost innovation in heartland cities. And the districts include regulatory relief, tax benefits, workforce development, and infrastructure.

To summarize, it is crucial to think proactively as tech changes unfold. The longer we wait, the more painful the transition will be. Now is the time to start having the discussions required to make meaningful changes. And I applaud the Committee for providing a platform for this important conversation.

[The prepared statement of Darrell West follows:]

A Hearing of the U.S. House Budget Committee
"Machines, Artificial Intelligence, & and the Workforce: Recovering & Readying Our Economy for the Future"
September 10, 2020

Statement of Darrell M. West, Ph.D.
Vice President of Governance Studies
Brookings Institution
Washington, D.C.

Chairman Yarmuth, Ranking Member Womack, and Members of the Committee. Thank you for the opportunity to testify at this hearing. I am Vice President of Governance Studies at the Brookings Institution and co-author with John R. Allen of *Turning Point: Policymaking in the Era of Artificial Intelligence* (Brookings Institution Press, 2020) and the author of *The Future of Work: Robots, AI, and Automation* (Brookings Institution Press, 2018). I am the co-editor with Nicol Turner-Lee of the Brookings technology policy blog TechTank and co-producer with her of the TechTank Podcast.

In my testimony, I argue that artificial intelligence is one of the transformative technologies of our time and likely to have major ramifications for the workforce and the economy. AI is being deployed in a number of different sectors and its usage will accelerate in coming years with advances in computer storage and processing capabilities. It will necessitate rethinking our policies in the areas of budgeting, taxes, infrastructure, agency modernization, health, education, workforce development, economic development, and market competition. The remainder of this memo outlines a series of suggestions for moving forward.[1]

What is Artificial Intelligence?

Artificial intelligence is automated software that analyzes data, text, and/or images and makes decisions based on those insights. It is characterized by several qualities that separate AI from traditional computer software: intentionality, intelligence, autonomy, and adaptability. It is these features that enable AI algorithms to find patterns or associations through "neural networks" that group data based on common similarities and act on them. In addition, AI-based systems learn from insights gathered via "deep learning" techniques that use statistics to spot underlying trends or patterns in data and apply that knowledge to changing circumstances. And it is not just numbers that can be mined as AI can employ "natural language processing" (NLP) that has the

[1] For more details on the analysis and recommendations, see Darrell M. West and John R. Allen, *Turning Point: Policymaking in the Era of Artificial Intelligence*, Brookings Institution Press, 2020 and Darrell M. West, *The Future of Work: Robots, AI, and Automation*, Brookings Institution Press, 2018.

capacity to ingest massive amounts of text or video to find patterns and meanings. NLP may be one of the most powerful derivative capabilities to emerge from the AI constellation.[2]

AI Impact on the Workforce

As AI and other emerging technologies become widely deployed, there are several possible ramifications for the workforce: job loss, job dislocation, job redefinition, job mismatch, and/or job churn. For example, there can be job losses in entry-level and mid-level positions as firms automate routine tasks and apply computational processes to augment or replace human activities. There also can be geographic dislocations as positions migrate to urban population centers clustered on the coasts and in a few metropolitan areas scattered around the heartland. Some positions will get redefined as AI performs tasks that currently are conducted by humans. There certainly will be new jobs created by technology, such as in data analytics and machine learning, but most people do not have the skills necessary to fill those positions so there will be job mismatches. And there could be job churn as people move from company to company. In an economy where benefits are tied to fulltime employment, any increase in job churn would create instabilities and insecurities in people's ability to maintain their income and their health and retirement benefits.

COVID-19, the Workforce, and the Economy

Most of the issues noted above have grown more worrisome with the advent of the COVID-19 pandemic and the resulting recession. Unemployment has grown and millions are suffering economically. Huge segments of the population are "financially unanchored" without sufficient monetary protection. The health and economic devastation coupled with tech disruption creates considerable urgency in making future policy changes that address the workforce in general but the negative consequences for individual workers in particular.

The pandemic has revealed stark inequities in access to online education, telemedicine, and opportunities for remote work. As an illustration, African-Americans are far less likely than Caucasians to access online educational resources and are far more likely to suffer from the coronavirus.[3] They also are more likely to have jobs in sectors where the work cannot be performed from home and a number are not able to afford the technologies required to work from their personal residence.

Tech Ramifications for the Federal Budget

It is hard to estimate the precise impact of technology innovation on the federal budget because there are so many direct and indirect ramifications for government revenues and expenses. Shifts

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[2] John R. Allen and Darrell M. West, "The Brookings Glossary of AI and Emerging Technologies," Brookings TechTank, July 13, 2020. https://www.brookings.edu/blog/techtank/2020/07/13/the-brookings-glossary-of-ai-and-emerging-technologies/

[3] Rashawn Ray, "How to Reduce the Racial Gap in COVID-19 Deaths," Brookings FixGov, April 10, 2020. https://www.brookings.edu/blog/fixgov/2020/04/10/how-to-reduce-the-racial-gap-in-covid-19-deaths/

in one area undoubtedly will affect expenditures and revenues in other parts of the budget. A detailed answer to that question would require sophisticated budget modeling.

But one thing that appears clear is we are going to need greater investment by the private and public sectors in several key areas. As I outline below, these areas will include infrastructure, agency modernization, healthcare, education, economic development, and market competition. With the increased importance of lifelong learning in a rapidly changing digital economy, for example, we will need to figure out ways to invest in and deliver effective workforce training, job upskilling, and continuing education.

At the same time, there are likely to be revenue ramifications as the economy shifts toward digital sectors. Many large technology platforms pay a relatively small percentage of their overall revenues in taxes and if that sector grows as a part of the overall economy while firms paying a larger tax share shrink, that could negatively impact government revenues. To deal with that possibility, it may be necessary to close business tax loopholes and/or reenact an alternative minimum tax for large companies.

As an illustration of misaligned tax incentives, research by economists Daron Acemoglu, Andrea Manera, and Pascual Restrepo finds "the U.S. tax code systematically favors investment in robots and software over investments in people". The reason, according to them, is capital investment in equipment is taxed at 5 percent, while the effective labor tax is around 28.5 percent. The result is a tax code that encourages automation far beyond any efficiency gains represented by the software.[4]

There also could be ramifications for the Social Security Trust Fund if there are job losses that reduce the inflow of payroll taxes. The Congressional Budget Office estimates the program could run out of funds in 2031 due to COVID-related job reductions. Any AI-related job disruption could harm the 40 percent of retired Americans for whom Social Security is their only income source.[5]

Improving Infrastructure

Right now, there are around 18 million Americans who lack sufficient access to the internet.[6] This creates problems in terms of economic development, education, healthcare, and employment. You need an online connection to apply for many jobs and a number of people do not have the connectivity required for online education, telemedicine, and remote work. The

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[4] Daron Acemoglu, Andrea Manera, and Pascual Restrepo, "Does the US Tax Code Favor Automation?", Brookings Institution, March 18, 2020. https://www.brookings.edu/bpea-articles/does-the-u-s-tax-code-favor-automation/

[5] Megan Henney, "Social Security Benefit Cuts Could Be Coming," *Fox Business*, September 4, 2020, https://www.foxbusiness.com/economy/social-security-benefit-cuts-could-be-coming-heres-who-it-will-affect-first?ocid=uxbndlbing

[6] Federal Communications Commission, 2020 Broadband Deployment Report, April 20, 2020, https://assets.documentcloud.org/documents/6878120/FCC-20-50A1.pdf

Federal Communications Commission has estimated that it would take $40 billion to close the bulk of that connectivity gap.[7]

In addition, many people lack laptops, notebooks, smart phones, or electronic devices that allow them to stream videos and take advantage of online service delivery. They are not able to utilize new opportunities in virtual education, telemedicine, and remote work and are stuck in low-paying jobs with little opportunity for advancement.

It is vital to close gaps based on race, income, and geography so that all can benefit from the digital economy. As noted by Nicol Turner Lee, those who lack online access fall behind, are not able to utilize digital resources, and suffer greatly during pandemics and economic downturns.[8] For individuals falling on the "wrong side" of the digital divide based either on income or race, it is very difficult to advance economically.

Agency Modernization

Government agencies need to modernize their operations and infrastructure in order to become more efficient and effective. Many state and federal organizations have antiquated information technology that is not user-friendly and does not deliver a high quality of service. Tools that have enabled innovation in the private sector, such as cloud computing, artificial intelligence, machine learning, and data analytics, are not widely deployed in most agencies, which harms agency performance and weakens public confidence in government.

This year, there were vivid examples of these problems in the COVID response. Many states had unemployment systems that were not up to the task of delivering assistance to those who filed jobless claims. Across the country, people reported long wait times, IT systems that crashed, and processes that were hard to understand. We need to modernize government agencies so systems can handle citizen needs, are easy to use, and process information efficiently.

Portable Health Benefits and Faster Vesting of Retirement Benefits

The emerging economy presents challenges with respect to ensuring health and retirement benefits. With a number of employers moving toward greater use of temporary staffing with limited benefits, it is vital that we figure out ways to provide essential benefits. Since most benefits are tied to fulltime employment, any increases in temporary jobs or long-term unemployment will necessitate attention to benefit delivery models.

A key to any reform is the idea of *benefit portability*. In the digital economy, people are moving across employers, and these movements could accelerate in the future. As noted by analysts

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[7] Federal Communications Commission, "Improving the Nation's Digital Infrastructure," January 19, 2017. https://www.fcc.gov/document/improving-nations-digital-infrastructure

[8] Nicol Turner Lee, "What the Coronavirus Reveals about the Digital Divide Between Schools and Communities," Brookings TechTank, March 17, 2020. https://www.brookings.edu/blog/techtank/2020/03/17/what-the-coronavirus-reveals-about-the-digital-divide-between-schools-and-communities/

Daniel Araya and Sunil Johal, "Introducing portable benefits for independent workers so that pension and health care benefits can be taken from gig to gig while requiring contributions from technology platforms that employ these workers" is an important feature of the emerging landscape.[9] In today's world, workers need benefit flexibility to survive in a working environment that can be turbulent and chaotic.

In addition, organizations need to shorten their vesting periods for people to become eligible for company retirement contributions. Right now, many organizations do not vest employees until they have worked at the firm for one or two years. If there is increased joblessness or job churn resulting from tech disruption, lengthy vesting periods will short-change workers, rob them of the benefits of compound interest, and lead to shortfalls in retirement income.

Lifelong Learning and Continuing Education

In a world of rapid technological, organizational, and economic transition, it is imperative that people engage in lifelong learning. The traditional model, in which people focus their learning on the years before age twenty-five, then get a job and devote little attention to education thereafter, is obsolete and dangerously out of tune with the emerging digital era. In the contemporary world, people can expect to switch jobs, see whole sectors disrupted, and need to develop additional skills as a result of major economic shifts. The type of work they do at age thirty likely will be different from what they do at ages forty, fifty, or sixty.

For this reason, it is important that people develop new capabilities throughout their lives. People need to stay abreast of the latest developments and understand that employers will look for different skills as the economy changes. Skills that might be perfectly suited for a certain time may become obsolete due to AI or machine learning and thereby force individuals to update their abilities.

Community colleges are vital in the contemporary situation because they train many adults who need additional coursework. With their lower cost and practical orientation, they are a venue of choice for people of limited financial means and working-class adults wanting to develop new skills. Since they are important in a workforce undergoing transition, it is crucial they be adequately funded so that they can fulfill their mission.

Vocational education and apprenticeship programs also help provide valuable skills and smooth people's transition into the workforce. Students in these programs can join the workforce with the particular skills that are needed and so can contribute to the economy right away.

One possibility to encourage continuing education is the establishment of a *lifelong learning account*. In an era of fast technological innovation and rapid job displacement, there needs to be a way for people to gain new skills throughout their working lifetime. When people are employed, their companies could contribute a set amount to an individual's fund. This account could be augmented by contributions from the person him or herself. The funds would be

[9] Daniel Araya and Sunil Johal, "Work and Social Policy in the Age of Artificial Intelligence," Brookings TechTank, February 28, 2017. https://www.brookings.edu/blog/techtank/2017/02/28/work-and-social-policy-in-the-age-of-artificial-intelligence/

analogous to individual retirement accounts or state government-run 529 college savings plans, but the owner of the account could draw on the account to finance online learning, certificate programs, or job retraining expenses. The account would be portable, so that if the person moved across state lines or switched jobs, the account would migrate with that individual.

Closing Geographic Disparities

As America deploys AI and moves to a digital economy, its two coasts have fared much better economically than the heartland. Much of the technology innovation and resulting economic activity is focused on the East and West coasts and a few metropolitan areas in between. According to research by Brookings senior fellow Mark Moro and analyst Sifan Liu, about 15 percent of American counties generate about 64 percent of GDP economic activity.[10]

That leaves little activity in large parts of the country. Having major geographic inequities is not healthy from an economic or political standpoint. The limited economic activity in rural areas, for example, spawns public discontent and a sense that the system is rigged against those places.

Several communities have sparked economic growth through regional innovation districts. As noted in a 2019 Brookings paper by Robert Atkinson, Mark Muro, and Jacob Whiton, just five cities "Boston, San Francisco, San Jose, Seattle, and San Diego -- accounted for more than 90% of the nation's innovation-sector growth during the years 2005 to 2017."[11]

To improve economic opportunity, these researchers propose public-private partnerships that boost innovation centers in heartland cities. The districts would include regulatory relief, tax benefits, workforce development funding, and infrastructure support designed to spur growth. Some places already have launched innovation districts and been successful at creating new jobs. This approach represents a way to use technology and other sectors to boost growth and better prepare young people for the emerging economy.

Boosting Market Competition

The dominance of large internet platforms complicates the economic situation for small and medium-sized businesses. In a 2020 House Judiciary Antitrust Subcommittee hearing, there were allegations of unfair competition and predatory business practices that hurt these firms. Several legislators suggested greater attention to the "consumer welfare" standard that has guided antitrust enforcement and clarification of the rules regarding possible harms to individuals and businesses.

During a recent Brookings TechTank podcast, Subcommittee Chair David Cicilline called for a Glass-Steagall Act for the internet that would separate the functions of selling goods and services

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[10] Mark Muro and Sifan Liu, "Another Clinton-Trump Divide: High-Output America vs. Low-Output America," Brookings The Avenue, November 29, 2016. https://www.brookings.edu/blog/the-avenue/2016/11/29/another-clinton-trump-divide-high-output-america-vs-low-output-america/

[11] Robert Atkinson, Mark Muro, and Jacob Whiton, "The Case for Growth Centers: How to Spread Tech Innovation Across America," Brookings Institution, December 9, 2019. https://www.brookings.edu/research/growth-centers-how-to-spread-tech-innovation-across-america/

from setting the overall rules of the marketplace. He suggests it is time to have clearer, fairer, and more transparent rules of the digital marketplace and that we need more inclusive policies to rebuild the overall economy.[12]

The Need for Action

To summarize, America is headed for significant economic disruption due to AI and machine learning, and shifts in business models. It is crucial to think proactively as these changes unfold. The longer we wait, the more stressful and painful the transition will be. Now is the time to start having the national discussions required to make meaningful changes. I applaud this committee for providing a platform for this important conversation. Thank you for your time.

[12] Brookings TechTank Podcast, "Why Rep. David Cicilline Thinks We Need a Glass-Steagall Act for the Internet," September 2, 2020. https://www.brookings.edu/blog/techtank/2020/09/02/techtank-podcast-episode-3-why-rep-david-cicilline-thinks-we-need-a-glass-steagall-act-for-the-internet/

Chairman YARMUTH. Thank you, Dr. West, for your testimony.
I now recognize Dr. Matheny from Louisville, Kentucky.

STATEMENT OF JASON MATHENY , PH.D.

Dr. MATHENY. Thank you, Chairman Yarmuth, thank you Ranking Member Womack, and Members of the Committee. And thanks also to my colleagues at the Center for Security and Emerging Technology at Georgetown whose research I will be drawing from today.

AI is a general purpose technology with a broad range of applications in healthcare, agriculture, energy, transportation, national security, and scientific discovery. Advances in AI are likely to be applied across many sectors of the economy spurring growth and enabling new technologies. Policies to strengthen U.S. leadership in AI have enjoyed bipartisan support, at least during the decade that I have worked on the topic.

I worked on AI strategies for both the current administration and the last administration, and there are more similarities than there are differences. Both administrations emphasize the points that I will make here today and each had a positive outlook on the potential for AI to improve American health and prosperity.

As Michael Kratsios, the U.S. chief technology officer recently said, our future rests on getting AI right. AI will support the jobs of the future. Jason Furman, the previous chair of the Council of Economic Advisers in the last administration said that his biggest worry about AI is that we do not have enough of AI.

So while AI will cause changes to the labor market, this has been true of every technology since the industrial revolution and this country has adapted. I believe we will adapt to AI and will be helped by more economic research on the likely effects of AI and automation on the labor force. And by benchmarking to assess progress in various applications of AI.

The United States is in a strong position globally. By most measures, we lead the world in AI and our lead is key—is due to key structural advantages. We have an open society that attracts the world's top scientists and engineers. The National Science Foundation shows that over the half of the master's and Ph.D.-level computer scientists who are employed in the United States were born abroad. We have a competitive private sector that spurs innovation, and we maintain strong international partnerships.

While the U.S. alone funds only 28 percent of global R&D, with our allies we fund more than half. We should double down on these strengths. We should ensure that we remain an attractive destination for global talent by broadening and accelerating the pathways to permanent residency for scientists and engineers. Most research suggests that increases in high skilled immigration yield increases in jobs and wages for Americans due to immigrants' contributions to economic growth and the creation of new companies.

We should also ensure that small and mid-sized businesses have access to the computing power needed for AI applications. We can leverage the purchasing power of the federal government to buy commercial cloud computing credits in the private market and award them through federal grants and contracts competitively as the National Science Foundation has done through its cloud bank

program. We should also strengthen our alliances and foster the responsible use of AI through organizations, such as the Global Partnership on AI, of which the United States is a founding member.

China has made extraordinary technological progress in recent decades and its future prospects should not be underestimated, but U.S. policy should be based on an appreciation of the strengths that have driven our leadership in AI thus far and how they can be leveraged in the future.

While our private sector leads in AI, the federal government plays a key supporting role. Federal research funding laid the foundation for the current wave of AI progress. Federal funding should continue to focus on areas where the private sector is likely to underinvest. That includes basic research, safety and security, testing and evaluation, and verification and validation.

The National Institute of Standards and Technology should be given the resources needed to lead interagency and public-private collaborations on AI testing and evaluation, including establishment of a national AI test bed: A digital platform containing public and nonpublic data sets, code, and testing environments on which AI systems from industry, academia, and the government can be developed, stored, and tested.

Fourth and last, the United States should ensure that it has access to leading edge microelectronics. This country is the birthplace of microelectronics and we continue to design most of the world's leading edge systems, but most devices are now manufactured elsewhere.

Offshoring most of our semiconductor industry has increased the risk of supply chain disruptions during crises. The United States should strengthen U.S. based semiconductor manufacturing to reduce supply chain risks and to increase the number of high-quality jobs at home.

At the same time, we should work with our allies to ensure that democracies remain at the leading edge of microelectronics by investing in joint research programs and by enforcing multilateral export controls on the manufacturing equipment needed to produce advanced chips.

The United States and our allies produce more than 90 percent of this equipment, so we are in a particularly strong position. Legislation, such as the bipartisan proposals for the CHIPS for America Act and the American Foundries Act can help maintain that position.

With these four points on the benefits of AI as a general purpose technology, the sources of U.S. leadership in AI, the federal government's role in supporting the private sector, and the importance of microelectronics, I thank the Committee for the opportunity to speak with you today, and I look forward to your questions.

[The prepared statement of Jason Matheny follows:]

Testimony before the House Budget Committee
"Machines, Artificial Intelligence, & the Workforce:
Recovering & Readying Our Economy for the Future"
by
Jason Matheny
Founding Director, Center for Security and Emerging Technology (CSET)
Walsh School of Foreign Service, Georgetown University
September 10, 2020

Chairman Yarmuth, Ranking Member Womack, Members of the Committee: Good afternoon, and thank you for the opportunity to talk with you today. I'm the founder and director of the Center for Security and Emerging Technology (CSET), a think tank at Georgetown University, that studies the security implications of new technologies, with a focus on artificial intelligence. I also serve as a Commissioner on the National Security Commission on Artificial Intelligence, to which I was appointed by the Senate Select Committee on Intelligence in 2018. I previously worked on similar topics in the federal government as Assistant Director of National Intelligence, and Director of the Intelligence Advanced Research Projects Activity.

In the next few minutes, I'll make four points that I hope we'll return to during the Q&A. They concern the benefits of AI as a general purpose technology, the sources of U.S. leadership in AI, the federal government's role in supporting the private sector, and the importance of microelectronics.

First, AI is a general purpose technology with a broad range of potential applications in healthcare, agriculture, energy, transportation, national security, and scientific discovery. Advances in AI are likely to be applied across many sectors of the economy, spurring growth and enabling new technologies. Policies to strengthen U.S. leadership in AI have enjoyed bipartisan support during the decade that I've worked on the topic. I worked on AI strategies for both the current administration and the last administration, and there are more similarities than there are differences. Both administrations emphasized the points I'll make here today, and each had a positive outlook on the potential for AI to improve American health and prosperity. As Michael Kratsios, the Chief Technology Officer of the United States, has said, "Our future rests on getting AI right. AI will support the jobs of the future."[1] Jason Furman, previous Chair of the Council of Economic Advisors, has said, "the biggest worry I have about it [AI]: that we do not

[1] Michael Kratsios, Remarks at the Center for Data Innovation Forum on AI, September 18, 2019, Washington, DC, https://www.datainnovation.org/2019/09/remarks-by-michael-kratsios-u-s-cto-at-center-for-data-innovation-forum-on-ai/

have enough of AI."[2] While AI will cause changes to the labor market, this has been true of every technology since the Industrial Revolution, and this country has adapted. I believe we will adapt to AI. We'll be helped by more economic research on the likely effects of AI and automation, and by benchmarking to assess progress in various applications of AI.

Second, the United States is in a strong position—by most measures, we lead the world in AI.[3] Our lead is due to key structural advantages:

- We have an open society that attracts the world's top scientists and engineers. National Science Foundation data show that over half of the master's- and PhD-level computer scientists employed in the United States were born abroad.[4]
- We have a competitive private sector that spurs innovation.
- We maintain strong international partnerships—while the US, alone, funds only 28% of global R&D, with our allies we fund more than half.[5]

We should double down on these strengths:

- We should ensure that we remain an attractive destination for global talent by broadening and accelerating the pathways to permanent residency for scientists and engineers.[6] Most research suggests that increases in high-skilled immigration yield increases in jobs and wages for Americans, due to immigrants' contributions to economic growth and the creation of new companies.[7]
- We should ensure that small- and mid-sized businesses have access to the computing power needed for AI applications. We can leverage the purchasing power of the federal government to buy commercial cloud computing credits in the private market and award

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[2] 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*, July 7, 2016, New York, NY, https://obamawhitehouse.archives.gov/sites/default/files/page/files/20160707_cea_ai_furman.pdf

[3] See, for example, Saurabh Mishra, et al., "The AI Index: Global AI Vibrancy Tool" (Stanford University, 2019), http://vibrancy.aiindex.org/; Daniel Castro, Michael McLaughlin, and Eline Chivot, "Who Is Winning the AI Race: China, the EU or the United States?" (Center for Data Innovation, August 2019), https://www.datainnovation.org/2019/08/who-is-winning-the-ai-race-china-the-eu-or-the-united-states/; Andrew Haynes and Luke Gbedemah, "The Global AI Index" (Tortoise, December 2019), https://www.tortoisemedia.com/intelligence/ai/; Jeff Ding, "Deciphering China's AI Dream" (Centre for the Governance of AI, Future of Humanity Institute, University of Oxford, March 2018), https://www.fhi.ox.ac.uk/wp-content/uploads/Deciphering_Chinas_AI-Dream.pdf

[4] Remco Zwetsloot, Roxanne Heston, and Zachary Arnold, "Strengthening the U.S. AI Workforce" (Center for Security and Emerging Technology, September 2019), https://cset.georgetown.edu/research/strengthening-the-u-s-ai-workforce/

[5] Melissa Flagg, "Global R&D and a New Era of Alliances" (Center for Security and Emerging Technology, June 2020), https://cset.georgetown.edu/research/global-rd-and-a-new-era-of-alliances/

[6] Zachary Arnold, Roxanne Heston, Remco Zwetsloot and Tina Huang, *Immigration Policy and the U.S. AI Sector* (Center for Security and Emerging Technology, September 2019), https://cset.georgetown.edu/research/immigration-policy-and-the-u-s-ai-sector/

[7] William Kerr, *The Gift of Global Talent: How Migration Shapes Business, Economy & Society* (Stanford Business Books, 2018)

them through federal grants and contracts, as the National Science Foundation has done through its CloudBank program.

- We should strengthen our alliances[8] and foster the responsible use of AI through organizations such as the Global Partnership on AI, of which the United States was a founding member.

China has made extraordinary technological progress in recent decades, and its future prospects should not be underestimated. But U.S. policy should be based on an appreciation of the strengths that have driven our leadership in AI thus far, and how they can be leveraged in the future. Imitating China is not a winning strategy. Instead, as writer and scholar James Fallows recommended, "We should be more like us."

Third, while our private sector leads in AI, the federal government plays a key supporting role. Federal research funding laid the foundation for the current wave of AI progress. Federal funding should continue to focus on areas where the private sector is likely to underinvest, including basic research, safety and security, testing and evaluation, and verification and validation. The National Institute for Standards and Technology (NIST) should be given the resources needed to lead interagency and public-private collaborations on AI testing and evaluation, including establishment of a national AI test bed—a digital platform containing public and non-public datasets, code, and testing environments on which AI systems can be developed, stored, and tested.

Fourth and last, the United States should ensure that it has access to leading-edge microelectronics. This country is the birthplace of microelectronics, and we continue to design most of the world's leading-edge systems, but most devices are now manufactured elsewhere. Offshoring most of our semiconductor industry has increased the risk of supply chain disruptions during crises. The United States should strengthen U.S.-based semiconductor manufacturing to reduce supply chain risks and create high-quality jobs at home. At the same time, we should work with our allies to ensure that democracies remain at the leading edge of microelectronics by investing in joint research programs and by enforcing multilateral export controls on the semiconductor manufacturing equipment needed to produce advanced chips.[9] The United States and our allies produce more than 90% of this equipment, so we are in a strong position. Legislation, including bipartisan proposals such as the CHIPS for America Act and American Foundries Act, can help maintain our position.

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[8] Andrew Imbrie, Ryan Fedasiuk, Catherine Aiken, Tarun Chhabra and Husanjot Chahal, *Agile Alliances: How the United States and Its Allies Can Deliver a Democratic Way of AI* (Center for Security and Emerging Technology, February 2020), https://cset.georgetown.edu/research/agile-alliances/

[9] Saif Khan and Carrick Flynn, "Maintaining China's Dependence on Democracies for Advanced Computer Chip" (Brookings Institution and Center for Security and Emerging Technology, April 2020), https://cset.georgetown.edu/research/maintaining-chinas-dependence-on-democracies-for-advanced-computer-chips/

With these four points on the benefits of AI as a general purpose technology, the sources of U.S. leadership in AI, the federal government's role in supporting the private sector, and the importance of microelectronics, I thank the Committee for the opportunity to speak with you today. I look forward to your questions.

Chairman YARMUTH. Thank you for your testimony.

Once again, I thank all the witnesses for those statements.

We will now begin our Q&A session.

As a reminder, Members can submit questions to be answered later in writing. Those questions and their responses will be made part of the formal hearing record. Any Members who wish to submit questions for the record may do so by sending them to the Clerk electronically within seven days.

As we usually do, the Ranking Member and I will hold our question periods till the end.

So I now yield five minutes to the gentleman from Pennsylvania, Mr. Boyle.

Mr. BOYLE. Thank you. I hope you can hear me OK, Mr. Chairman.

All right.

Chairman YARMUTH. Yes.

Mr. BOYLE. Thank you.

So whoever said this in the very beginning was right, that no topic, perhaps more—while exciting some people, I would say, inspires more fear, consternation/paranoia than AI. So all of the presentations were very interesting. I want to go back, though, to a point that was made very early on by one of the witnesses because something that I learned, certainly today if you look at our tax code, we treat capital and labor very differently and certainly make it much more attractive for capital versus labor.

I didn't realize that that is not just been a recent tendency, which was always my impression, but one of the witnesses stated that that goes back a ways.

So I was wondering what any of the witnesses would think about constructive ways that we could bring equality to our tax code, ideas like treating capital gains as ordinary income. There is a discussion right now obviously, perhaps started unintentionally by the President in terms of the use of the payroll tax for funding Social Security and Medicare.

I am curious about these ideas because as my line of questioning probably suggests, I am certainly one who thinks that, at the very least, labor and capital should be treated equally in our tax code and we shouldn't have our thumb on the scale, which in my view we heavily do in treating capital more favorably and thus making it actually more attractive for companies to replace the McDonald's worker with the touch screen that I now use—I am advertising my bad eating habits, but—that now we have at so many of our fast food restaurants.

So I will open that up to any of the witnesses and certainly any ideas or proposals you would have, and if you agree with my view that capital and labor should be treated more equally in our tax code.

Chairman YARMUTH. Who wants to take that? Dr. Acemoglu.

Unmute, please.

Dr. ACEMOGLU. OK. Yes. Somehow I was muting and unmuting and muting myself at the same time. Thanks for that question.

Yes, I was the one who talked about the taxation of capital and labor and it is a complex topic. Economists actually differ, in all

full disclosure. There are some economists who passionately think that capital should be taxed at the very low rate or not at all, but I think in the age of automation, the asymmetric treatment of capital and labor in the tax code has a lot of costs.

If you live in a world where every piece of capital needs to be combined with some human operators, there are still problems with asymmetric treatment of capital and labor, certainly distributional consequences, but there is a better case that increased demand for capital equipment is going to trickle down to workers.

But during our current era where automation is so prevalent from the McDonald's checkout kiosks, to customer service, to machinery, numerically controlled machinery, robots and algorithms everywhere, I think the asymmetric treatment of capital and labor does create more severe problems.

Now if that wanted to be reversed, for example, going back to the 1980's or the 1990's when capital and labor were still treated asymmetrically, but the gap was smaller, you know, a couple of items would help a lot. For example, reversing the very generous depreciation allowances which were often introduced during recessionary times as temporary measures and then weren't completely reversed later. That would be a very major step.

Then there is also the issue of, you know, why we have corporations that choose their own tax status, S-corporations versus C-Corporations, and that has changed a lot over recent decades.

And often that is a way of reducing the tax base for capital through some sort of tax arbitrage and I think that is something that needs to be followed through especially since Ranking Member Womack said this Committee is going to look for ways of increasing tax revenues.

And exactly like you have expressed, Representative Boyle, one has to also consider the taxation of capital gains and other items.

If you wanted to go on the other side, there has been a long line of argument in economics going back several decades that payroll taxes are particularly problematic. And in the United States that is actually a very important part of the taxes that labor faces, but, of course, I recognize that right now, with the budget deficit, makes more sense to think of, you know, creating that symmetry by increasing the taxation of capital especially broadening the tax base for capital rather than eliminating taxes, but certainly payroll taxes are something to think about in the future as well.

Thank you.

Chairman YARMUTH. All right. The gentleman's time is expired.

I now recognize the gentleman from Georgia, Mr. Woodall, for five minutes. Is Mr. Woodall on? Unmute if you are on. Not answering. Well, then, I will recognize the gentleman from Ohio, Mr. Johnson for five minutes.

Mr. JOHNSON. Well, thank you, Mr. Chairman. And I appreciate you holding this hearing today and many thanks to our witnesses too.

I am in my car, so I apologize if things are jumping around, but I am an IT guy. I was in undergraduate and graduate school in the late 1970's, early 1980's when AI first came on the horizon. And today there is no doubt, we all know it, technology spans every sector of our economy.

Investments and emerging technologies, such as AI, blockchain, and the internet of things have the exciting potential to drastically improve our economy, national security, and our very way of life through greater efficiency, increased global competitiveness, and creating countless other applications.

In addition to domestic uses for AI, the Department of Defense has been developing and utilizing AI applications for a range of military capabilities, including intelligence collection and analysis, cyber and information operations, logistics, command and control and also for semi or fully autonomous vehicles, but we all know, the United States is not the only country developing AI capabilities.

China, in particular, is investing billions in AI. It is imperative to our national security that the United States continues to be the leader in developing AI and other emerging technologies. However, China resorts to stealing innovation or subsidizing state-owned enterprises. This is not the role of America's federal government, nor should it be given the innovative spirit of the American people and the exciting advances in technology already occurring right here at home.

Rather it is imperative that our federal government enable the private sector to flourish by removing barriers to innovation, something that President Trump and his Administration has taken important steps to do so.

And supporting private sector research and development collaboratively through strategic federal investments in agencies such as the National Institute of Standards and Technology.

So I am very pleased to have introduced H.R. 6940, the Advancing Tech Startups Act, which is part of a larger public energy and tech agenda to create policies that foster American innovation, secure our supply chains, and protect American consumers.

Specifically, my legislation promotes a national strategy for encouraging more tech focused startups and small businesses in all parts of the United States. It is vital to our national security to reduce our reliance on other countries, such as China. And as I have stated, we don't need to rely on any other country. We should, once again, tap into American ingenuity and unleash the American innovation and entrepreneurship that we are famous for.

So Dr. Matheny, some suggest that the United States may be at risk of falling behind in AI development. For example, some experts predict China could in the near future surpass the U.S. and take the lead in AI development. In your opinion, where does the U.S. currently stand globally on AI? Are we leading the way or falling behind?

Dr. MATHENY. Thank you, Congressman Johnson. I think that the U.S. has a strong lead, but that we can maintain it by drawing on our structural advantages compared to China.

First, most scientists and engineers in the world weren't born in either the U.S. or China, and many more of those scientists and engineers would prefer to work and live in the United States than they would like to live or work in China. That is a great advantage to the United States.

High-skilled immigration was key to our victory during World War II and during the cold war. We were simply able to get more scientists and engineers on our side to win.

Second, as we do have a more competitive private sector and, sir, I think your efforts to empower small businesses where there is so much innovation is really key to our success.

Thank you.

Mr. JOHNSON. OK. Are there some actions that we, in Congress, can take or do we need to do more to maintain our global competitive edge in AI, especially given where China's going and the major investments that are in place?

Dr. MATHENY. I think there are two things that I would emphasize. The first is just how important our immigration policy is to allowing us to lead globally given that this is one of the asymmetric strengths that the United States has compares to China.

And the second is our lead in microelectronics. It would be very difficult for China to match us if we play our cards right. We shouldn't rest on our laurels, but if we pursue policies that strengthen our semiconductor industry while also placing the appropriate controls on the manufacturing equipment that China doesn't have and that China currently doesn't have the ability to produce itself and is probably a decade away from being able to produce itself, we will be in a very strong position.

Thank you.

Mr. JOHNSON. OK, well, thanks. Mr. Chairman, I yield back.

Chairman YARMUTH. The gentleman's time is expired.

And I now recognize the gentlewoman from Illinois, Ms. Schakowsky, for five minutes.

Ms. SCHAKOWSKY. Thank you, Mr. Chairman, and thanks to our witnesses.

So technology has certainly addressed some of the isolation problems that people have felt during the pandemic, and look how we are communicating today, so there has been a lot of important changes that technology and opportunities that technology has provided for us, but even before the pandemic, I think there were many, many consumers that reported feelings of helplessness when it comes to with respect to the digital economy.

You know, on my subcommittee in Energy and Commerce, which is the Consumer Protection Subcommittee, we have talked a lot about technology and its ups and downs, and we know that big tech has actually allowed fraud and fake news and fake reviews and counterfeit and stolen products that are thriving on their platforms.

And we have talked about—they come in and talk about self-regulation, and I think it is pretty clear that we need—that that isn't working very well.

But here is the other question. They ask about consumers are concerned about privacy. So Dr. West, I want to ask you. A functioning AI needs data, but we also need to protect consumer privacy.

So in your view, what are the main issues related to consumer privacy and control and ownership of data that we need to consider through as we think through the use of AI technology?

Dr. WEST. Thank you, Congresswoman, for that question. It is a great question. Privacy is very important to consumers. You can look at any set of public opinion surveys and that often ranks very high on the list next to security.

The problem with our current approach to policy at the national level is it is mainly based on what is called notice and consent. Like when you download software or even install an ad, you get this 20-page document that nobody reads and at the bottom, if you want to use the app, you basically have to agree to it.

Nobody reads these. We did a national public opinion survey and basically found that that to be the case. So my Brookings colleague Cam Kerry has been doing a lot of work on thinking about new privacy legislation and what he proposes is basically get rid of the notice and consent because it is not effective in protecting peoples' privacy and basically holding companies responsible for their data sharing practices.

Improving transparency so consumers know more about what is going on, improve everybody's sense of how—what kind of data practices are being deployed.

I mean, there are all sorts of geolocation features that are now built-in to apps. Like if you check the weather, basically the weather app is localized to you so there is a geolocation feature there, there is all sorts of privacy problems that get developed there. So basically we suggest a greater accountability for companies.

California, of course, at the state level has adopted a much tougher law than what we have had nationally. We really encourage Congress to embrace the issue of privacy at the national level. We don't want to end up in a situation where there are 50 different privacy laws. I mean, that creates havoc for the tech companies, makes it difficult for them to innovate. We need a national privacy law that can really address the concerns that consumers have.

Ms. SCHAKOWSKY. Thank you.

In the remaining time that I have, I wanted to really ask any of you who wanted to comment on this. You know that AI is used in policing, in social work, in banking, in healthcare, and we also know that this is a time of racial reckoning in this country, disparities that we see, and we had a hearing in my subcommittee on the issue of discrimination built into algorithms, built into our technology, built into AI.

And I wanted to just ask whoever to talk about how we can ensure that there is accountability to make sure that there is not the kind of built-in bias that discriminates against many in our population?

Someone grab this.

Chairman YARMUTH. Anyone want to handle that real quickly?

Dr. ATHEY. I can speak quickly. I think that we have to consider what the algorithms are replacing, and in some cases they are replacing human decisions, which have perhaps a different set of biases sometimes driven by the fact that the humans are using less information or don't have a full view of someone's circumstance like in resume screening being too superficial.

So in principal, when well-designed, when training data is carefully selected and when best practices are used, actually

digitization can improve the situation and reduce bias, but it has to be done well and it has to be done carefully.

So I believe that we need more research, we need more best practices, and whenever they are used in government situations or regulated situations, we do need to include accountability and ongoing monitoring in order to make sure there are no unintended consequences.

Often engineers themselves don't understand the source of the problem and they won't look for it unless they are asked to, but they also like to use best practices if those are delineated and available. And so this is partly just a maturation of the industry and a maturation of the best practices.

So I am long-term optimistic, but we have to do the hard work to make it improve things rather than make them worse.

Ms. SCHAKOWSKY. Thank you so much.

I yield back.

Chairman YARMUTH. The gentlewoman's time is expired.

And I yield five minutes to the gentleman from Georgia, Mr. Woodall.

Mr. WOODALL. Thank you, Mr. Chairman, for giving me a second chance. You have always been gracious in that way.

Chairman YARMUTH. Of course.

Mr. WOODALL. Mr. Matheny, I wanted to thank you for mentioning the stability in national AI policy between the two administrations that you have had an opportunity to serve. We tend to focus on the chaos, which I think leads to less confidence as opposed to the leaders in the room who are working hand-in-hand administration to administration.

Could you talk a little bit about that? We are about to come up on another major election. Do you anticipate that stability in policy continuing whether it is into a second term of the Trump Administration or the first term of a Biden Administration?

Dr. MATHENY. Thank you, Congressman Woodall. I would expect there to be continuity in the U.S. strategy on AI. I think there really has been a bipartisan consensus that I have seen and a lot of continuity at the Office of Science and Technology policy, in particular, which I think has done a great job both in the last administration and in this administration continuing much of the strategic work that was laid out.

Michael Kratsios and Lynn Parker, in particular, at the office had been outstanding in coordinating the interagency. They led a smart and ambitious AI strategy, which I hope to see continued. It is, I think, one of the best cases of bipartisan coordination around a key technology topic.

Thank you.

Mr. WOODALL. I very much appreciate that.

Dr. Athey, you mentioned not just in your response to Ms. Schakowsky, but also in your opening statement a need to be aware of unintended consequences.

Are there particular unintended consequences that weigh on you in your work or is that just a general admonition as we plow new ground?

Dr. ATHEY. Well, I think maybe one—one answer relates back also to the question about labor versus capital and excessive auto-

mation. In general, firms are going to be thinking primarily about their bottom line and they are often short-term.

So it is going to be—you know, a firm might be indifferent between a worker and a machine from a cost perspective and if they are indifferent they will go with the machine. But, of course, from society's perspective, we care about the jobs and we care about the people and we care about their transitions.

So we do want to think about how are we investing in this R&D generally. We can't always count on companies to take the longer term perspective and our national innovation strategy and R&D strategy can, in principal, develop this general purpose technology in a way that focuses more on augmentation of humans.

So one thing about this general purpose technology is that somebody makes better AI and then lots of people adopt it. And so if somebody makes AI that helps replace humans, lots of other people can copy it. But if universities or a particular company or government invests in AI that augments humans, it is also the case that that can diffuse.

So I think that we can—we need to be intentional about our strategies and recognize the places where we as a society care about the direction of technological innovation so that it pushes more and makes it cheaper and easier for the private sector to then pick up augmenting technologies.

A second thing that I worry a lot about is just that the most recent innovation has been in black box technology. It is powerful in general purpose because it does the work for you.

An engineer who doesn't know anything about a domain can plop down modern machine learning and the machine learning will spit something out, but if it is just applied without a context, without domain experts, without ethical experts or legal experts or people who are thinking about your national security consequences, we might end up in dangerous situations.

And so actually like the privacy and security issues, I think, are especially concerning when we realize that all of us are being observed and monitored sort of 24/7 by our phones and by everything that we do as it all gets digitized. That can create national security issues in that somebody always does something wrong, so we are available for blackmail.

And we are also going to see in the future, because it is so easy and cheap, a lot more worker monitoring, which can be good for safety. We can make sure people are driving safely. We can make sure truck drivers aren't asleep. We can make sure that workers aren't going to be injured on an assembly line if we use video to monitor them.

But, again, we are creating this massive corpus of information about people. And we also need to make sure that that information is applied in a fair way and for benefit rather than being exploiting in various ways.

Mr. WOODALL. Mr. Chairman, I know Dr. Acemoglu referenced companies that were doing it wrong. I hope as this hearing continues we will have an opportunity to talk about some of those companies that are doing it right so that we can benefit from that experience.

I yield back, Mr. Chairman.

Chairman YARMUTH. Absolutely. I will make sure we do that.

Thank you, Mr. Woodall.

I now recognize the gentleman from Michigan, Mr. Kildee, for five minutes.

Mr. KILDEE. Well, first of all, thank you, Mr. Chairman. I assume you can hear me OK?

Chairman YARMUTH. We can.

Mr. KILDEE. I very much appreciate you holding this hearing. It is a very interesting and, I think, obviously very important topic.

I represent an area that has seen a pretty drastic drop in manufacturing jobs over the last 30 or so years. Often, and almost exclusively, attributed to trade policy. And while trade has clearly contributed to the loss of manufacturing jobs in my region of East Central Michigan, Flint, Saginaw, Bay City area, clearly technology has played a pretty significant role in that job loss. We have gone from, in my hometown, of about 80,000 direct manufacturing employees in the auto sector to something around 10,000 right now; but we still produce about half the cars that we used to produce.

So that technology disruption obviously has had a pretty dramatic impact on my community, and now we are trying to imagine and you are thinking and researching about how AI may have that same disruptive effect. So I am curious about any thoughts that any of you have about the pace of development of AI as it relates to manufacturing and specifically around the production of automobiles. I know this might require some speculation, but I think it is really important that we engage in that speculation.

And I am particularly interested, Dr. West, your references to the work of Mark Moro, I have a past relationship with Brookings and did a lot of work around this space, particularly around communities being left behind.

So I am curious if, maybe starting with you, Dr. West, but others might comment on those two aspects: The pace of these trends as they might relate to heavy manufacturing, particularly the auto sector, and then any thoughts you have on compensating interventions that we can deal with that might add to the way we typically deal with trade disruption through trade adjustment assistance, or something like that, how we might think about support for those communities that are being disproportionately impacted by these trends.

So maybe starting with Dr. West.

Dr. WEST. Thank you, Congressman.

I do worry about job losses, and manufacturing is one of the areas where there is already a lot of automation and AI that is being introduced, and we fully expect that to accelerate.

When you look around the world, there are countries that have almost fully automated factories right now where it is basically a bunch of robots driven by AI technology and a handful of humans just monitoring the computer control panels.

But it is not just manufacturing. Finance is going to be disrupted. The retail sector, Amazon already has opened a number of stores with basically no retail clerks. They basically use computer vision to see what you have put in your bag or, you know, what it is that you are purchasing, and they automatically charge you

as you are exiting it. So there certainly is going to be, I believe, an acceleration of job losses.

And in terms of the geographic thing, the thing I would worry about here is if you look at venture capital investment, three-quarters of it now is going into New York, California, and Massachusetts. So, if anything, the geographical inequity is going to accelerate. Already, you know, much of the high tech industry is centered on the East Coast and West Coast and a few metropolitan areas in between, but much of the country is being left behind. My Brookings' colleagues in our Metro Program have done a lot of work on this. This is very worrisome. It creates political anger. People get upset. They feel the system is rigged. They feel like they are being left behind.

So we do need to think about public policies that will address the geographic aspects. Now, one positive development is the growing tendency to move toward remote work. It turns out you no longer have to live in Seattle or San Francisco or Boston or New York in order to work for these tech companies.

In fact, you know, the real estate is growing so expensive in those areas that they are kind of pricing a lot of employees out of that market. So they are starting to rely more on remote work and telework, and so I think public policy can contribute to that.

There is a rural digital divide where people living in the country have less access to broadband and less access to high-speed broadband. They are less able to take advantage of these remote work things. So Congress should definitely invest in infrastructure, development in the broadband area just to reduce that digital divide so that, as companies start to move to telework and remote work, everybody can take advantage of that, including people living in the heartland.

Mr. KILDEE. Thank you. It is a fascinating subject. I look forward to pursuing it further.

My time has expired, so I yield back. Thank you, Mr. Chairman.

Chairman YARMUTH. I thank the gentleman. The gentleman's time has expired.

I now recognize the gentleman from Texas, Mr. Flores, for five minutes.

Mr. FLORES. Thank you, Chairman Yarmuth, and I appreciate you holding this informative hearing today.

I want to note something that you said at the beginning, that the government moves at 10 miles an hour when the rest of the economy is moving at 100 miles an hour, and I will talk about that in a minute.

I personally am excited about the opportunities that AI brings moving forward. I know that several people are apprehensive about it, but I think that we as policymakers need to be excited about it.

A couple of things I want to comment on before I go on to my questions. Number one is, I think that there has been a lot of discussion about R&D, and I think one of the essential roles of the federal government is robust investment in basic research and development, and I say this from the perspective that I represent two large tier 1 research and education institutions and also have a great high tech footprint in several parts of my district that rely

on that, and those discoveries that come out of the search for basic knowledge from basic R&D.

The second thing is I think we as policymakers need to be very careful about trying to get into adjusting the mix of capital versus labor because, as you said early on, Chairman Yarmuth, the government moves slowly, and I think we as policymakers could wind up being well behind where the economy is if we are not careful with that.

I would like to thank all of the witnesses for participating. Dr. Matheny, I have a couple of questions for you. As we are all aware, Taiwan through its TSMC Foundry is a leading semiconductor manufacturer for many countries, and particularly we in the U.S. rely on them for AI development.

The first question is this: Does the U.S. rely too heavily on other countries for AI development, and what can the U.S. do to put less of this reliance on other countries?

Dr. MATHENY. Thank you. Thank you, Congressman Flores. And, first, thanks also for your emphasis on research. I think one of the most exciting opportunities is for AI to be applied to research itself, to accelerate science and engineering. I think some of the more exciting demonstrations that we have seen on this include DeepMind's use of AI to solve protein folding problems, which are really important for biomedical research. So I hope we will see more of that in ways that can expand the economy and produce jobs.

To your very good question about Taiwan Semiconductor Manufacturing Corporation. I think the U.S. does rely too much on imported semiconductors, which introduces at least three risks.

The first is that our dependence on manufacturing in Taiwan means that we have a supply chain that could be disrupted by a conflict with China.

The second is that Taiwan is vulnerable to having its workforce and its IP poached because of its proximity to China.

And third is we risk having our own know-how vanish in a key industry the more we import.

I think Intel's recent announcement that they were considering outsourcing their most advanced manufacturing, which would be really the only U.S. based advanced manufacturing of semiconductors, is extremely worrying. So I think it is prudent to reshore some semiconductor manufacturing to the United States, particularly the leading edge chips that are used to power many of the AI applications that will be valuable in the future.

And beyond the security benefits, this would also create new manufacturing jobs for Americans.

Thank you.

Mr. FLORES. Thank you.

You know what, you actually answered the second part of my question that talked about the economic and national security threats that exist if we rely on other regions and other countries. Let me ask a second question.

As you are aware AI development requires talented workers with particular skill sets. In order for the U.S. to continue leading the way in AI development, it is critical that we continue to develop domestic talent in addition to attracting talent from abroad.

When you answered Mr. Johnson's question a minute ago, you talked about attracting the best talent from abroad. What policy recommendations do you have to ensure that the U.S. successfully cultivates a domestic talent supply for AI?

And, for instance, talk in particular about what the education system will look like for that group of persons.

Dr. MATHENY. Thank you for asking the question.

My sister is a school teacher and a great one, so I have a deep sympathy for school teachers who are trying to teach computer science and mathematics. These are difficult topics to teach, but we need to find ways of teaching more of our students the strong math skills that they are going to need.

Mathematics is really the discipline that is most useful to succeeding in AI. And we simply need to find better ways of teaching math to our students and finding ways to teach more of it.

We also need to address the AI labor needs that aren't in research and development. I know discussions around tech talent often center around the scarcest and most educated parts of the workforce; but a critical talent gap also sits in skilled labor, and for our skilled labor to compete globally, it will need help from technology.

China enjoys a manufacturing advantage due to its vast workforce, which is about 11 times the size of the U.S. manufacturing workforce. But despite its larger size, the Chinese manufacturing sector only produces about twice the amount of value-adds. So the average U.S. manufacturing worker is about six times as productive as the average Chinese manufacturing worker.

So reshoring manufacturing will require that we both increase the parts of our labor force while also increasing the productivity per worker, which is going to have to be achieved through both training and technology. One example is cobots, robotic systems that complement human workers in order to increase their productivity per person.

Thank you.

Mr. FLORES. OK. Thank you, Dr. Matheny. And my time has expired.

Chairman YARMUTH. The gentlemen's time has expired.

I now recognize the gentleman from California, Mr. Panetta, for five minutes.

Mr. PANETTA. Great. Thank you, Mr. Chairman. I appreciate this hearing, appreciate this opportunity, Ranking Member Womack. I apologize if my connection is spotty, but I have two daughters learning remotely, sucking up a lot of the bandwidth. I guess it would be in more ways than one, not just virtually but mentally for their parents; but that is a whole other story.

Let me just say I appreciate this opportunity to have this type of hearing, especially when it comes to the risks of automation for workers, especially for those jobs where automation only provides a marginal cost in productivity benefit over the human worker.

Now, I think we all sort of agree that we need to focus on these workers and how such changes will affect them, but we need to be very careful not to discourage automation or technological progress because I think all of us agree that automation and, yes, AI hold

tremendous promise when it comes to improving our lives and our economy.

Now, it can also eliminate, as we know, some very tedious tasks so that workers can focus on being more productive, and it does lower prices for consumers, improving our daily lives, and raising the standard of living for low-income families. So because automation has that ability to increase worker productivity, it is our responsibility to ensure that workers benefit from their increased value.

But taxing or otherwise disincentivizing automation I don't think saves jobs, and I do think it will make our economy less nimble and risk us falling further behind our competitors, like China.

And that is why I believe we need to continue to invest in automation and cutting edge technology like artificial intelligence. That is why we should continue to keep the U.S. competitive in these areas for the sake of our security.

And yet if the successes in these areas do lead to displacement, it is our responsibility to help those workers, and we should be prepared to support those workers, rethinking our social safety net, how we retrain those workers, bolstering their workers' rights, strengthening collective bargaining for higher wages and job security so that the productivity increases.

That also means we need to study how workers can best complement automation and artificial intelligence, but we should not, we should not shy away from these fundamental challenges by stunting progress and protections for our national, economic, and food security.

Now, here on the Central Coast, when it comes to food security, we live up to our jobs, we live up to our responsibilities. We have a lot of farms, farmers, and farm workers. And as Dan Kildee will tell you, I live in the salad bowl of the world because of it. We have a lot of specialty crops that cannot be harvested like traditional row crops in the Midwest, concerning corn, soy, and wheat. We have crops where human discernment as to what is a ripe, safe, and aesthetically pleasing product is really difficult to replace.

But our ag workforce is very necessary right now. Unfortunately, though, it is an age thing and it is shrinking. And the pandemic is highlighting not just how valuable that workforce is but how vulnerable they are.

Now, obviously, it is a two-prong solution. Yes, one is immigration reform, looking at the Farm Workforce Modernization Act that passed out of the House this year. The other, though, is investment in specialty crop mechanization, dealing with how you can harvest those types of very difficult to harvest crops.

Now, obviously, the private industry is working more to develop these technologies and to fulfill that labor gap, but I believe the federal government has a critical role to play in helping oversee and scale up these investments, if I may say so.

Now my first question, Dr. Athey, is as we develop these types of technologies to save labor, to save our food security, what steps do you think are necessary to protect existing farm workers and for them to transition and adapt to these new types of existing circumstances?

Dr. ATHEY. Thank you for that question.

I believe that historically we have not really done the greatest job in dealing with displaced workers in general. In economics class we teach about, you know, all of the benefits from trade and, you know, more efficient production of products; but then as a society we forget about that second step where you actually get the redistribution done and deal with the consequences.

But where I am optimistic is that I think we have a lot more tools at our disposal now to reach people, to use data to figure out what is the best next step for a worker, what types of up-skilling will actually work for a person in this circumstance. And that in turn can help people feel comfortable in the investment because, of course, for a worker to take their scarce time and invest in trying to acquire a skill, they need to have confidence that if they do make that effort and take that scarce time and money, they will be able to use that to get a new job.

And so I think we have just had services in the past that haven't really responded to the individual worker, to the individual worker's circumstance, and then provided them with effective training and relocation services.

But I believe that we can do better. I am collaborating with a project in Rhode Island working with the state government to try to improve both the data to evaluate training programs and as well try to help workers to have better information for making choices. And I think that with technology and data we can do better, and we can also reduce the cost of delivery by bringing services to people remotely in their homes at a time that is convenient for them, so they don't have to get in their car, they don't have to hire a babysitter and, you know, sacrifice income in order to receive the training that they need.

So I am optimistic about the future, but we have to be intentional about it, and we actually have to execute and follow through on those types of promises.

Mr. PANETTA. Agreed. Thank you, Doctor.

Thank you, Mr. Chairman. I yield back.

Chairman YARMUTH. The gentleman's time has expired.

I now recognize the gentleman from Oklahoma, Mr. Hern, for five minutes.

Unmute. Mr. Hern, unmute. Oh, you need to be helped?

Mr. HERN. I did it twice. It is good. OK. We are good again.

Chairman YARMUTH. There you go.

Mr. HERN. Thank you, Chairman, Ranking Member Womack, for holding this important hearing today, and thanks to all of our witnesses for being her today. This is a topic that I find quite fascinating, being an engineer myself.

Unfortunately, due to the unforeseen spread of a particular virus from China, economic growth has been stunted, and so this really gets to be a real exacerbated issue right now that it is up to us really to fix.

The U.S. economy has been forced—it is force built by hard working, first starting Americans, and we only move forward as a country if we continue to support innovation and encourage workers to get back into the workforce.

AI can act as a great catalyst to both needs, and the U.S. Government should create a regulatory environment which enables

growth and innovation, rather than creating hurdles to both, if we want and would like to beat China and others in this space as our own available workforce declines.

My question now is—there has been many answers to the questions that I had; but one of the witnesses really is pretty fascinating as we get into it. We talked a lot about the technical aspects of this.

But, Dr. Athey, let's just talk about the workforce. There has been a lot of talk about workforce replacement, but we haven't talked at all about the lack of workforce. And for the first time in at least a generation government figures show a larger of open jobs than people out of work. Obviously, this was pre COVID, but it was only six months ago. And certainly a lot of us, probably all of us, hope we get back there very quickly.

And part of that problem is demographics, labor and market growth. The U.S. birth rate has been falling and is at a 30-year low, and simultaneously baby boomers are hitting retirement age, a big force behind the falling number of unemployed. Some would argue it is the real problem of our Medicare issues and our Social Security issues. We don't have enough people working to fund those programs, along with the aging population.

In fact, McKinsey Global Institute research on the automation potential of the global economy focuses on 46 countries representing about 80 percent of the global workforce and has examined more than 2,000 work activities and quantified the technical feasibility of automating each of them. But the proportion of occupations that can be fully automated using current technology is actually pretty small, only about 5 percent.

And if you could speak to that AI as our workforce continues and declines and our need for consumption grows, I would like to get what your thoughts are on policies—and I am being flippant in this; but, you know, if you go back to the McKinsey group, it forces higher fertility and prevent us all from getting older, which are two driving forces. And while that is ridiculous, you can't, there is at least one—and I would like to piggyback off on my colleague from California when he talks about immigration. You know, there is a big push, and the President has pushed for this, for merit-based immigration, bringing people in that can add to where we need to go from a technology standpoint to help us continue our drive for AI.

So as you are aware, AI requires talented workers from particular skill sets so that we can continue to lead the way as our witnesses have testified. And so what policy recommendations do you have to ensure the U.S. successfully cultivates a domestic talent supply in this space? Will students need a different education to pursue careers in AI versus what they are doing right now?

Dr. ATHEY. Thank you, Congressman, for the question. And you raised a number of really crucial issues.

Of course, everyone on the Budget Committee I am sure is acutely aware that the amount of our budget that we are spending on older Americans is increasing dramatically, and so we need to really think about how we are going to deliver services to our aging population more efficiently and also what can we do to keep people in the workforce, preferably in the workforce longer, which might

be in a second career or a part-time job that looks very different than how work was done in the past.

So I think the first important consideration is to think about what will all of these elderly people need and how can we help them live independently, live fulfilling lives, and get of the services they need. I think AI and automation can actually help quite a bit because some of the things that make it difficult to work as you age include, you know, physical challenges, as well as memory challenges and, you know, certain cognitive aspects of the job, all of which can be alleviated through augmenting AI or physical robots, which might allow humans to work longer and focus on the aspects of the job that involve interpersonal relationships, comforting seniors, helping them get their psychological needs met.

So you might have seniors helping seniors. It is also the case that actually there is a lot of service work at that time that in the end may not be fully replaced by automation.

So I see that this aging population is a challenge, but it also points our way toward solutions for those people. And, more broadly, the demographic crisis highlights for us that immigration will be important because we see a shortage of workers on the horizon and a shortage of taxpayers in the working age when you look at the demographics.

It is much harder to predict what is exactly going to happen to automation in 10 years, but we already know how many 20-year-olds we have in the country who will be 40 in 20 years. Unless we bring in more 40-years-old, you know, we are kind of stuck with what we have got.

So we can expand immigration, but we can also think about how to most effectively use the people we have and allow our aging population to contribute in meaningful ways as they age.

Thank you.

Mr. HERN. Thank you so much.

Mr. Chairman, I yield back.

Chairman YARMUTH. The gentleman's time has expired.

I now recognize the gentleman from New York, Mr. Morelle, for five minutes.

Mr. MORELLE. Thank you very much, Mr. Chairman, for holding another really, really important issue facing the country.

Before I begin, I do want to also add my welcome to Representative Jacobs, who I had the privilege of serving with in the New York State Legislature, and I am delighted that he has joined this Committee. I am looking forward to continuing to work with my neighbor to the west in up-state New York.

I just want to say a couple of things. I think some of the comments by the other members have been really, really provocative, and there are a ton of questions here. To me this isn't a question of whether or not AI, machine learning, robotics, and innovative technology will reshape the landscape economically and as it relates to the workforce. It is doing it. It will continue to do it. It is happening, in many respects, at breakneck speed. And I think then the question for us, we have always marketed ourselves as a nation of opportunity, a nation of innovation.

So the question is, as public policy challenges emerge because of it, what do we do? How do we think through this? I think that is why this hearing is so critical.

The way I see AI, I guess I think about it in a couple different buckets. One is, to the extent that it could displace human beings in some jobs and in some occupations, the more I see it as ways to create tools that will allow people to do their jobs faster, better, more efficiently. But there is no question it is going to have an impact and we need to think about it.

One of the things, as it relates to the budget—and perhaps people can talk about this—you know, the President has talked about elimination or deferral of payroll taxes. Obviously, that has an impact on Social Security. It has an impact on Medicare. But even beyond the call for reduction of payroll taxes, to the extent that there is a displacement of workers or lessening of wages because jobs become a focus of commodity-like activities, what I am struck by is so much of what we have built on the safety net, Medicare and Social Security being two of the most obvious, built into a system where we get revenues based on payroll.

So, you know, there have been suggestions by some folks looking at this, to the extent that we look at displacement, should there be alternative ways of looking at taxation so we can continue to provide resources to Social Security, to Medicare to make sure that particularly as the baby boom generation starts to move into some of these programs, you are going to see this significant percentage of the population in Medicare, in Social Security, and given the reproduction rate in the United States is at an all-time low, and mix that in with AI and machine learning, robotics.

Could anyone—and perhaps, Dr. West, maybe you can help answer this. Is there something we should be looking at in terms of a replacement for payroll taxes that is based on—I know people have talked about the difference between capital and people when it comes to investment and tax payments.

Can you talk a little bit how we can make sure that our revenue base doesn't decline if we see jobs displaced by either AI, robotics, machines, et cetera.

Dr. WEST. That is a great question, Congressman.

I think we do need to think about the tax system both in terms of tax rates, tax credits but possibly also new types of taxes. And if you go back a hundred years to the start of the industrial revolution, you know, we found our tax system to be inadequate at that time, and so we developed new taxes, we developed new social programs. And I think now as we are moving to the digital economy, we need to be asking big questions like that.

So I am not sure exactly what the kind of new taxes could be, like people propose a financial transactions tax that would kind of help with income inequality in general. Some countries are implementing digital services taxes. So there is a lot of new ideas that are being formulated there.

And on the first part of your question, you are right about the importance of market competition, and the key in innovation has always been small and medium size enterprises. We are worried about a loss of market competition, and so I think Congress should really think about ways to promote small and medium size enter-

prises just so we can maintain the startup the economy that has fueled American prosperity for several decades.

Mr. MORELLE. Yes, thank you. I think that is a really important comment.

And I would just say in the few seconds that I have left, what I do worry about is we don't want to create disincentive for investment in innovative technologies. We also don't want to put ourselves in a position where, as a result of that, we have displaced workers and the payroll taxes that support much of our social infrastructure.

So I want to thank the panelists. Thank you, Mr. Chair, for a great hearing. I yield back.

Chairman YARMUTH. Thank you. The gentleman's time has expired.

And now I recognize, in his debut Budget Committee appearance, Mr. Jacobs from New York.

Mr. JACOBS. All right. Can you hear me, or no?

Chairman YARMUTH. You are live.

Mr. JACOBS. I am having some problems here.

Chairman YARMUTH. You may have muted yourself.

Now you are fine. You should be good.

Mr. JACOBS. Can you hear me?

Chairman YARMUTH. Yes.

Mr. JACOBS. OK. Sorry about that.

Thank you, Mr. Chairman. Thank you, everybody. Great to be on. And I guess I need a little AI to help me with the unmuting here.

I just wanted to first comment, Dr. Matheny, on some things you talked about regarding semiconductors. I have an area, Batavia, New York, in my district where they have been working for a number of years in developing an advanced manufacturing park. One of their hopes would be to lure a semiconductor facility there because of the inherent assets we have in terms of low-cost power due to the proximity of the Niagra Falls Power Plant and also abundant water.

And in talking with them, they discussed this issue of the loss of our semiconductor industry nationally, and one statistic I just wanted to echo why this is so important what you are talking about, in the year 2000, the United States had 24 percent of the semiconductor production in the world. Now we are at 12 percent. In the year 2000, China had zero percent of the production, and now they have 16 percent, and they are investing another trillion dollars in this sector in the next decade.

So, you know, this is a major issue and look forward to pushing for policy nationally that will help level the playing field so that we can make sure that we maintain and grow this sector for the important reasons that are mentioned here.

I wanted to ask a question of Dr. West. My district, as we talk about inequalities, would be geographic. My district is rather rural and definitely have concern—we have major issues with lack of high-speed internet access, and it is being more pronounced right now with the needs for distance learning and telehealth, but in an effort to be economically competitive in the future.

And I was just curious—so, clearly, I am all in for any additional money and programs to push for rural broadband because it is important as any other piece of infrastructure right now for our area. But in terms of you mentioned innovation districts as the model of something to try to allow areas that are not on the coast to be competitive in the new day era, and I was wondering if there is examples of success that you have of innovation districts? Thank you.

Dr. WEST. Well, it is funny you should ask that—and the Chairman will love this because Louisville is actually an example. Louisville is an example where they have developed a pretty successful regional innovation district. Brookings actually is helping advise some of the organizations there. It is a public-private partnership. So you can talk to the Chair about how they did that.

On the rural part of your question, I can really appreciate this because I grew up on a dairy farm in rural Ohio many years ago, and rural areas are really being left behind right now. So we really need to address the infrastructure part and especially the broadband part because, as I mentioned earlier, like there are opportunities for remote work, like you don't have to live in San Francisco, you could live in your district and still work for any of these tech companies, but you need high-speed broadband.

Just this week my Brookings' colleague, Tom Wheeler, had a short report where he gave a couple of very specific ideas for the Federal Communications Commission, which he used to head. One is a reform of the E-Rate program, which was set up to connect classrooms. It turns out there is a $2 billion surplus in that fund, meaning there is unspent money that was designed to connect classrooms. Now that so many people are engaged in home schooling, you know, we could actually redirect some of that $2 billion to improve rural broadband in order to facilitate home schooling. It is very consistent with the purpose of that program, so you should talk to the people at the FCC about that.

And then, second, with the Lifeline program, which the FCC also runs, including cable companies, not just phone companies, in rolling out digital services and broadband, just because today people are almost as likely to get their broadband via a cable company as a phone company. So if we could broaden the Lifeline program to basically address the ways people are ordering broadband, that would help, and also making—including companies that offer prepaid services.

So in the Tom Wheeler post, he talked about all of these ideas. But I think they are particularly relevant for your district and other rural areas across America.

Mr. JACOBS. Great. Thank you very much.

I yield back the rest of my time.

Chairman YARMUTH. The gentleman yields back.

I now recognize the gentleman from California, Mr. Khanna, for five minutes.

Mr. KHANNA. Thank you, Mr. Chairman. And thank you, Dr. West. I highly recommend Mark Moro's paper, and it is not just in Chairman's Louisville district, but even in Paintsville, Kentucky, they have had quite a lot of success in bringing technology to rural communities, and I appreciate your work and Brookings' work on that.

I had a question for Professor Acemoglu, whose work I admire very much. I was struck by this idea of excessive automation, and I understand the tax incentives that may be off, but bracketing that aside, what explains the move toward excessive automation? Is it a sense that there is some kind of market failure where companies are actually making irrational decisions to automate in ways that aren't profitable, or is it that it is marginally profitable but it is not having aggregate productivity gains for society?

Dr. ACEMOGLU. Thank you very much, Congressman Khanna. I think that is a great question. And it is a variety of factors.

First of all, it is indeed the tax incentives, so we cannot ignore that. You know, there is no natural rate at which capital and labor are going to be taxed, so it is a policy choice, and that policy choice is going to have consequences.

A second important factor is that labor and capital use may have social consequences and economic consequences that go beyond what companies calculate.

So, for example, if people are better citizens or they contribute more to their community or to their families when they are employed, that is not going to be part of the calculation of companies, and it is part of policymakers to actually decide that.

So do we, for the same GDP, would we be happy when that is produced by humans partly versus when a lot of it is produced by capital? I think a lot of policymakers would say actually for the same GDP, we would like it quite a bit if humans are part of that equation, which means that we actually value as a community, as a society, humans being part of that calculation.

And technology has gone in a way that makes it possible for greater substitution of machines and algorithms, so some of those external effects that were less relevant now become more relevant.

And the third factor is that it is not necessarily irrational, but different companies have different business models. So if you look at the periods in which the American economy has done very well while it was also automating, this diversity of perspective, diversity of approaches was very important.

Let me give you one example. Mechanization of agriculture. That is an even more transformative automation event than the ones that we are talking about right now. More than half of the U.S. economy was agriculture, and there was a huge, tremendous decline in labor share in agriculture as machines started performing tasks that were previously done by humans.

But during that period, American growth didn't just come from agriculture. It also came from other sectors that picked up labor that was displaced or the children of the labor that were displaced often because some greater human capital was necessary. So the manufacturing sector introduced a lot of both production and non-production jobs, a lot of the non-manufacturing sector expanded.

So it is sort of diversity of approaches, diversity of technologies was quite critical. So one of the things that may be less active today is that we are not using the enormous technological platform that AI presents us in ways that can create jobs, tasks, opportunities for labor in other sectors of the economy.

So, for example, when earlier on there was a discussion of robots and what was going on in Flint, Michigan, you know, that is abso-

lutely central that there were a lot of production jobs that were eliminated.

The same has happened everywhere. If you look at South Korea, if you look at Germany, other countries that have introduced a lot of robots, production jobs were eliminated in more or less the same number as in the United States. But in many of these cases, there were also non-production jobs that were created more or less simultaneously, sometimes in the same companies, sometimes in the same markets, and that is what we haven't seen in the United States.

When you look at Flint, when you look at Saginaw or other parts of the industrial heartland, you have these production jobs disappearing, but we are not using the technology to create other jobs to compensate for this.

Mr. KHANNA. Very briefly, how would you create other jobs? What would be one or two bullets points of what we could have done in Flint to create those other jobs?

Dr. ACEMOGLU. Well, I think in Flint, you know, it is a little bit hard for me to say from here what exactly the skills that would be easily transferable. But when you look at broadly, you know, there are many applications of AI in education, in healthcare, in manufacturing that are completely capable of creating jobs.

For instance, automation in manufacturing also enables job creation because it reduces offshoring, so there is mounting evidence that, you know, not the jobs that were destroyed to trade with China or to the first wave of automation are not going to come back. But there are certainly opportunities for many jobs to come back, offshore jobs to come back as the automation process continues because it is a cost-saving possibility.

So many of those are not in the production line. They are in the supporting capacities. But they are very, very important and potentially high wage jobs. And, again, evidence from Germany suggests that many of the jobs that were created, even in the same companies that were automating at the same time, were paying higher wages or comparable wages to the production jobs that were destroyed.

Mr. KHANNA. Thank you.

Chairman YARMUTH. The gentleman's time has expired.

I now recognize the gentleman from Virginia, Mr. Scott, for five minutes.

Mr. SCOTT. Thank you, Mr. Chairman. I had to find it.

I am sorry, I came on a little late, so let me just ask a couple of general questions.

First, to any of the panelists, how real is the threat to laid off workers that their employers might decide to increase artificial intelligence rather than rehire their workers?

Chairman YARMUTH. Any takers?

Dr. ACEMOGLU. I can give a quick answer to that.

We don't know. We don't know for sure, but in recent surveys, about 75 percent of companies are saying that they are either taking steps to increase automation or they are planning to do so. So there is a real possibility that some of those jobs will not come back even if the economy picks up.

The other issue that we need to think about is that the sectoral composition of the economy is going to change in a post COVID–19 world. The hospitality sector will probably be much slower to come back, so there will be a natural reallocation.

Some of that reallocation is, obviously, healthy and efficient, but it will still have great costs on some of the poorer communities and some of the poorer segments of U.S. society.

So I think those are, as some of the earlier comments indicated, questions related to the social safety net; but broadly—and this has been one of the main themes that I have tried to emphasize—it is not just a social safety net issue. If we think that displacement is just a social safety net issue, that would mean that we would be happy to have a lot of workers being displaced and find ways of providing good social services and a decent standard of living to them.

But, again, I don't think that would be a healthy economy or a healthy society. That is why it is important for us to find ways of using our existing and technology know-how and our technological capabilities in order to find ways of deploying our enormously productive, our very well skilled workforce in other activities.

Thank you.

Mr. SCOTT. Let me ask you a followup question to that. If there are going to be fewer workers, does that have budget implications on your people having taxes and, therefore, lower revenues?

Dr. ACEMOGLU. Oh, I am glad you asked that. That is a very, very important question as well.

So if you—one of the themes that I emphasize is that our tax system is asymmetric. It taxes capital less than labor, and it has become more so. That has major budgetary implications because if you look at the U.S. distribution of income, the share of labor has gone down from around 67 percent of national income to less than 58 percent.

So that means that income is shifting away from the more heavily taxed factor to the more lightly taxed factor, and it will have budgetary implications.

And another theme that I have tried to emphasize, but it was very quick so this gives me an opportunity to underscore it one more time, is that part of the reason is because our capital tax base is very narrow.

It is not just a question of jacking tax rates on capital and introducing huge wealth taxes or anything like that. There is just a big chunk of capital income that we don't tax, and that means it is costly, it is asymmetric, it may distort the allocation of capital and labor in work places, but increasingly has major budgetary implications.

Thank you.

Mr. SCOTT. Does that include—you know, we have tax credits for investments in machines but not in education. Is that something we ought to address?

Dr. ACEMOGLU. Absolutely. Absolutely, 100 percent. If you look at decline in the tax rates basing capital that went from over 15 percent to less than 5 percent in the last 20 years, about half of that is because of the very generous investment tax credits, which are so generous that if you have debt financed capital investment

in software or S corporations, you may actually be getting a small net subsidy. We have nothing similar to that for education or training.

Thank you.

Mr. SCOTT. Well, talking about education and training, to get into an AI job, you don't sign up for an education for AI. I heard math is important, but what should the Committee on Education and Labor be doing for higher education?

Dr. MATHENY. I can take a piece of this.

One thing that I think would be especially useful is a tithe, a 10 percent allocation for public research grants to go toward teaching because otherwise we are eating our seed corn. We are spending all of our Federal R&D on the research rather than on the teaching. And in most of the major universities where AI is being taught, there is a natural tension for the professors to focus on research as opposed to allocating time to teaching. We need to make sure that we are training the next generation, and a tithe, particularly on NSF grants, could help with that, turning it over to others.

Mr. SCOTT. Well, thank you, Mr. Chairman. My time has expired. Thank you so much.

Chairman YARMUTH. The gentleman's time has expired.

I now recognize the gentlewoman from Texas, Ms. Jackson Lee, for five minutes.

Ms. JACKSON LEE. Thank you very much, Mr. Chairman, and thank you very much for the hearing both with you and the Ranking Member, and thank you to the panelists.

Let me just add a description that should not be taken as an offense, but we are all speaking now to the have's because the have-not's are not in the room. And I think this is a very important basis upon which we are responding because that is the focus that I will have, along with maybe a more definitive question about a tax scheme that would work to help AI.

I am going to start with Dr. West, who early in his testimony mentioned the question of income inequality and worker dislocation. Those people today are not in the room. We, as Members of Congress, represent a wide landscape of individuals.

Can you pointedly, Dr. West, talk about what should be our response on the apparent and existing income inequality and the potential worker dislocation?

Dr. WEST. That is a great question, Congresswoman, and you are exactly right. There are income disparities. There are racial disparities. This is a huge problem. We are almost in a situation where technology is helping to fuel the inequality in the sense that the have's are doing better and getting tax breaks and have programs that support them, and people at the lower end aren't even in the game. They don't have access to the digital economy. There are 18 million Americans who do not have broadband. A larger number doesn't have a high-speed broadband.

So the way that we need to address these issues, certainly infrastructure investment, the things we have talked about earlier, a rural broadband, in underserved urban areas as well, putting more money into education, and especially opportunities for online education, because that would be a way to help overcome the disparities; but you need the broadband in order to be able to access that.

The same thing applies in terms of telemedicine. One of the features of COVID is it has jump started what already was in existence, a trend toward telemedicine, and has really accelerated it, but not everybody is able to share in the benefits of that. And given the racial disparities in the incidents and fatality rates of COVID, like that is a scandal that people who need it the most are not getting access.

So there are a lot of different things we need to do, and we certainly need to address the inequities in the tax system.

Ms. JACKSON LEE. Well, clearly, it means that out of the Budget Committee we should be focusing on just the infrastructure that you mentioned. It is a shame that in 2020 we are still fighting to get broadband everywhere, and for those of us who are watching our schools open and they are hybrid or virtual, to see people standing in line trying to simply get laptops because they don't even have that and as well hot spots or the hot boxes so they can have the opportunity to have access.

Let me do a round robin question dealing with COVID–19. We have heard a very stark admission of the knowledge of how deadly COVID–19 was as early as February 7, 2020, if I might. Let me ask all of you to comment how COVID–19 could have been attacked, if I might, starting with Dr. Athey and going to Dr. Matheny, with artificial intelligence in terms of treatment, in terms of outreach, in terms of saving lives.

Doctor—is it pronounced correctly, Dr. Athey?

Dr. ATHEY. Yes, Dr. Athey. Thank you very much for the question.

And I think the telemedicine point is super important. We were a little slow getting started in trying to get information to people, getting people in touch with their doctors without broadband access and without good access to medicine. We weren't always making good decisions for patients early.

Another thing is that actually using AI machine learning to understand what treatments work best was actually very limited in the United States by our disjointed medical system and the inability to do analysis that incorporates data from multiple sources because, as the epidemic happened, patients were being treated in hospitals. The insurance companies only get the data later once bills have gone out, and that is not fast enough.

So it turned out that we were just unprepared to be able to do analysis that spanned multiple medical centers and give real-time intelligence. We also missed opportunities to have a more coordinated approach to clinical trials and R&D that was really focused on getting the most information and the best treatment decisions possible given the patient flow that we had. There was just a lack of coordination.

And I really hope that if anything like this ever happens again, we are prepared to be able to do the right analysis and coordinate the studies and the research, and that just requires really advanced preparedness and a lot of kind of air traffic control from the federal government. And AI machine learning can only do their work if they are given the opportunity to access data and really influence decisions.

Thank you.

Chairman YARMUTH. OK. The gentlewoman's time has expired.

I now recognize the gentleman from New Jersey, Mr. Sires, for five minutes.

Mr. SIRES. Thank you, Mr. Chairman. Can you hear me?

Chairman YARMUTH. I can hear you fine, yes.

Mr. SIRES. I want to thank the panelists for being here today.

You know, I always think of a job as something that creates self-worth in a person, and we seem to be obsessed with this productivity word and, obviously, artificial intelligence creates a lot of productivity. But you have countries like China and you have countries like India who have such large populations, and as artificial intelligence is more productive, more and more people are left behind.

Do you think that these countries with such large population will ever come to a point and they say, OK, artificial intelligence is great, but we have passed beyond the ability to provide jobs for the people of my country. Maybe we should slow down this artificial intelligence that is creating so much automation and leaving, so many people behind because, as you know, if there is no work in a country, it leads to unrest.

I just wonder if any of the panelists would want to address that where a country would say, hey, let's put a little brakes on this because our population is staying behind, is being left behind.

Can anybody talk to that a little bit?

Dr. ACEMOGLU. I would be happy to. I would be happy to comment on that.

Mr. SIRES. OK.

Dr. ACEMOGLU. You know, I think, first of all, I completely agree a job is much more than just productivity. I think self-worth is important for the community, important for society. I think these are critical. But the tragedy in some sense is that, at least on the current measurements, we are not even doing that well on productivity. Despite the bewildering array of technologies all around us and all of this excitement that goes on, we are actually enduring one of the eras in our history where productivity growth is lowest.

This goes to underscore what I was trying to emphasize, that it is not a question of AI versus not AI. It is a question of how we are using AI technology. And if we are not using it well, we would destroy jobs and all of the self-worth and community contributions that we are talking about and also not reap all of the benefits in terms of productivity.

I think that is exactly the sort of situation that we are in right now, so a lot of AI goes into marginal activities, such as self-checkout kiosks or things that humans can do very well, then it will not bring the productivity gain. I don't think that China is ever going to turn back from AI, partly because they have made a huge investment in that, but also because part of the AI's appeal to authoritarian regimes is that it actually provides a much better monitoring system, facial recognition, snooping on communications, control of the internet. But those are exactly the sorts of things that are not going to bring huge productivity gains and they are not going to contribute to making jobs more meaningful.

But if you look at what American companies invest in, it is not that different. We pour a lot of money into facial recognition and

monitoring aspects of AI as well. So that, again, goes to my broader point, that I think there are ways of making use of the AI platforms in a manner that is going to bring much better social benefits and jobs and productivity than we are doing currently.

Mr. SIRES. So the productivity to work ratio for the United States is 6:1, as somebody mentioned before, and in China it is 1:1. So I was just wondering, if China does not want a 6:1 or an 8:1 productivity ratio.

Dr. ACEMOGLU. I would say China definitely wants that and has made huge progress——

Mr. SIRES. But doesn't that leave a lot of people behind? I mean——

Dr. ACEMOGLU. Right. So——

Mr. SIRES. If you reach that kind of productivity like in the United States?

Dr. ACEMOGLU. Well, it may or may not. If consumption keeps up with it and that productivity gain is broadly distributed in society, it may not. In China, it hasn't taken that form. The inequality has actually increased a lot, the gap between cities and rural areas and even within cities between migrant workers and non-migrant workers have opened up hugely.

But, sure, I think there is a huge drive in China toward increasing labor productivity, but they are also willing to invest an enormous amount of resources in order to monitor these workers better, in order to monitor their communications, the civil society participation, and other social activities, even if those things aren't proactive because they do need to maintain the current political system.

Thank you.

Mr. SIRES. Thank you.

Thank you, Chairman.

Chairman YARMUTH. The gentlemen's time has expired.

I now recognize the Ranking Member, Mr. Womack, from Arkansas for 10 minutes.

Mr. WOMACK. Thank you, Mr. Chairman, and thanks to all of my colleagues who have participated, and to the witnesses, thank you very much. A very interesting discussion.

I am going to start where I kind of left off in my opening remarks, and that was about matters of fiscal accountability at the federal level, and I don't need to tell anybody engaged in this forum this afternoon that we are in some very difficult circumstances right now.

COVID has exacerbated it three times more so than what we would have otherwise had in terms of a deficit goes.

And to my colleagues on this call today, I will sound a bit like a broken record. I am an appropriator by nature. I just happen to be the Ranking Member of the Committee and formally Chaired the Committee.

But as an appropriator, I am very concerned about the escalating cost associated with mandatory spending, how much of the federal budget it is commanding and the squeeze, as I call it, that crowding out effect that it is having on the matters of the discretionary budget that we appropriators are in charge of, should be in charge

of—the last few years is an exception, but that is a whole other story.

Mr. WOMACK. But the fact is, that if we are going to invest in anything in our country, if we are going to ask the federal government to have a role in resourcing a lot of this R&D, then it is going to face continued and escalating pressure from the mandatory outlays that continue to consume a larger and larger share of federal resources.

So here is my question and I am going to pose this to Dr. Matheny, and that is, with that in mind, if we can all agree that there is this crowding out effect, how would the federal government prioritize spending on matters of research and development and so forth in the AI spectrum?

And what have you seen from your federal government, if anything, that is worked? So help me understand how we would prioritize the spending that goes toward a more robust AI circumstance in our country?

Dr. MATHENY. Thank you. It is a great question.

I think that the federal government can most cost effectively focus on basic research, on testing and evaluation, and on safety and security, areas that suffer market failures so that the commercial sector is likely to under invest.

Much of the current wave of AI research that we see right now is due to federal investments in basic research, particularly by the National Science Foundation and by the Office of Naval Research, and DARPA, dating back to the mid–1980's, which funded early work on deep learning, provided training grants to much of the current generation of AI researchers.

And that work in basic research really does need to continue so that we fund the next generation of breakthroughs that will fuel future AI systems. Equally important is the work of the National Institute of Standards and Technology in its bench marking and its testing and evaluation that has been critical for actors in both the private sector and the public sector to be able to bring their tools to have them tested on a level playing field, understand where they work and where they break. And just as important also has been the federal government's investments in microelectronics.

In the 1960's, NASA effectively started our microelectronics industry, but we also have examples of less successful programs, very large projects, overly broad goals. I think the Strategic Computing Initiative which ran from the mid–1980's to the mid–1990's is an example of that.

So where the government can help is really on the cases where the commercial sector isn't going to invest on its own, where the goals, though, can be clearly defined, and where we can lift up and address those market failures.

Thank you.

Mr. WOMACK. You bet.

Dr. Acemoglu, am I even close on the name? OK. Good. Thanks for the thumbs up.

And Mr. Sires reiterated the point you made—I think it was you that made the point early on in your testimony—that China had 11 times as many people in the workforce, but they were only two times as productive. If the American worker has proven to be the

most productive worker, I guess, on the planet says a lot about our ability and about our capacity.

One of my concerns has been is that the pace of the private sector in virtually every area is a lot faster than our education system seems to be trying to deliver.

Is that a fair statement?

Dr. ACEMOGLU. Yes, I believe so. I think it is definitely true that our education system has lagged behind. AI, for all the reasons that we have discussed today, has already started changing the labor market and it will change it even more, but our education system, both at the university level but also at middle school and high school level, is very backward looking.

We continue to teach in the way that we used to, you know, for the most part, 30, 40, 50, 60 years ago. AI actually provides—I think Susan mentioned this already—provides tremendous opportunities for revolutionizing many of the key sectors such as healthcare and education.

AI can be used for taking over some of the tasks that educators do that are quite boring, such as grading, but even more importantly, it can create a much more interactive classroom, enable teachers to understand the specific challenges and needs of students and cater their teaching and curriculum to their needs in real-time. It can enrich what we teach and how we teach it. There are already companies that have completely transformed their training systems using AI.

So I think there are a lot of opportunities, but sure, we are lagging behind. And it is absolutely critical, as you have pointed out, for our success that the American worker maintains their productivity edge over other nations, but we have not done very well in that regard either.

If you look at an inclusive measure of productivity growth, what the economists called total factor productivity growth, in the three or so decades following World War II that was growing over 2 and a half percent a year and it is around 1 percent for the last 20 years.

So we are not really doing enough to keep our productivity edge relative to other nations, many of whom have faster productivity growth rates.

Mr. WOMACK. Mr. Chairman, my final question—and I am going to throw this on the table. I don't know really who to direct it to, but we have seen some challenges in recent years of building government industry partnerships in what is to me even more disconcerting is a lot of the companies that we are talking about are now not only not building those partnerships, but they are just unwilling to work with the federal government or work with, you know, partner nations or you can pick from the spectrum of issues.

Just last year, Google pulled out of a major AI project called Project Maven with the Department of Defense. It is my strong opinion that we need to see some change in this area.

Why is this occurring and what are the long-term consequences of not having the proper relationships between government and industry? And is it the slow pace of government in general because we all know that we don't operate with a lot of speed?

Dr. WEST. And Congressman, I would be happy to jump in on that question. And I agree, it is important for a government to work with industry. I think the Google thing, there was some idiosyncrasies to that decision. Other tech companies are embracing the role of working with the federal government, but I do think, as part of your concern about debt and deficit issues, we do need to think about agency modernization just because we have to get the federal government acting much more efficiently than it is right now just in terms of the administration of services.

And the way to cut some of the program costs without hurting the beneficiaries is to make the organization more effective. And so the public sector still lags the private sector in using AI.

Just one quick example, every federal agency should be using AI for fraud detection. It is something that is very common in private companies. We know there is waste and fraud in the federal government. The AI looks for outliers, it looks for unusual activities. Like, this is one tool the federal government agencies should be using to try and get a better handle on the spending side. I think that is an example of where technology can be part of the solution.

Mr. WOMACK. Yes. And in the budget when I was Chairman that we prepared for Fiscal Year 2019, a key component of trying to do the deficit reduction was the fact that we had billions and billions of dollars of improper payments and there has to be a way that we can get after those without unnecessarily burdening ourselves.

Anyway, my time is expired. Thanks, again, to all the panelists. Thanks to my colleagues. Chris, welcome, again, to the Budget Committee.

And Mr. Chairman, as always, I am going to yield back my time and with regrets that you didn't get to see Authentic win the race there on your home track, but nonetheless a good derby.

Chairman YARMUTH. I thank the Ranking Member. I did watch it on television. Fortunately, I tried to set up a betting account and they were so swamped with people trying to do that I couldn't get on, so I didn't lose anything. That was a plus.

Mr. WOMACK. Well, AI, if we had a little better AI platform, we could have probably fixed that early on.

Chairman YARMUTH. Probably so. Thank you for that.

And I yield myself 10 minutes for my questions.

Once again, thanks to all the witnesses. It has been an extremely enlightening conversation and I think a very valuable one.

I am going to kind of segue off where the Ranking Member was because we spend most of the hearing talking about impact on jobs and I think that is kind of the natural topic and how that might impact tax revenues and so forth, but we really didn't focus much on how AI might help reduce expenses for the government.

And I can see—I think Dr. Athey you mentioned telemedicine and I think there is a lot of potential as you mentioned for reducing costs in Medicaid, transportation costs, as well as probably getting better diagnoses and drug interactions and so forth. I think there is a lot of possibilities there.

Where might be some other areas in which there actually could be a positive impact of AI on expenses for the government?

Dr. ATHEY. Thank you for that question, Chairman, and I think that really does pick up from the Ranking Member's comments as well that government can be much more efficient than it is.

Now, I would have actually been pretty scared 10 or 15 years ago to suggest governments invest more in IT because IT's projects are—often fail in private sector, frankly, and when governments take them out, we have a lot of problems with procurement of large IT projects, but one of the things that I think has been really impactful in how AI and machine learning have been diffusing through the economy in the last few years is the way in which IT services delivers has changed.

We are having more software as a service, we are having more cloud computing, so that you don't have to say take on this huge project which has huge risk and then you are kind of locked into a software for the next 20 years, but rather you are getting services that meet your needs that are updated automatically and where a lot of R&D can be centralized and focused on use cases.

So I do believe that it is a good time to start thinking about modernizing the federal government infrastructure. And then alongside of that, in these very common AI applications like fraud detection was mentioned, also security. Cybersecurity is a huge problem and, again, because of its antiquated infrastructure, the federal government and all of its employees are vulnerable.

And so if we can start modernizing and we can put in best practices, we can deliver services more efficiently and effectively.

Now, I also want to pick up on another comment that you made, which we really didn't talk enough about today, I think, which is that, you know, when labor is used as an input, then that is affecting the cost of a product.

Daron and I have both mentioned that there are some cases where the worker and the machine are sort of creating similar cost structures, but there are other settings where investments can really lower the marginal costs of providing services, as well as the marginal costs of receiving services.

And actually, especially for state and local governments, that is very true. We—people are standing in line and wasting their time and taking off of work to get needs met and a person is sitting behind the counter doing something where all of this would just be so much faster and better if you could just get—do it electronically and get your needs met.

And so while that loses a piece of employment for the worker sitting behind the counter, maybe there is other things that your government could be doing—more childcare, more elder care, you know. There are other services that are under provided where those human workers could be better deployed if we use technology to do things where the human time is getting wasted on both sides of the table.

Chairman YARMUTH. I appreciate that.

And I think, even though, we are focused—we are the U.S. Congress, we are focused on the federal budget, we also need to think about impacts on state and local budgets. These are all tax dollars and we do have a federal system.

As I said before the hearing started off the air that this is something I have been planning to do for about a year and a half now.

And when people would come to my office, different groups would come to my office when they were still doing that, I would invariably ask them at the end of the meeting, what impact artificial intelligence is having on their profession or their activity?

And I never forget, I had the Kentucky CPAs in the office and they were there to lobby about tax policy, which is understandable. At the end of the meeting I asked them, in your professional meetings, do you ever talk about artificial intelligence? And their eyes all opened wide and they said, that is the number one topic at all of our meetings because they see a dramatic reduction in the need for accountants because of artificial intelligence.

I had the War College—people from the War College in my office. I asked them that, and one high-ranking soldier said, we don't think that there will ever be a battlefield decision made by a human being again. And I am sure he was exaggerating somewhat, but the idea was that AI can consider all the hundreds, if not more, variables that would go into a decision as to when or where to stage a military action.

And so particularly, you know, I talked to IBM people and they say Watson, at least in their analysis, can now do 70 percent of what lawyers do with greater accuracy. They can read MRIs. Watson can read MRIs and CT scans more accurately than radiologists can.

All of these things—meaning to say, the impact is not necessarily just going to be on the routine type of jobs; that there are going to be some very high level jobs that are going to be changed or eliminated, many cases, which connects me back to the education issue, that when you look at professional jobs that require years and years and years of education and hundreds of thousand dollars' worth of tuition and you are seeing the possibility that those jobs might be eliminated, how do you think this is going to change the future of even professional education?

Dr. West, you want to try that one.

Dr. WEST. I think you are right. It certainly is not just entry level jobs that are going to be affected by AI and automation, but higher level jobs, including the example you gave of radiologists. Accountants should be worried. They are exactly right because there is a lot of really good finance AI that is out there. Financial advisers, the same thing.

So I do think that we need to keep our eye on the education process. When I talk to young people today, I tell them one of the most important skills they need to develop is adaptability because they are going to face such a changing economy, a changing workforce, and changing job needs and job skill needs that whatever knowledge and skill they have at age 21 when they are graduating from college, it is probably going to be completely inadequate 10 years later. It is certainly going to be inadequate 20 and 30 years later. So they are going to need to constantly upgrade their job skills. It is the reason, in my testimony I talked about lifelong learning.

I think the adult education aspect is going to end up being as big as higher education today, so the education component is very important.

Chairman YARMUTH. I am glad you said that. It is exactly what I tell students when I talk to them, too. You are going to have to be adaptable. It is the number one talent.

I promised Mr. Woodall, Dr. Acemoglu, that I would let you answer—he asked about companies, corporations that are doing the right thing. So in the time I have left, do you want to expand on those that are good examples for us?

Dr. ACEMOGLU. Sure. I think—let me say two things.

One is in answer to Congressman Woodall's question, but before I do that, I want to sort of build on what Dr. West has said. I think adaptability is extremely important and it is going to become more important.

But I also think that there is a lot of uncertainty about which types of jobs AI is going to be more threatening to and there is some disagreement, but if you look at the current users of AI, which are still sort of limited, they are still more geared toward more low-paying jobs.

And part of the reason for that is because when you look at higher paying jobs, they involve a variety of tasks and only some subset of those tasks can be automated. And when the rest aren't, then the adaptable workers especially benefit a lot.

So I expect AI technology in whatever direction it goes to add to our concerns about inequality. So that I think is a very important thing.

When it comes to which companies are using AI—I think, you know, there are many companies in Silicon Valley that are using AI in extremely creative ways. I think the problem is that some of those are not very, very good when they look—when you take their social implications into account.

So, for instance, I think you can use AI as a sort of, niche industry right now, but there are a couple of companies that are working on using AI for doing test grading. That is going to be a growth industry, and I think it is going to be very, very useful. But there are many fewer of them that are using AI technology for creating more adaptable classrooms.

There are a few, but I would say that is one area that is actually very promising, but because of the complexity of the question, I think one of the concerns is that, when I have talked to some of those companies, they think that their technology would not get a hold in many school districts because it would involve hiring more skilled teachers and school districts are not going to have the resources or the interest in doing that.

So I think there is sort of a chicken and egg problem. There is a lot of creativity that could be put to use AI in very new and inspiring ways, but we may not have the infrastructure to support that completely yet.

Thank you.

Chairman YARMUTH. All right. Well, thank you very much, and my time is expired.

So as we close, let me, once again, thank all of you witnesses for your time and your wisdom and knowledge, and all the Members for participating.

And if there is no further business, this meeting is adjourned.

[Whereupon, at 3:25 p.m., the Committee was adjourned.]

SHEILA JACKSON LEE
18TH DISTRICT, TEXAS

WASHINGTON OFFICE:
2160 Rayburn House Office Building
Washington, DC 20515
(202) 225-3816

DISTRICT OFFICE:
1919 SMITH STREET, SUITE 1180
THE GEORGE "MICKEY" LELAND FEDERAL BUILDING
HOUSTON, TX 77002
(713) 655-0050

ACRES HOME OFFICE:
6719 WEST MONTGOMERY, SUITE 204
HOUSTON, TX 77019
(713) 691-4882

HEIGHTS OFFICE:
420 WEST 19TH STREET
HOUSTON, TX 77008
(713) 861-4070

FIFTH WARD OFFICE:
4300 LYONS AVENUE, SUITE 200
HOUSTON, TX 77020
(713) 227-7740

Congress of the United States
House of Representatives
Washington, DC 20515

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HEARING STATEMENT:

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COMMITTEE ON THE BUDGET
WEBEX
SEPTEMBER 10, 2020
1:00 P.M. EDT

- Thank you Chairman Yarmuth and Ranking Member Womack for convening this critical hearing on the subject of artificial intelligence and its effects on the economy, labor markets, income inequality, as well as implications for federal policy and the budget.

- Let me welcome our witnesses:
  - Susan Athey, Ph.D.
    Economics of Technology Professor, Stanford Graduate School of Business;

Associate Director, Stanford Institute for Human-Centered Artificial Intelligence

- Daron Acemoglu, Ph.D.
  Institute Professor of Economics, Massachusetts Institute of Technology

- Darrell West, Ph.D.
  Vice President and Director of Governance Studies, Brookings Institution

- Jason Matheny, Ph.D.
  Founding Director, Center for Security and Emerging Technology, Georgetown University;
  Commissioner, National Security Commission on AI

- Mr. Chairman, it has been over six months since the United States diagnosed its first case of the coronavirus, and, yet, we are still struggling to contain this virus.

- As more and more cities and states across the country are labeled as hotspots for the virus, the American people are losing confidence in our ability to guide the country's return to normalcy.

- As of this morning, there were 6,363,437 cases of coronavirus and over 190,885 related deaths in the United States alone.

- In the state of Texas, there are over 675,000 cases and the death toll is over 13,980 individuals.

- Harris County, which encompasses my district, has reported over 113,000 cases and 2,363 deaths.

- Throughout this pandemic, artificial intelligence has become an essential tool in understanding, treating, and facilitating recovery

from the coronavirus through vaccine development, patient screening, and outbreak detection and surveillance.

- Although the term "artificial intelligence" may conjure images of sentient, self-aware machines, current AI technologies are systems that learn from data to identify patterns, improve predictive capability, and guide decisions.

- This incredible feat of modern innovation has the potential to not only help us get control over this pandemic but also boost the economy by driving productivity growth in the long run.

- In fact, in 2020, worldwide revenues for the AI market are expected to total more than $150 billion, but AI could generate up to $13 trillion in economic activity by 2030, which is equivalent to 1.2 percent additional GDP growth per year.

- While these figures are encouraging, it is imperative that we always look at both sides to an issue.

- Like previous disruptors, increased implementation of AI technology is likely to cause significant workforce changes, especially to low- and middle-wage jobs in sectors like manufacturing, accounting, transportation, retailing, and food services.

- As a result, Black and Latino Americans, who fill a large share of these positions, are disproportionately at risk of job and wage losses.

- Even before the COVID-19 pandemic slowed our economy, many workers had already struggled to compete against automation and

technological advancement to find stable, well-paying jobs or advance their careers.

- And now, as companies accelerate their investments in AI-enabled automation during the pandemic, many Americans fear that the jobs they left in March could be eliminated permanently.

- The American people are looking to Congress for guidance in this time of chaos and uncertainty.

- It is imperative that we find a way forward that leverages the benefits of AI innovation while also protecting the American workforce, especially the marginalized communities that face the largest risk of job replacement.

- This pandemic and current economic crisis have already highlighted the stark disparities and barriers that low-income and people of color face every day.

- It has also shown us that income security and related programs are crucial for supporting low-income Americans and others in times of need.

- Without federal action, the continuation of AI reliance will exacerbate the trends of declining job security and labor force participation, and growing income inequality.

- Congress must commit to federal policies that focus on reskilling and upskilling our workforce in addition to requiring new approaches and federal support for training, education, apprenticeship, and credential partnerships, especially for mid-career workers who will still need to provide for themselves and their families as they learn new skills in this transition period.

- And so, I urge my fellow Members of this Committee as well as other Members of Congress to come together and create a dynamic, strategic plan of federal support that not only encourages technological innovation but also creates educational and training initiatives as well as opportunities for job creation so that no workers are left behind.

- We must act now.

- The world is changing rapidly, but we cannot let fear and uncertainty of the future keep us from moving forward.

- The American people have endured challenge after challenge, and we have always prevailed.

- This will be no different.

- As we seek to revitalize the economy in the aftermath of the pandemic, we must ensure that the implementation of AI and new technologies lead to inclusive economic growth and broad societal benefit.

- Thank you, Mr. Chairman, for convening this important hearing, and I look forward to hearing from our witnesses.