Economic Research:

Automation Marches On: Do Jobs Need To Be Collateral Damage?

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It's a familiar refrain in campaign rhetoric, around the Thanksgiving dinner table, and pretty much anywhere on the internet: (Country name) is stealing American jobs!

But is that commonly held view true? S&P Global suggests that the answer isn't so black and white. While unfavorable trade dynamics have resulted in lost jobs in a number of industries, automation and the industrial adoption of advanced technologies have a further-reaching impact on the state of the U.S. labor market (albeit without an expected boost to productivity of late).

**Overview**

- Along with trade dynamics, automation has led to job loss in a number of industries.
- Technological advancement's far-reaching impact includes U.S. trade in services and the type of jobs created.
- Focused education initiatives and skills training will help tackle job loss, particularly among displaced workers, and address slowing productivity.
- S&P Global Ratings' economists found that if the U.S. adds one more year of education to today's workforce over a five-year period, the productivity boost to the economy would add an additional $325 billion or 1.8 percentage points to potential GDP.
- Government balances also have a bit more breathing room: With an increase in workforce education, the federal deficit will be $92 billion narrower by 2021 versus the baseline.

Some argue that it's only a matter of time before machines take all our jobs; others believe that while the disruption is painful, civilization has seen this before and, over time, has learned how to adapt to change and come out ahead, though this could take decades, not months.

But, for now, one way to help tackle the problem of lost jobs and slowing productivity today is education, including teaching new skills to potentially displaced workers. Preparing older, more seasoned employees for a new tech-savvy world may not only help their job security prospects but also give economic productivity a boost as these workers combine their years of expertise with new technological skills.

Furthermore, it's not just a manufacturing story. The adoption of advanced technologies has affected employment conditions in a number of other industries--from restaurants and retail to construction, finance, law, and even accounting.

For many Americans worrying that robots will soon take their jobs, these fears are well founded. Low-paying jobs and those that require less education are often the most vulnerable to being replaced by a machine. But, even those who don't lose their jobs to technology may see a (perhaps welcome) change in their responsibilities. Workers in highly skilled jobs reportedly spend more than 30% of their time doing routine work, and automation may free up time spent...
on manual or routine work so that they can focus on more essential or strategic duties.

Overall, we at S&P Global see automation as both a problem and a solution for job creation in the economic future. We argue that a better way to look at the effects of automation may be to understand how jobs could evolve with technological progress, and what kinds of education and (re)training may help employees succeed in a future where they work side by side with colleagues that are made of nuts and bolts rather than flesh and blood.

**Trade...And Trade-Offs**

We can't ignore the fact that, for many manufacturing industries, trade has been responsible for lost jobs.

The number of U.S. manufacturing jobs shrank 36.6% from its 19.6 million peak in June 1979--to 12.4 million in May 2017. To give context, manufacturing jobs accounted for 24% of total jobs in 1974. It's now 8.5%. And while this figure bottomed out in 2010, at 11.5 million (with manufacturing jobs growing 8.3% in the ensuing seven years), certain industries have fared far worse than others. Among those with declining employment from 2011-2016, apparel suffered the most, losing 12.8% of positions according to the Bureau of Labor Statistics (BLS). In fact, from 1991 to 2016, the apparel industry shed 85% of its jobs, and employment at textile mills tumbled 76%. Hence the appeal of trade restrictions to shore up these and other industries--primarily through taxes and tariffs that would make imports more expensive.

Many associate these job losses with the importation of cheap goods and the labor associated with their production. However, the number of job losses directly caused by cheap imported goods represents a small fraction of the normal churn of U.S. labor markets. According to a January 2016 research paper, "Import Competition and the Great US Employment Sag of the 2000s," by Daron Acemoglu, David H. Autor, David Dorn, Gordon H. Hanson, and Brendan Price from the Journal of Labor Economics, imports from China displaced as many as 985,000 workers in American manufacturing industries and 1.98 million workers in the entire economy from 1999-2011--depressing local labor markets in communities that produced such goods as textiles, apparel, and furniture, with interindustry linkages magnifying the employment effects from the trade shock. But while the loss of nearly 1 million manufacturing jobs and 2 million total in a decade is significant, the U.S. labor market records about 1.7 million layoffs and discharges and about 5.25 hires every month under normal conditions in a jobs market that employs around 150 million people.

Furthermore, blaming trade in consumer products from countries such as China is misguided, given that the vast majority of what is sold in the U.S. is produced domestically. An August 2011 report from Galina Hale and Bart Hobijin at the Federal Reserve Board of San Francisco found that "Made in China" goods represented just 2.7% of U.S. personal consumption expenditures in 2010, with less than half of that figure, only 1.2%, reflecting the actual costs of Chinese imports. The rest of the money spent on that product goes to U.S. companies and workers in the form of U.S. transportation, wholesale, and retail activities. Updating that analysis to 2014, S&P Global found similar results. Goods with the "Made in China" label accounted for just 1.9% of U.S. consumer spending (about one-fifth of the 10.3% foreign share), with only 0.9 percentage points of that total reflecting the cost of the goods. Thus, for every dollar spent on such items from China in 2014, 53 cents go toward services provided by companies in the U.S.

Meanwhile, the costs that would come with protecting a certain segment of the labor force could outweigh the
benefits. In his June 2016 paper "The Truth About Trade," Dartmouth College social sciences professor Douglas A. Irwin examined the effects of increased isolationism. He cited the fact that, while few Americans are employed in the manufacturing apparel industry (124,000 jobs in May 2017), more than 45 million U.S. residents live below the poverty line. As such, it’s difficult to see the economic benefits of increasing clothing prices for 45 million low-income Americans (as well as everyone else) in an effort to save just some of the jobs in an industry that accounts for roughly one of every 1,000 full-time jobs in the U.S. labor force. We only need to think of what a 45% tariff would do to the price of a new pair of Chinese-made shoes to get the picture.

We agree that the potential costs of increased isolationism would far outweigh the benefits of protecting American businesses in such a manner—potentially igniting international tensions and ignoring the benefits U.S. consumers get in the form of more product choices at lower prices (which helps lower-income households most, of course). It’s worth noting that trade now represents 27% of U.S. GDP (in 2016 nominal terms), up sharply from 16% during the Reagan Era—with the U.S. getting more imports from China and Mexico (together, 35%) than any other country. Slapping tariffs on these goods and services would likely benefit only a small fraction of American workers and would hurt consumers and producers that rely on imports for inputs. Given that 11.5 million jobs, particularly transportation jobs, were supported by American exports last year (7.7% of total U.S. jobs), retaliatory tariffs on U.S. goods and services would clearly be detrimental to a number of these workers.

**Rounding Up The Usual Suspects**

During the 2016 U.S. presidential campaign, the poster child for struggling American manufacturers was the unemployed factory worker, with trade the culprit. And it’s true that manufacturing has lost more than 7 million jobs from its peak of 19.6 million in June 1979. But in contrast to claims that manufacturing is in freefall, U.S. manufacturing production is near all-time highs (see chart 1). Although the Great Recession brought about a sharp decline in manufacturing production and significant job losses, the country’s manufacturing remains on a long-term growth path (in inflation-adjusted dollars). In fact, from 2010-2016, U.S. manufacturing output grew 14%, or roughly 2.3% annually—roughly in line with the economy as a whole, which expanded 12%, or 2.1% a year, during that period.

Ironically, when they are hiring, manufacturers (and other businesses) say that they can’t find workers with suitable skills needed to complement their new production capabilities. Given reports that job openings are at all-time highs, the mediocre jobs report this May suggests that businesses are struggling to fill these positions in an increasingly tight market. Workers also appear to have given up. The labor participation rate is now at a 38-year low, with only around half of that drop likely because of retiring baby boomers.
Moreover, the lost manufacturing jobs were more the result of technological updates than trade. Indeed, "The Myth and the Reality of Manufacturing in America" June 2015 study by the Center for Business and Economic Research at Ball State University found that technological change--rather than trade--was responsible for 85% of that total. It noted that this should be viewed as an illustration of the impact of productivity growth, not actual lost jobs from productivity.

**Definitions (Cambridge Dictionary)**

- To automate: to make a process in a factory or office operate by machines or computers, in order to reduce the amount of work done by humans and the time taken to do the work.
- Artificial Intelligence (AI): the use of computer programs that have some of the qualities of the human mind, such as the ability to understand language, recognize pictures, and learn from experience.

In other words, manufacturers are producing more with fewer people. That helps explain why Deloitte found in its 2016 Global Manufacturing Competitiveness Index that U.S. manufacturing is now the second-most competitive in the world, behind China. But not for long. Deloitte expects U.S. manufacturing to surpass China by the end of the decade, largely thanks to increased productivity from advanced technologies.
The authors of the Ball State study, professors Michael J. Hicks and Srikant Devaraj, suggest that the dynamics of labor usage in manufacturing are contributing to the belief that the sector is in decline. They cite that, from 1998-2012, productivity expanded in all sectors (when adjusted for inflation and with significant sectoral variation) (see chart 2). This growth was led by computer and electronics, but double-digit gains were recorded in automobiles, transportation equipment, and primary metals machinery, among others.

**Chart 2**

*What Explains The Lost Jobs?*

In general, they found that, if productivity levels had been the same in 2010 as they were a decade earlier, the economy would have needed 20.9 million manufacturing workers. Instead, the country employed just 12.1 million. In this light, it's easy to see why there's so much hand-wringing about the state of U.S. manufacturing--and why many in Washington have seized on it as a hot-button issue.

Unfortunately, we've indicted the wrong guy: trade. Meanwhile, automation seemingly got off scot-free and is still at large.
At Your Service

And while many in Washington continue to point at China and Mexico as the culprits, it's worth bearing in mind that U.S. trade in services has been booming, thanks, in part, to technological change, with the cyber highway helping to pave the way.

As it stands, the U.S. maintains a strong and growing trade surplus in services (even as American companies increase their outsourcing of services such as customer call centers and tech support). According to the U.S. International Trade Commission’s 2016 annual report, the U.S. continues to be the largest global exporter and importer of services in the world. U.S. services exports reached approximately $752 billion in current dollars, or 34% of total U.S. exports in 2016—up from around 20% before 1980—while imports of services were $503 billion, or 18.5% of total imports, according to the Bureau of Economic Analysis (BEA) (see chart 3). Services supplied by U.S.-owned foreign affiliates, the leading channel through which many American services are delivered to foreign markets, increased 3%, to slightly more than $1.3 trillion, in 2013 (latest available data).

Chart 3

The Unsung Hero: U.S. Trade Surplus in Services

The relative strength in American exports in services in the past 35 years or so, as compared with merchandise (both...
manufactured and agricultural goods) exports, reflects broader changes in the world's biggest economy—primarily that the share of services in GDP and employment has been steadily rising since the 1950s. Service industries (leisure and hospitality, retail trade and transportation, financial and insurance services, information services, business and professional services, etc.) now account for about 80% of the economy and employ more than 80% of the country's private-sector workers.

The emergence of the internet and the increased capacity to move data around the world at low cost have created entirely new export opportunities for services providers and America's small businesses. This growth in information technology and declining transportation costs have facilitated the surge in the trade of services, especially in digitally deliverable services (those that are enabled and facilitated by information and communication technologies). These include business, professional, and technical services; royalties and license fees; financial services; insurance services; and telecommunications. Digitally deliverable services continue to be an important contributor to U.S. trade, accounting for more than half of all services trade and more than one-sixth of overall trade in goods and services, according to the U.S. Department of Commerce. The U.S. had trade surplus in digitally deliverable services of $160 billion. Because exports have increased at a faster rate than imports, the surplus has expanded by 19% since 2011.

Extending Ball State's illustrative exercise on productivity changes and job formation to the service sector, S&P Global found that growth in real production per worker has been meaningful since 2000. Applying 2000 levels of real production per worker to 2016 levels of production in the service sector, S&P Global found that it would have required 134 million workers to produce 2016 levels of real production. Instead, the economy employed 110 million workers. While service sector employees expanded by 15% during this period, total output increased by 41%, with a 22% average rise per worker. The manufacturing sector also saw significant production gains combined with a significant drop in jobs—with production per worker more than twice that for services. But, unlike the manufacturing sector, the service industry saw exports consistently grow more than imports, and thus global demand—through the trade channel—likely gave American service sector a positive boost, albeit small.

**Jumping On The Bandwagon…Or In A Self-Driving Car**

Advances in technology create jobs. For example, as cars started speeding along American roads, that probably wasn't the best time to gain expertise in shoeing and tacking up a horse or fixing a wagon wheel. On the other hand, opening a motel or a fast-food restaurant to serve motorists and truck drivers would have been a good career move.

Historically, technology ends up creating more jobs than it destroys because of how automation works, says M.I.T. economics professor David Autor in his 2015 report "Why Are There Still So Many Jobs? The History and Future of Workplace Automation."

Automation substitutes for labor so that a task can be done faster or for less cost. But many forget that automation also complements labor. It raises output in a way that leads to more demand for human workers to do the accompanying tasks that haven't yet been automated. Essentially, workers become the supervisors of machines.
In The Economist's June 25, 2016, special report "Artificial Intelligence: The Impact on Jobs," James Bessen, an economist and lecturer at the Boston University School of Law, highlights an example from weaving during the Industrial Revolution. While the introduction of machines to the textile industry initially led to lost jobs, the automation of more and more tasks in the process allowed workers to focus on things machines couldn't do, such as tending multiple machines to keep them running smoothly--thus boosting output. During the 19th century, the amount of coarse cloth a single American weaver could produce in an hour increased by a factor of 50, with the labor needed effectively disappearing--dropping 98%. Cheaper cloth increased demand for cloth, in turn creating more jobs for weavers, and their numbers quadrupled from 1830-1900.

In an example from our lifetime, it would have been easy to predict that ATMs would spell doom for bank tellers--and, indeed, the average number of tellers at an average American bank branch fell to 13 in 2004 from 20 in 1988, Mr. Bessen notes. However, the cost savings allowed banks to open more branches to meet customer demand--and the total number of bank employees increased. Rather than resulting in a net loss of positions, the implementation of ATMs allowed bank employees to spend less time on routine tasks and more on activities, such as sales and customer service, that machines couldn't do.

The automobile was another technological advancement that changed the way the economy ran. Sure,
horse-and-buggy drivers were out of business. But the introduction of the automobile opened the door to many new industries, including motels, fast food, and even drive-ins. Today, with the driverless car becoming more and more a reality, it's hard not to wonder what will the economy look like in 10, 20, or even 50 years.

With that in mind, it's important to remember that a large--and fast-growing--contingent of American workers will be displaced by technology. Around 3% of all working Americans are drivers of some sort--the majority drive trucks while others drive taxis or buses. A CNBC article (Sept. 2, 2016) notes that these jobs aren't evenly distributed across the country, and some places are going to be hurt more than others. All you have to do is look at the sea of yellow cabs on Broadway in New York City to understand how disruptive that could be.

And while retail may not be at the top of the list of industries where the use of automation is commonplace, that does not mean that automation in retail isn't happening. Robert Schulz, at S&P Global Ratings, says "The great retail disruptor ecommerce, as dominated by Amazon, is a widespread form of automation, notably on the consumer-facing front-end of a retail purchase. Amazon is already testing the friction-less checkout, which goes beyond simple self-checkout." But, "on the back end, much of the order processing involves robots picking goods, if not yet packing. And the sorting and shipping process is a mix of automation and human workers."

In the restaurant segment, mobile ordering and mobile pay, a form of automation, are increasing penetration. Tabletop digital order and pay in casual dining is also increasing.

So while self-driving cars and drones are not yet delivering retail goods (which have been picked and packed by robots), over the final mile it's safe to say that use of automation in the front and back-end of the retail experience is on the rise.
For Self-Driving Cars, The Question Is: How Soon Is Soon?

While it seems clear that, sooner or later, roadways around the world will be lousy with self-driving cars, significant hurdles--some technological, some philosophical--may mean that "later" is the more likely scenario.

As it stands, there are a number of technological paths being considered, and carmakers themselves can't seem to agree on whether to collectively pursue the types of vehicles that are truly autonomous--i.e., without any possible intervention from the driver--or those in which steering wheels and gas pedals can still be controlled by a human being.

That said, various real-world trials, such as Uber Technologies’ experiment with driverless cars in Pittsburgh and Google’s extensive testing of autonomous vehicles, suggest that a world in which everyone is a passenger is just around the corner. And while the wide-scale adoption of auto-related innovation has sometimes come in fits and starts (consider the example of backup cameras, which took more than a decade to go from development to full assimilation), advances such as adaptive cruise control, blind-spot warning alerts, and advanced emergency braking systems are all contributing to the development of autonomous vehicles.

Meanwhile, questions of legal liability also pose some hurdles. While figures on the U.S.'s National Transportation Safety Board website suggest that 94% of vehicle crashes are due to human error, and the group works to sort out the rules and regulations for autonomous driving, it remains to be seen whether the makers of such vehicles are prepared to assume legal responsibility when the cause of a crash is outside the human realm.

Beyond that, perhaps the greatest challenge companies face lies in getting consumers to accept the idea of ceding total control to machines that will cart them around at highway speeds. While consumers are generally happy with collision-protection technologies--in fact, they have produced the highest level of satisfaction in some J.D. Power studies--more than one-fifth of car owners have trouble using or understanding their vehicle’s safety features. Add to that the risk of confusion caused by the variability of marketing names and acronyms for similar systems, differences in default settings, and the difficulties drivers may encounter when switching from one system to another, and it’s clear that manufacturers have their work cut out for them.

As such, car dealers may play a big role in smoothing the way for wider acceptance of autonomous vehicles--once manufacturers can guarantee that fully functional designs exist, of course.

Either way, younger Americans are, unsurprisingly, more open to the idea of autonomous vehicles than older generations are. This is especially important because millennials will soon be buying more cars than any other generational cohort. According to J.D. Power surveys, Gen-Yers are twice as likely to trust fully automated self-driving vehicles as Gen-Xers are and five times as likely as baby boomers are.

But there also seems to be a disconnect between the general sentiment about self-driving and the actual act of being driven in such a vehicle. While 67% of 16-to-21 year olds have said they are very or somewhat positive about the idea of autonomous vehicles, 85% of them reported being somewhat or very concerned about the idea of actually traveling in one. Foremost among their concerns is the fear that the vehicle could be hacked or hijacked in some way. Moreover, the multitude of scenarios that a self-driving car could encounter while operating among a mix of autonomous and driven vehicles could make for significant growing pains.

(Editor's note: The preceding was adapted from "Global Automakers Are Scrambling For Position As The Market Evolves, Conference Speakers Say," published Nov. 2, 2016, on RatingsDirect.)
Welcome To The Machine

While debate continues about how soon machines will have the broad intellectual capabilities that humans do, one thing seems inarguable: Technology will continue to match and exceed human performance in more and more tasks. It doesn't take much imagination to realize that, at some point in the not-too-distant future, nearly all routine functions will be done by machines (with the operative word in that assessment being "routine").

As such, technological progress that allows output to increase faster than labor and capital is--and will be--the main source of per capita economic growth. Naturally, this comes with some caveats. While automation will continue to create wealth and add to GDP in coming years, that growth will come with a cost, changing the skills that workers need to succeed. In a December 2016 report, President Obama's office argued that aggressive policy action would be needed to help workers who are disadvantaged by this transformation, as well as to ensure that the benefits of AI and automation are available to all citizens.

Not NSYNC

Somewhat counterintuitively, all of these technological advances haven't seemed to boost recent productivity growth in any significant way (see chart 5). In fact, productivity growth in the past decade has slowed in almost every advanced economy, and the U.S. is in one of its slowest-growth periods since the end of World War II (see “The Strange Case Of Shrinking U.S. Productivity Growth: Myth, Mismeasurement, Or Multiyear Phase?,” published May 5, 2016).
During the current expansionary period, which started in the fourth quarter of 2007, labor productivity has increased at an annualized rate of just 1.1%, according to a January 2017 report from the BLS. That's well off the rates of the 10 business cycles since 1947—and only a brief, six-quarter cycle in the early 1980s saw a rate that low (also 1.1%). So, while the U.S. has seen an amazing surge in technological innovation and efficiency gains, that productivity boost remains out of grasp. As the San Francisco Fed Senior Advisor John Fernald frames it, according to the Financial Times on May 3, 2016, if the robots were taking over, "we would see lots of capital growth and not much labor growth." If the U.S. was seeing a surge in automation, labor productivity and capital investment would also be growing at a rapid pace, as fewer workers and more technology did the work. Instead, we've seen a deceleration.

That said, it's not inconceivable that productivity growth will accelerate sometime soon—if not in the immediate future—and to the extent that automation fosters positive advancement in diverse sectors, Americans will be better off in the aggregate. S&P Global thinks productivity will likely improve in the coming quarters, at least moderately, as the economy reaches full employment—which recent data indicate we're near.

There is a real risk of hysteresis—the process through which low resource utilization leads to persistently weaker productive potential—for the economy as drawn-out cautiousness with business investment could weigh on productivity through capital-embodied technology. But, proper demand stimulus (businesses' confidence that they can
sell more goods), together with a mix of policies to address structural headwinds, such as the slow diffusion of technology, a mismatch in skills between workers and positions, and a declining share of entrepreneurial businesses, will expedite a return to the little over 2% productivity growth from 1950-2007.

Don't Fear The Reaper Or The Robot…Learn How To Operate It

Human fears about the rise of technology are nothing new—after all, the legend of “steel-driving man” John Henry dates back to at least the 1870s. (And, sure, he won the race against the steam-powered hammer, but who among us would pay such a price to do so?) Meanwhile, Luddites were originally a group of early-19th century English textile workers who destroyed machinery as a form of protest (taking their name from an apprentice, Ned Ludd, who, according to legend, smashed two knitting machines in 1779).

In today’s economy, workers who are most threatened by automation are often those who are lower paid, lower skilled, and less educated (see chart 6). According to the Council of Economic Advisors, jobs for people with less than a high-school degree have a 44% chance of being replaced by automation; for low-paying jobs (less than $20 per hour), it’s 83%. By contrast, a job that requires someone with a bachelor’s degree has only a 6% chance of being automated; for high-paying jobs (more than $40/hour), it’s only 4%.

Chart 6

Share Of Jobs Likely To Be Automated, By Education


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That doesn't mean that a low-paying job is, by its very nature, apt to be cut. Technical feasibility is a necessary precondition for automation. But even assuming a job can be automated, other factors are important. For example, if an employee makes a low wage, investing in a comparatively expensive robot may not provide sufficient return on investment. At the same time, social skills still matter. While an iPad or TV may be able to entertain a child, most parents would still prefer to leave their children in the care of a human childcare worker than a robot.

Automation is also changing responsibilities for skilled jobs. Highly skilled workers (whose annual incomes exceed $200,000) spend more than 30% of their time on routine tasks (25% for CEOs) that could be automated, according to a January 2017 report by McKinsey Global Institute. Automation would free up time for such employees to engage in more intellectual pursuits, which would add to their businesses' bottom lines.

Re-Upping On Humans

In this light, it's important to remember that, while robots may be taking work from us, they aren't our enemies. We agree with the 2016 report from the president's office that starts with the premise that investing in and developing AI is something that we, as a society, need to do. But the report also suggests that we need to educate and train Americans for the jobs of the future--and help those who have been left behind in the transition. As the report notes, empowering workers would ensure broadly shared growth.

Along these lines, Bill Gates has argued for a "robot tax," saying he thinks that governments should levy companies' use of them as a way to fund other types of employment. In a February interview with business-news website Quartz, Mr. Gates said that such a tax could help finance jobs for which humans are particularly well suited, such as assisting with elderly care or working with kids in schools. The piece quoted Mr. Gates as saying: "Right now, the human worker who does, say, $50,000 worth of work in a factory, that income is taxed and you get income tax, Social Security tax, all those things. If a robot comes in to do the same thing, you'd think that we'd tax the robot at a similar level."

Setting aside the manner in which it would be financed, S&P Global agrees that re-education is the key factor to consider. Given many businesses complain that they can't find workers with the skills they need in this new economy, they would likely agree.

Still the central question is: Can American workers keep up with the pace of change? And can we afford not to offer reeducation and training to the workforce if we want to see sustainable economic growth?

Retraining seasoned workers with the tools they need in a new automated society would keep them--and their experience--in the jobs market. That means their knowledge of their businesses wouldn't be lost to the next generation, as they could train the younger workers. Naturally, they'd also be making an income to help themselves and their families. The increased economic activity would also mean more tax revenue for Uncle Sam, which would help pay for retirement benefits as the baby boomers leave the workforce.
America, Back To School

The U.S. has been through this transition before—and not so long ago. Roughly half a century ago, from 1960-1965, the U.S. workforce gained a year of education, surpassing the period from 1950-1980, when Americans gained an average of about eight months of education every five years. And in the early part of the 20th century, when automation of the U.S. farm left many out-of-work farm hands migrating to cities, agriculture states were the first to institute universal public high school education to prepare for the future. The G.I. bill at the end of War War II turned many a war veteran into a college graduate.

In fact, our research shows that, if the U.S. were to add another year of education to the American workforce, GDP would likely be $325 billion, or an aggregate 1.8%, higher in five years than in our baseline forecast (see chart 7). During the five-year period, labor productivity growth would be up by 0.2 percentage points on average than in our baseline case. While our scenario doesn't specify by type of education, targeting an area such as the gap between technological change and worker skills may have even more immediate productivity gains.

In our hypothetical scenario, this translates to about 755,000 more jobs in the next five years in the economy. Higher capacity for growth in both labor and products markets together add more room for more cyclical growth, as well as higher rate of growth in the economy, and also provide more breathing room for government balances as the federal deficit would be $92 billion narrower or, as a percent of GDP, 0.4 percentage points lower (3.67% versus 4.04%). This is a meaningful boost to the overall macroeconomic conditions of the economy, considering the recovery that has been dogged by hysteresis (a persistently weak growth environment compared with previous cycles) during the present business cycle.
Historically, data at the state level support these results. A clear and strong correlation exists between the education of a state's workforce and median wages, with better-educated individuals more likely to participate in the job market and earn higher wages and less likely to be unemployed. Nationally, the unemployment rate for people 25 years and older with a college degree was 2.4% in April 2017—three times the unemployment rate for those with less than a high-school degree. According to our research, education is an investment in the health and livelihood of future generations, with greater parent education positively correlated to a child's health, cognitive abilities, academic achievement, and future economic opportunities (see "How Increasing Income Inequality Is Dampering U.S. Economic Growth, And Possible Ways To Change The Tide," published Aug. 5, 2014).

Evidence indicates that a well-educated U.S. workforce is not only good for today's workers and their children but also for the economy's potential long-term growth rate and government balance sheets—what do we need to do to reach these levels?

We'd argue that a degree in a STEM (science, technology, engineering, and math) field is often not necessary to bring many workers up to speed. Instead, simply increasing technological literacy could be the ticket to bring back workers displaced by automation. It's also easy to assume that a more tech-savvy employee—albeit with less industry experience—would do the trick. But that ignores the years of industry experience a seasoned employee brings to a
firm—even when that worker is technologically challenged.

Holding onto older workers may also benefit society as a whole. Data on labor dynamics reaching back to the 1980s indicate that many men of prime working age (25-54) have been dropping out of the labor force (now women, age 25-54, are also leaving the market) (see chart 8). However, productivity climbs higher with age, until it peaks at age 50, when productivity is 60% greater than someone who’s 20 years old (Wall Street Journal "For Economy, Aging Population Poses Double Whammy," Aug. 3, 2016). So, for the benefit of the U.S. economy, we need those people of prime working age back to work!

A paper by Nicole Maestas of Harvard University and Kathleen Mullen and David Powell of the Rand Corporation found that a 10% increase in the share of a population over age 60 decreases the growth rate of GDP per capita by 5.5%. One-third of that drop was from slower labor force growth as the workers retire.

But two-thirds of the reduction was due to slower productivity from the remaining workers. That older worker's experience was not only increasing his own productivity, but also that of those who work with him. With him gone, that associated drag on productivity means lost potential economic growth both today and tomorrow. Whether the U.S. reverses that trend could spell the difference between continued ho-hum growth, or an economic renaissance for the 21st century.

**Chart 8**

**Labor Participation Rate By Age, Sex**


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Change Is Inevitable--Progress Is Optional

As with all "creative destruction," the advent of scalable automation technologies and global value chains continues to generate winners and losers. And if 30 years of evolution in the manufacturing sector has taught us anything, it's that effective retraining measures must be put in place to catch workers likely to fall through the cracks, either temporarily or permanently. Efforts need to be taken to reduce skills mismatch in the labor market--and the burden lies in both the public and private domains (see "Better Job Skills And A Good Education Are Two Sides Of The Same Coin," published Aug. 27, 2014).

As information technologies have radically changed work in a wide variety of occupations--from construction to finance--in the past few decades, many employers have had persistent difficulty finding workers who can make the most of these innovations. This is one reason businesses are working now to reskill the workers U.S. businesses need to thrive. According to the Harvard Business Review (HBR) October 2016 report "AT&T's Talent Overall," the company plans to reinvent itself and re-skill its current employees to keep pace in this rapidly changing world. HBR says AT&T's gambit to reeducate its "enormous workforce is without precedent." Let's hope they succeed.

For policymakers, ensuring that all individuals are furnished with better and more relevant skills is vital for expanding the productive base of an economy. Simply put, those workers who acquire the latest skills earn good pay; those employers who hire the right workers and train them well can realize the competitive advantages that come with new technologies. Policymakers need to think differently about skill--encouraging, for example, industry certification programs for new skills and partnerships between community colleges and local employers. This would produce not just more college graduates, but also graduates with the skills employers want. Perhaps lawmakers could ease excessive occupation licensing regulation and make licenses transferrable across states for greater labor-market fluidity.

Meanwhile, for firms looking to capitalize on productivity gains from new technologies, increasing in-house training and apprentice programs--often teaming up with government agencies, unions, and colleges--would go a long way toward finding the right people for the positions. This also would help employees redefine their jobs within the company or industry, protecting against job losses or underemployment.

Evidence of a skills mismatch in the U.S. labor market can be seen in the fact that there are more job openings (a record high 6.04 million) than hirings (5.05 million) on the last business day in April 2017, eight years into the U.S. expansion. The inability to fill openings points to a lack of qualified candidates and gets to the heart of why there's been persistently low productivity growth. At the same time, the ramifications of all this aren't confined to the U.S.

On a global scale, increased automation could mean that low-wage countries that once attracted manufacturers lose their cost advantage, as well as the accelerated economic expansion that often comes through shifting workers to factory jobs. In a January 2016 survey of institutional clients, Citi found that 70% believe that automation and the developments in 3-D printing will encourage companies to move manufacturing processes closer to home--with North America gaining the most from this development, while other emerging markets, like China, having the most to lose. Citing the 2016 World Bank "Digital Dividends" report, World Bank President Jim Yong Kim said this April that, "we
estimate that two-thirds of jobs that currently exist in developing countries will be wiped out by automation." While how fast automation will cut jobs is unclear, he noted that we need to think about "the investments we need to make right now, in order to prepare ourselves for the economy of the future."

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