

The Robots Are Coming

What automation means for the future of the American economy

Since the dawn of the Industrial Age, one of the most durable science fiction plotlines envisions a future in which machines take over, rendering their human creators obsolete. Today, a growing chorus of scientists and other observers say that scenario may already be unfolding. A December 2016 White House study, *Artificial Intelligence, Automation, and the Economy*, suggested that in the next 20 years or so, nearly half of current jobs in the United States could be threatened by robots or computer software that performs faster, more reliably, and cheaper than people can.

Manufacturing, food processing and other industries have already seen robots take over many tasks and jobs, but even white-collar workers are at risk, warns Martin Ford, a prominent futurist and author of the bestseller *Rise of the Robots*. “Machines are beginning to think,” says Ford. “It’s not just about muscle power any more. It’s now about brainpower. People who thought they were immune, because their job requires a smart person who can learn and adapt, may now be in jeopardy.”

Unlike some doomsayers, Ford does not see technological progress as evil. Still, any disruption of this magnitude calls for a concerted plan to help society adjust, he believes. Ford spoke with *Outlook* about the surprising array of professions that may be threatened by AI, and some controversial solutions to the disruption that robots may bring to American society.

OUTLOOK: Which is the greater threat to U.S. employment: the exporting of jobs to other countries, or technology?

Martin Ford: Offshoring of jobs has certainly been an important phenomenon over the past few decades. And of course, Donald Trump made it a major part of his presidential campaign. Overall, though, robots represent the greater threat. In fact, some of those factories that moved overseas for cheap labor are returning to the United States. Unfortunately, they’re not bringing jobs back, because those factories are increasingly automated. That’s a big reason it’s economically viable to have them back in the United States, where labor costs are much higher.

Much the same is happening with service jobs, such as all those call-center jobs that moved to India. Automated systems are handling more and more of those calls—so from a job perspective, it doesn’t really matter where those centers are.

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This Month's Expert



With more than a quarter century in computer design and software development, Martin Ford has emerged as one of

the nation's most respected futurists on the subject of how robotics and artificial intelligence are changing our economy and society. His book *Rise of the Robots* was a *New York Times* bestseller and winner of the 2015 Financial Times/McKinsey Business Book of the Year Award.

Mr. Ford explored similar themes in his 2009 book *The Lights in the Tunnel: Automation, Accelerating Technology and the Economy of the Future*. A sought-after guest on radio and television, he has written for *Fortune*, *Forbes*, *The Atlantic*, *The Washington Post* and other publications. Mr. Ford did his undergraduate work in computer engineering at the University of Michigan, and earned a graduate business degree from the University of California, Los Angeles.

But what's perhaps most remarkable is the widening scope of jobs and professions that are at risk, thanks to technology. As computers become better and better at thinking and reasoning, we're getting to the point where any white-collar jobs that involve sitting at a computer producing reports and analysis are going to be very highly susceptible.

OUTLOOK: What white-collar jobs are you talking about?

MF: In financial services, robo-advisers are already using algorithmic management to balance client portfolios, suggest asset allocations, and offer other basic investment advice. I saw recently that Goldman Sachs acquired a startup company that promises to automate a lot of what their analysts do. Traditionally, places like Goldman have hired people out of Harvard and Yale and brought them to Wall Street, where they sit in front of spreadsheets for 12 hours a day. A lot of that can be automated.

In journalism, software systems are getting better and better at generating and writing news stories. Computers increasingly will be used to create stories that rely on poring through a database or searching the Web for information. Human journalists will still be needed to cover events, interview people and comment on issues, of course. But with computers doing so much online fact-gathering, there will likely be a net need for fewer human journalists.

OUTLOOK: What other professions will be affected?

MF: In medicine, at-risk jobs might include radiology and pathology, which require refined technical skill but not as much direct patient contact as other specialties. Becoming a radiologist takes an incredible amount of training: college, medical school, and then residency. But it's not hard to envision a time when it will be considered medical malpractice to let a human being interpret a visual image, when machines are going to be so much better at it.

In law, a big part of what attorneys do is research. That's in jeopardy because, as with online journalism, computers are getting more and more adept at legal research. There's also an evolving computer specialty known as "quantitative legal prediction"—using data and algorithms to project whether a particular court case will be won, lost, or overturned by an appeals court. That's something that's traditionally been handled by some of the highest-paid lawyers, using all their experience. It's a big part of their value. Algorithms can now do that, and they're getting better and more accurate all the time.



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OUTLOOK: What will the proliferation of robots and artificial intelligence mean for agriculture?

MF: Technology has already had a huge impact on agriculture, when you consider that a century or so ago, the majority of Americans worked on farms. Today, agriculture represents 2 percent or less of the workforce, and yet farm productivity has never been higher. Most of that transformation has been due to advanced tractors, combines and other machines, rather than computers or information technology, so it's been primarily a mechanical disruption.

That's changing very rapidly now. With precision agriculture, automated farm equipment, fed by tracking data, is increasingly able to deliver the exact amount of water and fertilizer to individual plants, which is something that no equipment, or even humans, could do in the past. That's making farms increasingly cost efficient, using less fertilizer and water.

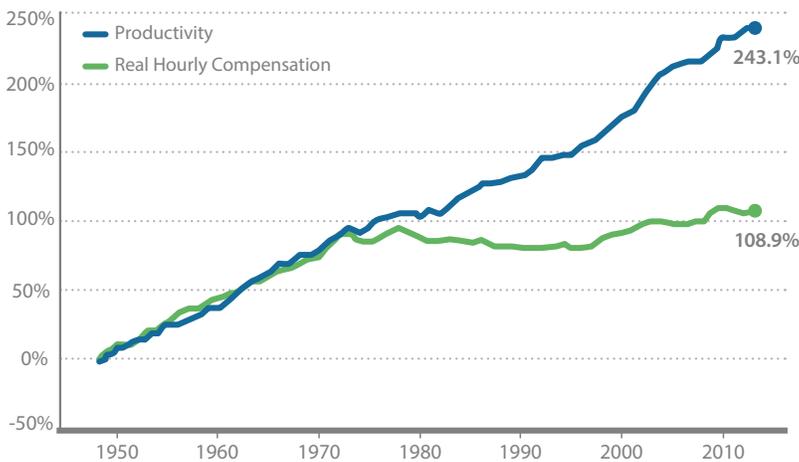
OUTLOOK: How will this affect employment in agriculture?

MF: Because farming has become so mechanized already, job loss due to such things as precision ag won't be as severe as in some other industries. Agriculture still relies heavily on human labor to pick delicate fruits and produce, such as strawberries, that can't be machine-harvested. Traditionally, you need a human eye and touch to tell ripe from unripe, and spoiled from unspoiled.

In California, some farmers are shifting away from those kinds of fruits and vegetables toward crops that can be machine-harvested. Robots can come in and shake a tree, and all the almonds fall on the ground and can be vacuumed up. At the same time, though, robots are getting better and better at handling that delicate produce. They're getting better at sensing the quality and ripeness of a strawberry and handling it gently.

Countries such as Japan, where the farming population is aging rapidly, and Australia, which has a shortage of low-wage labor, are pushing heavily into robotic harvesting. The U.S. has a relatively plentiful supply of migrant workers, so the drive to adopt robots isn't quite as pressing. Still, as the robots get better and cheaper, those efficiencies will be harder for U.S. farms to resist. That's bound to have an impact, not just on agriculture but on our assumptions about immigration and the number of lower-skilled jobs that are going to be available in the future.

CUMULATIVE CHANGE IN U.S. PRODUCTIVITY AND WAGES OF PRODUCTION WORKERS SINCE 1948



Source: Economic Policy Institute

OUTLOOK: How likely is that workers who lose jobs to automation will be able to shift into other industries?

MF: People who are skeptical about the long-term impact of robots and computers on employment point out that even though millions of agriculture jobs disappeared in the past century, we didn't wind up with massive unemployment in the United States. Well, that's true, because farm workers moved on to factories and the service sector. That's less likely to happen this time.

OUTLOOK: What's different now?

MF: Technology is essentially going to transform the whole economy. You can't assume that when one industry sheds workers, others will absorb them, because all industries are being impacted

simultaneously. From 1947 to 1979, U.S. productivity and wages grew at approximately the same annual rate. Since then, productivity and wages have decoupled, and the process is accelerating. From 2000 to 2009, while productivity grew at 2.5 percent per year, wages grew at just 1.1 percent.

In other words, technology is making us more productive, but workers aren't necessarily feeling the benefit. We've seen declining labor force participation and job creation, and longer "jobless recoveries."

OUTLOOK: What steps should the country consider to overcome these disruptions?

MF: One solution worth serious consideration is a guaranteed income. We're eventually going to have to accept that maybe some people aren't going to work, or maybe people are going to work less, and maybe the primary purpose of your life is not going to be working. But you'll still have an income that can support your life. I'm not suggesting this type of approach because I want to replace capitalism. I'm suggesting it because, given the extent of the job displacements we are likely to see in the years to come, there may be no alternative.



Halting technology is not an option. Rather, what we have to do is adapt to it.”

OUTLOOK: Won't that idea face stiff political resistance?

MF: Absolutely. Our culture places such a high value on work, and celebrates production. People will make the point that just giving people money isn't enough; they've also got to have something to do with their time, something that will give them a sense of accomplishment, and those are very valid points and real challenges. But in the near term, the most important challenge is going to be distributional, and that's a huge challenge politically, because “redistribution” is probably the most toxic word in the political vocabulary right now. But we may reach the point where the cost of not having a basic income exceeds the cost of having it. At that point, maybe it becomes more politically viable.

OUTLOOK: What other solutions do you suggest?

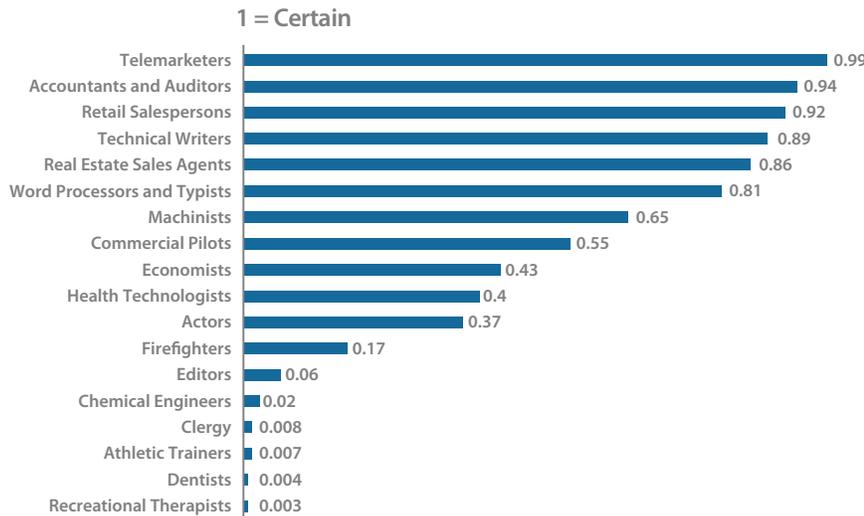
MF: One of the most important things we can do right now is to address our critical need for public infrastructure. We have pent-up demand to repair and improve roads, bridges, schools, airports, and train stations.

Consider the transportation industry, for example. We're rapidly progressing toward an era of self-driving cars and trucks, which will bring enormous safety benefits. But it's going to threaten jobs for a lot of drivers. Construction, on the other hand, still requires many human workers. So a major effort to keep our roads from falling apart won't just help keep roads safe in a driverless world; it will help mitigate job losses.

OUTLOOK: Is it realistic to think we can slow the growth of robotics and other technologies in our lives?

MF: Any middle-class person living in an advanced country today has a much better standard of living than a rich person who lived, say, 100 years ago. He or she will likely live much longer, too, thanks to advances in health care and wellness technologies. Technology has transformed everything from communications to transportation to consumer products. Do we really want to say to our children and our grandchildren, “You're not going to experience the kind of progress that we had?” Halting technology is not an option. Rather, what we have to do is adapt to it.

PROBABILITY ROBOTS WILL TAKE YOUR JOB IN NEXT 20 YEARS



Source: *The Economist*

OUTLOOK: *You've cited Watson, the IBM computer that won "Jeopardy!," as a turning point in the relationship between people and computers. Why was that so important?*

MF: We think of computers as being able to deal with data in a proper format, as in accounting, where everything is arranged in nice rows and columns. But here was a computer processing completely unstructured data in the same way a human being would. What most impressed me was the natural language ability. Those "Jeopardy!" questions weren't just tricky; many of them included jokes and puns that require a high level of what we think of as human reasoning. And yet Watson defeated the top human champions.

Since then, we've seen other, even more impressive demonstrations. Take Google's DeepMind, which prevailed at the ancient Chinese game of Go. Unlike chess, where you can compute levels ahead using fast-paced, brute-force algorithms, Go involves an essentially infinite number of possible moves. The best Go players in the world can't really tell you why they're doing what they're doing. It's something that happens inside their brains. It's intuitive. That sounds like something that a computer would never crack, right? Yet DeepMind taught itself to play Go by looking at historical examples of the game, and then by playing against itself. It essentially became superhuman, and was able to defeat the best player in the world. These examples keep coming. It's going to be one triumph after another.

Interest Rates and Economic Indicators

The interest rate and economic data on this page were updated as of 12/31/16. They are intended to provide rate or cost indications only and are for notional amounts in excess of \$5 million except for forward fixed rates.

KEY ECONOMIC INDICATORS

Gross Domestic Product (GDP) measures the change in total output of the U.S. economy. The Consumer Price Index (CPI) is a measure of consumer inflation. The federal funds rate is the rate charged by banks to one another on overnight funds. The target federal funds rate is set by the Federal Reserve as one of the tools of monetary policy. The interest rate on the 10-year U.S. Treasury Note is considered a reflection of the market's view of longer-term macroeconomic performance; the 2-year projection provides a view of more near-term economic performance.

HEDGING THE COST OF FUTURE LOANS

A forward fixed rate is a fixed loan rate on a specified balance that can be drawn on or before a predetermined future date. The table below lists the additional cost incurred today to fix a loan at a future date.

FORWARD FIXED RATES

Cost of Forward Funds				
Forward Period (Days)	Average Life of Loan			
	2-yr	3-yr	5-yr	10-yr
30	6	7	6	5
90	12	16	12	10
180	15	26	20	17
365	41	54	42	33

Costs are stated in basis points per year.

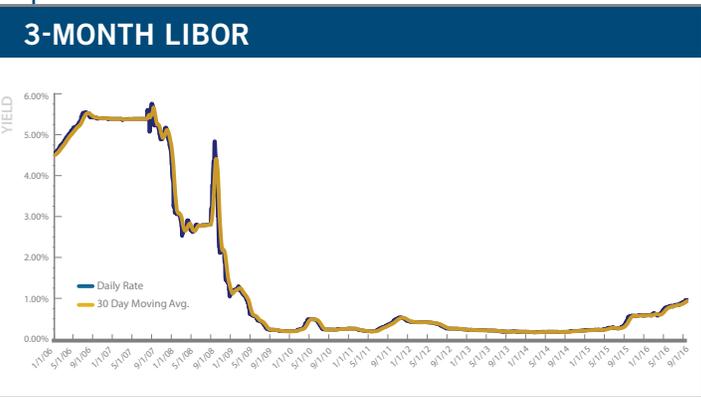
ECONOMIC AND INTEREST RATE PROJECTIONS

Forecasts courtesy of Bloomberg and Blue Chip Economic Indicators

				US Treasury Securities	
2017	GDP	CPI	Funds	2-year	10-year
Q1	2.20%	2.20%	0.70%	1.22%	2.40%
Q2	2.30%	2.40%	0.83%	1.36%	2.52%
Q3	2.40%	2.30%	0.96%	1.49%	2.61%
Q4	2.30%	2.40%	1.15%	1.64%	2.70%
2018	GDP	CPI	Funds	2-year	10-year
Q1	2.40%	2.30%	1.27%	1.82%	2.80%

SHORT-TERM INTEREST RATES

This graph depicts the recent history of the cost to fund floating rate loans. Three-month LIBOR is the most commonly used index for short-term financing.



PROJECTIONS OF FUTURE INTEREST RATES

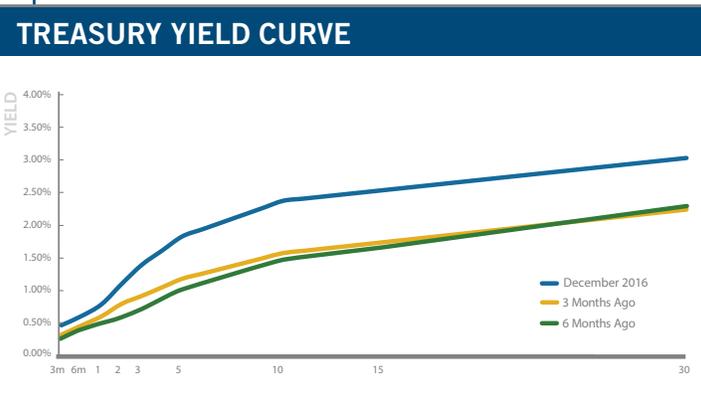
The table below reflects current market expectations about interest rates at given points in the future. Implied forward rates are the most commonly used measure of the outlook for interest rates. The forward rates listed are derived from the current interest rate curve using a mathematical formula to project future interest rate levels.

IMPLIED FORWARD SWAP RATES

Years Forward	3-month LIBOR	1-year Swap	3-year Swap	5-year Swap	7-year Swap	10-year Swap
Today	1.01%	1.20%	1.67%	1.94%	2.12%	2.29%
0.25	1.10%	1.34%	1.77%	2.01%	2.18%	2.31%
0.50	1.28%	1.49%	1.87%	2.09%	2.24%	2.38%
0.75	1.43%	1.62%	1.96%	2.16%	2.29%	2.42%
1.00	1.56%	1.73%	2.04%	2.22%	2.34%	2.45%
1.50	1.81%	1.90%	2.16%	2.31%	2.42%	2.52%
2.00	1.92%	2.10%	2.28%	2.40%	2.49%	2.57%
2.50	2.05%	2.20%	2.36%	2.46%	2.53%	2.61%
3.00	2.18%	2.31%	2.43%	2.52%	2.58%	2.64%
4.00	2.31%	2.43%	2.55%	2.61%	2.65%	2.69%
5.00	2.46%	2.56%	2.63%	2.68%	2.71%	2.74%

RELATION OF INTEREST RATE TO MATURITY

The yield curve is the relation between the cost of borrowing and the time to maturity of debt for a given borrower in a given currency. Typically, interest rates on long-term securities are higher than rates on short-term securities. Long-term securities generally require a risk premium for inflation uncertainty, for liquidity, and for potential default risk.



COBANK UPDATE

About CoBank

CoBank is a \$120 billion cooperative bank serving vital industries across rural America. The bank provides loans, leases, export financing and other financial services to agribusinesses and rural power, water and communications providers in all 50 states. The bank also provides wholesale loans and other financial services to affiliated Farm Credit associations serving farmers, ranchers and other rural borrowers in 23 states around the country.

CoBank is a member of the Farm Credit System, a nationwide network of banks and retail lending associations chartered to support the borrowing needs of U.S. agriculture and the nation's rural economy.

Headquartered outside Denver, Colorado, CoBank serves customers from regional banking centers across the U.S. and also maintains an international representative office in Singapore.

For more information about CoBank, visit the bank's web site at www.cobank.com.

Halverson Appointed as CoBank CEO



Tom Halverson

Effective as of the beginning of the year, Tom Halverson was appointed by the board of directors as the new chief executive officer of CoBank. Halverson succeeds former CEO Bob Engel, who stepped down on December 31, 2016.

"We are delighted to have Tom formally in his new role and leading CoBank forward into the next chapter of its history," said Everett Dobrinski, chairman of the CoBank board of directors. "We're pleased to have successfully completed the CEO succession process and remain focused on ensuring the bank continues to fulfill its important mission in rural America."

Halverson joined CoBank in 2013 and previously served as chief banking officer, with responsibility for all lending operations. Prior to CoBank, he spent more than 16 years in a variety of executive positions with Goldman Sachs, including managing director and chief of staff for Goldman Sachs Bank USA, head of credit risk management for Goldman Sachs in Asia (ex-Japan) and executive director of credit risk management and advisory in London. Before joining Goldman Sachs, he served as principal credit officer for country risk at the European Bank for Reconstruction and Development. Halverson holds a bachelor's degree from Wabash College in Indiana and a doctorate in war studies from King's College University of London.

"I am grateful for the confidence of the board and for the opportunity to build on CoBank's long track record of success," Halverson said. "CoBank remains financially and operationally strong, with an outstanding value proposition and a reputation for excellence in the marketplace. I look forward to working with the board as we continue to finance vital rural industries and work closely with our Farm Credit System partners, while improving the bank's capabilities and the overall experience we offer to our customers."

Dobrinski thanked Engel for his years of service to CoBank, including the last 10 as chief executive officer. "We're grateful for Bob's leadership and for his outstanding service to the organization, which included 16 consecutive years of earnings growth and a significant increase in assets," Dobrinski said. "We wish Bob only the best as he begins the next chapter of his life and career."

As previously announced, Bob Engel remains employed by CoBank in a senior advisor capacity through June 30, 2017.