

Technology and the Future of Work

Diana Farrell

President and CEO

JPMorgan Chase Institute

“Society needs to adopt a view of continuous learning and reskilling throughout a person’s life, with emphasis on more demand-driven and vocational training and a greater focus on team-based skills and cross-functional and disciplinary integration.”

—DIANA FARRELL

The technological changes that drove the first, second, and third industrial revolutions in developed countries in the eighteenth and nineteenth centuries saw huge portions of the population moving off the farm and into factories. The resulting mass migration and social dislocation produced years of disruption, requiring time and major policy interventions to navigate.

Today, the world economy and its participating workforce is engaged in a shift of equal or larger proportion, brought about by the technological advances of our age. **Digitization** is translating huge amounts of economic and social activity into machine readable formats that can be analyzed and re-imagined. Companies are using **artificial intelligence**, from machine learning to predictive analytics, in a growing range of contexts. **Robotics** and other semi-autonomous machines are taking on tasks that were long believed to be executable only by humans. Finally, advances in **materials and biological** sciences, such as nanotechnologies and bio-engineering, are rendering robots more human-like and able to change how humans work.

Many of these technologies have been used in some form for decades, but they are now entering a new phase. As in the legend of the rice and the chess board, in which each square on the board produces a doubling of the wager from one grain of rice to two, then from two to four, the improvements and use cases for these technologies are now scaling “on the second half” of the technological chess board.

Much of this change is full of promise. Yet there are real risks that the gains from technological advancement will only benefit some industries and some societies and will not translate broadly to improve prosperity and well-being. The future of work might see huge proportions of the workforce shifting into lower-productivity, lower- paid occupations and jobs.

We have historical precedent for how rapid technological advances produce radical changes in society. We don’t know whether the “fourth industrial revolution” in which we are currently engaged is going to look the same as the technological advances that preceded it, but the possibility requires us to learn the lessons of the past. It is not too soon to mobilize—now—to imagine the future of work and design policies and approaches that can optimize its benefits. That process begins by understanding the dynamics already underway.

Simultaneous Impacts from Technology

The technological advances of today are affecting the future of work in three key ways: by scaling and speeding up human capabilities, by substituting labor with machines, and by enabling new ways to access and supply labor.

Scaling and speeding up human capability. Technology has been enhancing human capability since the invention of the Gutenberg press. Modern applications of technology to improve productivity are legion, though two examples offer representative scope of today’s possibilities to change the work landscape.

One is *MITx*, a pilot project launched by MIT to create a digital replica of the classroom. MIT offered the prototype course “Circuits and Electronics” in March 2012 to over 154,000 students from more than 160 countries. As is typical with massively

open online courses (MOOCs), less than 5 percent of registered students passed the course, but that percentage clouds the course's impact. In absolute terms, 7,157 students passed in one semester—as many as MIT could accommodate in person in forty years.¹

A second example comes from the field of robotics, in which recent developments in top artificial intelligence labs are resulting in the development of modern robotic hands that can spin, grip, pick, make beds, and place objects of any size.² Efforts to enhance and support aging or injured human bodies, and to improve memory and access to information, show equal promise.

Substituting labor with machines. Manufacturing provides less than 9 percent of US employment, down from over 30 percent in the 1950s.³ Advancements in automation account for much of this decrease, allowing today's factories to produce far more product with far fewer people. Jobs across a range of service industries will soon see a similar decline.

In fact, in their assessment of the susceptibility of US labor to computerization, Frey and Osborne examined 702 occupations and concluded that roughly two-thirds of US jobs are at high risk or medium risk of being computerized. More specifically, the analysis showed that 47 percent of US employment is in high-risk jobs that have a 70 percent to 100 percent probability of becoming computerized in the next ten to twenty years; 19 percent of employment is medium risk, with a 30 percent to 69 percent probability of becoming computerized; and 33 percent is low risk, meaning not likely (0 percent to 29 percent probability) of being computerized.⁴ The most vulnerable to least vulnerable jobs move along a continuum from simple, repetitive, and routine to optimizing, complex, and creative.

High-risk jobs include equipment operators (notably transportation drivers), jobs that require basic cognitive skills such as inputting data, and a range of administrative jobs. On the low-risk end of the continuum are jobs that require higher cognitive ability, such as creativity, cross-disciplinary faculties, technical abilities, and social or emotional connections.

These trends are not necessarily negative from a labor, economic, or social perspective. Automation can be welcome when it solves a labor shortage or other source of economic friction. For instance, Japan is experimenting with robots in assisted living facilities to address the mismatch between a rising elderly population and a shortage of specialized care workers. Japan's Ministry of Economy, Trade, and Industry has provided 4.7 billion yen (\$45 million) in development subsidies since 2015, and the labor ministry spent 5.2 billion yen (\$50 million). These investments have resulted in the introduction of more than 5,000 robots in assisted care facilities from March 2016 to March 2017.⁵

In another context, language translation is reducing friction in online trading, with significant economic impact: a recent study led by AI expert Erik Brynjolfsson at MIT found that the introduction of a machine language translation application on an online platform led to a 17.5 percent increase in international trade between participants.⁶ The authors conclude that language barriers between humans limit trade, and machine-based translation reduces the need for those humans to engage in translation-motivated searches before executing a transaction.

Notwithstanding these positive applications of automation technology, the speed and scale with which human tasks are becoming automated is uncertain and is very likely to result in significant displacements for workers in the most vulnerable occupations.

New ways to access and supply labor. As workers are automated out of jobs in the traditional economy, many are embracing independent work accessed through online platforms as an alternative or supplement to traditional jobs. Growth in the Online Platform Economy has enabled more employers and employees, suppliers and consumers, and even suppliers and businesses to find each other and exchange labor and goods.

The number of significant online exchange platforms has grown from over forty to more than 120 in the last two years. The JPMorgan Chase Institute segments the Online Platform Economy into four sectors: the transportation sector, which involves drivers transporting human riders and/or goods; the non-transportation labor sector, which deals in services such as dog walking, home repair, etc.; the selling sector, in which independent sellers find buyers through online marketplaces; and the leasing sector, in which people rent their homes, parking spaces, and other assets. Transportation dominates in terms of both the number of participants and total transaction volume, accounting for over 60 percent of total platform economy participants and generating as much revenue as the other three sectors combined.

The JPMorgan Chase Institute's most recent report shows 1.6 percent of the 2.3 million families in its sample earned platform income in the first quarter of 2018, up from 0.3 percent in the first quarter of 2013; 4.5 percent earned platform income at some point during the prior year. Generalizing these numbers to the 126 million US households suggests that 5.5 million households earned income from the Online Platform Economy at some point during the year.⁷ As a fraction of all jobs, there were almost as many people working in the platform economy in the first quarter of 2018 as there are workers in the information sector (1.8 percent of all jobs in 2016); the 4.5 percent that earned platform income for all of 2017 is comparable

to the percentage of workers in public administration (4.6 percent of jobs in 2017).⁸

Despite the scale of employment in the Online Platform Economy, participant engagement and income from online platforms is more sporadic than in most traditional jobs, and the work typically lacks both benefits and opportunities for advancement. Monthly platform earnings represent an average of 20 percent or less of total take-home income for individuals who participated in the Online Platform Economy in the twelve months captured in the JPMorgan Chase Institute's data set.⁹ Of the transportation platform participants who drove at any point in the twelve-month period, 58 percent had earnings in just three or fewer months. In the other sectors, engagement was more sporadic. Moreover, as platforms have grown in number and size, earnings have declined or remained stagnant. Specifically, average monthly earnings in the transportation sector fell by 53 percent between 2014 and 2018, and average earnings in the other three sectors were flat.

In sum, online platform work does not yet seem to be replacing more traditional sources of income, but it is changing the composition and wages of work for growing numbers of people.

Unintended Consequences and Emerging Risks

Many will view some of the issues described above, particularly the push toward automation, as trends developed society has seen and recovered from as new jobs in heretofore unimagined new areas emerge. That has been true to a considerable degree, but there are five troubling and related signs that deserve close attention.

Shrinking share of total income to labor. Over the past few decades, economies around the world have seen a fall in the share of total income allocated to labor. In 1947, 66 percent of total income accrued to labor in the US. In 2016, that number had fallen to 58 percent. The pattern for OECD countries is similar, showing an income-to-labor decrease from the 1990s to the late 2000s of 66 percent to 61 percent. The IMF estimates that in advanced economies about 50 percent of the decline is attributable to technological advancement, while another 25 percent is attributable to global integration, which is itself facilitated by technology.¹⁰ More technological advances will likely reinforce this long-standing trend.

Income inequality. OECD research suggests that countries where labor income share has decreased likewise show an increase in income inequality.¹¹ Indeed, the long-standing rise in both income and wealth inequality in the US and other countries is well documented. The average income of the top quintile earners in the US, after transfers and taxes, was over twenty times greater than for the bottom quintile earners.¹² Differential income growth rates by wage level has caused that gap to widen. Between 1979 and 2016, real hourly wages increased 51.7 percent for workers at the ninety-fifth percentile of wages and 4.4 percent for workers at the tenth percentile.¹³

Rising income inequality is increasingly linked to direct and indirect economic growth limitation, as noted in a recent IMF study, and is a challenge to political stability and trust in the legitimacy of the system.¹⁴

Living wages. When the majority of income-generating resources are controlled by a small percentage of society, and labor holds less power in the economy, members of the working class are less able to negotiate wages to allow them to adequately support a family through income from full-time work. Indeed, the cost of living in many places in the US has long been rising while incomes remain stagnant. The extent of the problem was laid bare in 2003 when the MIT Living Wage Lab created a tool to estimate the cost of living and the minimum living wage necessary to cover basic living expenses across many US cities, including housing, groceries, basic health care, etc. Calculations from the tool show that the median living wage in the US in 2017 was \$16.07 an hour for a family of four with two working parents, more than twice the federal minimum wage of \$7.25 an hour. A typical family of four needs to work nearly four full-time minimum-wage jobs to earn a living wage.¹⁵

Today, 42 percent of Americans make less than \$15 an hour and 30 percent make less than \$10 an hour.¹⁶ Two out of every five people struggle to access consistent housing, food, and health care. A full-time minimum-wage worker can afford a one-bedroom rental home at fair-market value in only twenty-two out of 3,000 US counties.¹⁷ Even before the technological disruption we anticipate on the horizon has fully revealed its impact, a significant share of jobs in today's economy barely meet the "sufficient" threshold.

The downward pressure on wages is further exacerbating cost-of-living challenges felt by so many—even those in developed countries experiencing overall economic growth. According to an MGI report, the share of households that experienced flat or falling incomes, after taxes and transfers, increased from less than 2 percent between 1993 and 2005 to between 20 percent and 25 percent from 2005 to 2014.¹⁸ The most recent US Bureau of Labor Statistics data show a 0.2 percent decrease in real average hourly earnings from July 2017 to July 2018.¹⁹

Widespread income and expense volatility. Low wages are not the only source of pressure on low- and moderate-income households. Many also struggle with irregular incomes. Extensive research from the JPMorgan Chase Institute provides robust

evidence that Americans at all income levels experience high degrees of income and spending volatility. In fact, family income and spending typically fluctuate by about 30 percent on a month-to-month basis. These fluctuations are only slightly positively correlated, meaning families could simultaneously experience an expense spike and an income dip.²⁰

To withstand typical volatility, families need emergency savings and a cash buffer, yet few Americans have either, which makes them vulnerable. A 2016 Federal Reserve survey found 46 percent of families could not readily pay for a \$400 emergency expense, or would have to borrow or sell something to do so.²¹ When such an expense is associated with medical services or auto repairs, common sources of high-value expenses, the lack of a cash buffer can affect a family's financial and physical health and the ability to maintain steady employment.

Insufficient transition to higher-value-added, higher-income jobs. If the economic environment makes it difficult for people to earn higher wages for the same work, or to smooth earnings and expenses, workers can still seek better, higher-paying jobs as a way to increase income and spending power. Yet that too is becoming out of reach for many, as new job creation falls in the sectors where new technologies are advancing most rapidly. In the past, creative destruction has led to new and higher-value-added job creation and may do so in the future, at least to some extent. But the trend suggests fewer new jobs created in industries affected by technological disruption: in the 1980s, 8.2 percent of US workers shifted into jobs that emerged for the first time during the decade. In the 1990s, that number was 4.4 percent; in the 2000s, it was only 0.5 percent.²² Such dramatic decline in the share of new jobs suggests a real barrier to workers moving into newly created, higher-value-added jobs.

It is important to point out that the long-term impact on the job market remains something of a puzzle. There are still many "jobs" in the economy. Indeed, the current unemployment rate in the US is at historical lows. But many of the jobs available to people with lower skill levels offer inconsistent hours, are contract-based, and are in lower-value-added sectors that do not represent a shift toward the higher-value, higher-paying jobs associated with new technologies. MIT economist David Autor suggests the job market is polarized, with continued availability of low-paying, low-skilled, and unstable jobs on the low end and high-skilled jobs on the high end, but a disappearance of the administrative, clerical, labor, and craft jobs that once allowed huge portions of the middle class to thrive.²³ The focus on jobs alone, therefore, may be missing the point. The more relevant issue may be the ability to create new jobs at scale in high-income sectors.

Call to Action

Absent direct policies and concerted action to address these risks, the economy of the future could fail to create a broad base of well-paying jobs with stable wage growth and benefits. As important as these issues are for the US and other developed nations to examine and address, they also have important ramifications for developing countries. Many nations have been on a deliberate path to mimic the economic growth path taken by developed countries. These countries have embraced the process of advancing urbanization and shifting the workforce from agriculture to manufacturing to services, with a view toward preparing more of the labor force to participate in higher-value, higher-income activities. Yet technological developments may have created a break in the development chain, rendering that path unpassable by emerging economies. For a continent like Africa, where the population is expected to grow four-fold by 2100, the risk of a burgeoning labor force with no jobs to do is real.

A future of work that is broad-based and broadly accessible by the majority of people will require a range of purposeful interventions by government, the private sector, and the civic sector. Society must renew its focus on workforce preparation so that more people can participate in new, higher-value activities. This is important not only for future generations, but also for existing workers likely to be displaced and affected by changes. Closing the existing skills gap will require both investments and changes in education, both to the traditional PK-12 basic education system, as well as to our ideas about when education "stops." Society needs to adopt a view of continuous learning and reskilling throughout a person's life, with emphasis on more demand-driven and vocational training and a greater focus on team-based skills and cross-functional and disciplinary integration.

As important and necessary as these education investments are, their impact will be limited if not undertaken in concert with a holistic range of economic and social policies. This may well include a new look at a range of economic levers, including changes to the tax code, increases to the minimum wage, reform of unemployment and wage insurance, effective savings programs, and modified compensation and tax structures. Beyond income, more may need to be done to address the cost of and access to decent housing and health care at the community level.

The future of work is already here. Now is the time to mobilize.

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Diana Farrell is the founding President and Chief Executive Officer of the JPMorgan Chase Institute, where she has created a legacy of producing and publishing unique data analyses and insights that leverage the bank's own transactions data. Previously, Ms. Farrell was the Global Head of the McKinsey Center for Government and the McKinsey Global Institute. Ms. Farrell served in the White House as Deputy Director of the National Economic Council and Deputy Assistant to the President on Economic Policy for 2009-2010. During her tenure, she led interagency processes and stakeholder management on a broad portfolio of economic and legislative initiatives. Diana coordinated policy development and stakeholder engagement around the passage of the Dodd-Frank Act and served as a member of the President's Auto Recovery Task Force. Ms. Farrell currently serves on the Board of Directors for eBay, The Urban Institute, and the National Bureau of Economic Research, and is a trustee Emeritus of Wesleyan University School. In addition, she is a trustee of the Trilateral Commission and served as a Co-Chair of the World Economic Forum's Council on Economic Progress. Ms. Farrell is also a member of the Council on Foreign Relations, the Economic Club of New York, the Aspen Strategy Group, the Bretton Woods Committee, and the National Academies of Science's Committee on National Statistics. Ms. Farrell holds a M.B.A. from Harvard Business School, and has a B.A. from Wesleyan University from where she was awarded a Distinguished Alumna award.

- ¹ Larry Hardesty, “Lessons learned from MITx’s prototype course,” July 16, 2012, news.mit.edu/2012/mitx-edx-first-course-recap-0716.
- ² Mae Ryan, Cade Metz, and Rumsey Taylor, “How Robot Hands Are Evolving to Do What Ours Can,” July 30, 2018, *New York Times*, www.nytimes.com/interactive/2018/07/30/technology/robot-hands.html.
- ³ YiLi Chien and Paul Morris, “Is U.S. Manufacturing Really Declining?” On the Economy Blog, Federal Reserve Bank of St. Louis, April 11, 2017, www.stlouisfed.org/on-the-economy/2017/april/us-manufacturing-really-declining.
- ⁴ Carl Benedikt Frey and Michael A. Osborne, *The Future of Employment: How Susceptible Are Jobs to Computerisation?* Oxford Martin, 2013, 114.
- ⁵ Malcolm Foster, “Aging Japan: Robots May Have Role in Future of Elder Care,” *Reuters*, March 27, 2018, www.reuters.com/article/us-japan-ageing-robots-widerimage/aging-japan-robots-may-have-role-in-future-of-elder-care-idUSKBN1H33AB.
- ⁶ Erik Brynjolfsson, Xiang Hui, and Meng Liu, *Does Machine Translation Affect International Trade? Evidence from a Large Digital Platform*, NBER Working Paper No. 24917, 2018.
- ⁷ Diana Farrell, Fiona Greig, and Amar Hamoudi, *The Online Platform Economy in 2018: Drivers, Workers, Sellers and Lessors*, JPMorgan Chase Institute, 2018.
- ⁸ Diana Farrell, Fiona Greig, and Amar Hamoudi. *The Online Platform Economy in 2018: Drivers, Workers, Sellers and Lessors*, JPMorgan Chase Institute, 2018.
- ⁹ Diana Farrell, Fiona Greig, and Amar Hamoudi, *The Online Platform Economy in 2018: Drivers, Workers, Sellers and Lessors*, JPMorgan Chase Institute, 2018.
- ¹⁰ Dao Mai Chi, Mitali Das, Zsoka Koczan, and Lian Weicheng. “Drivers of Declining Labor Share of Income,” IMFBlog, April 12, 2017, blogs.imf.org/2017/04/12/drivers-of-declining-labor-share-of-income/.
- ¹¹ International Labour Organization, International Monetary Fund, Organisation for Economic Co-operation and Development, and World Bank Group, *Income Inequality And Labour Income Share in G20 Countries: Trends, Impacts and Causes*, September 2015, www.oecd.org/g20/topics/employment-and-social-policy/Income-inequality-labour-income-share.pdf.
- ¹² Congressional Budget Office, “The Distribution of Household Income, 2014,” 2014.
- ¹³ National Low Income Housing Coalition, *Out of Reach: The High Cost of Housing*, 2018, nlihc.org/sites/default/files/oor/OOR_2018.pdf.
- ¹⁴ Jonathan D. Ostry, Andrew Berg, and Charalambos G. Tsangarides, *Redistribution, Inequality, and Growth*, International Monetary Fund, April 2014.
- ¹⁵ Amy K. Glasmeier, “New Data Up: Calculation of the Living Wage,” MIT Living Wage Calculator, January 26, 2018, livingwage.mit.edu/articles/27-new-data-up-calculation-of-the-living-wage.
- ¹⁶ Irene Tung, Yannel Lathrop, and Paul Sonn, *The Growing Movement for \$15*, National Employment Law Project, November 2015, www.nelp.org/wp-content/uploads/Growing-Movement-for-15-Dollars.pdf.
- ¹⁷ National Low Income Housing Coalition, *Out of Reach: The High Cost of Housing*, 2018, nlihc.org/sites/default/files/oor/OOR_2018.pdf.
- ¹⁸ McKinsey Global Institute, *Poorer Than Their Parents? Flat Or Falling Incomes in Advanced Economies*, McKinsey & Company, July 2016.
- ¹⁹ Bureau of Labor Statistics, “Real Earning - July 2018,” 2018. www.bls.gov/news.release/pdf/realer.pdf.
- ²⁰ Diana Farrell, Fiona Greig, *The Monthly Stress-Test on Family Finances*, JPMorgan Chase Institute, 2017.
- ²¹ Board of Governors of the Federal Reserve System, *Report on the Economic Well-Being of U.S. Households in 2015*, May 2016, www.federalreserve.gov/2015-report-economic-well-being-us-households-201605.pdf.
- ²² Carl Benedikt Frey and Michael A. Osborne, *The Future of Employment: How Susceptible Are Jobs to Computerisation?* Oxford Martin, 2013, 114.
- ²³ David Autor, *The Polarization of Job Opportunities in the U.S. Labor Market: Implications for Employment and Earnings*, Center for American Progress, April 2010.