Scarce Skills, Not Scarce Jobs

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For Centesimus Annus Pro Pontifice Foundation 2017 International Conference

Technology and the Future of Work

New technologies are disrupting societies around the globe. Since the middle of the 20th century, developed nations have seen the share of employment in manufacturing decline dramatically. In the US in 1958, for instance, there were 300 thousand production workers in the broadwoven textile industry and 500 thousand production workers in the steel industry; today there are only 16,000 in the broadwoven textile industry and 100,000 in steel. Although some of those jobs have been lost to globalization, most—about three-quarters by my estimates—have been lost to technological automation.

These losses place a heavy burden on our societies. The manufacturing sector has long been a major source of well-paying jobs for people who do not have a university education. The loss of these jobs has reduced economic opportunity for many and made it harder for less-educated workers to earn middle-class incomes. In the US, this trend has contributed to growing economic inequality; in Europe, it has contributed to growing unemployment. And in both, it has contributed to political instability. The burden of reduced opportunity falls most heavily on the less well-established sectors of society, such as the young and immigrants.

Nor is this strictly a problem of the developed world. "Premature deindustrialization" is affecting lesser developed nations (Rodrik 2016). The effect is to limit

growth opportunities, to limit urbanization and the associated trend toward democracy. In effect, many developing nations can no longer look toward manufacturing exports as a path to economic growth.

And now a whole new set of information technologies is rapidly emerging that use "artificial intelligence" and "machine learning." These increasingly promise to give computers the ability to automate tasks performed by all sorts of white collar and professional workers. Some people predict that these technologies will cause massive job losses across a broad range of occupations and industries over the next 10 or 20 years. Frey and Osborne (2013) write that these new technologies put "a substantial share of employment, across a wide range of occupations, at risk in the near future"

Are we about to witness even greater social disruption brought on by mass unemployment? Are we approaching the "End of Work"? Not in the next 10 or 20 years. I argue that widespread fears about automation creating mass unemployment are misplaced for the near future. New technologies are, indeed, disrupting our societies, but new technologies are creating more jobs than they are destroying. The real challenge, instead, is that the new jobs require new skills, often learned on the job; these skills are difficult to acquire and the opportunities to learn are too limited. The result is that new technologies are exacerbating economic inequality, giving opportunity to some, but leaving many behind, including many young workers.

It is critical that we correctly identify the challenge posed by these new technologies. Our only hope of meeting that challenge depends on having the right policy remedies targeting a correct diagnosis.

Automation Can Create Jobs

Technology has been automating work since ancient times and has raised concern about employment since ancient times as well. During the Industrial Revolution, many commentators, including Marx, predicted that automation would impoverish the working classes. Keynes raised the specter of technological unemployment during the 1930s. In the US, politicians were concerned about computer automation during the 1960s. Yet repeatedly, predictions of imminent doom have proven premature.

Of course, this time the predictions might be right; past performance is no guarantee. Nevertheless, it is important to understand the mistake that past observers made in order to make sure we are not repeating it. Indeed, what people perennially misunderstand is that automation occurs in a dynamic economy. While automation reduces the amount of labor needed to, say, produce a yard of cloth, the effect is also to lower the price of cloth. This, in turn, increases demand for cloth; if demand increases enough, employment of textile workers will rise despite the labor-reducing effect of automation.

To be concrete, consider textile workers of 100 years ago. The most advanced textile mills of that time in the US had very many machines and very few workers relatively speaking: they had 24 looms for each weaver employed. Over the course of the 19th century, the mills had already become highly automated. In fact, 98% of the labor that had been required to produce a yard of cloth in 1810 was taken over by machines by 1910.

Now you might think that it is obvious that such automation would have eliminated jobs for weavers. You would be wrong, however. Although jobs for textile workers have declined sharply since 1958, during the 19th century jobs for textile workers generally and for weavers in particular *grew dramatically*, confounding the predictions of Marx and others.

What happened to make this so? Demand increased. Two hundred years ago, cloth was very expensive and most people had little of it. A typical person had only one set of clothing, often made of wool or linen. Automation reduced the price of cloth sharply and so people bought more, much more. By 1910 in the US, people were consuming 10 times as much cloth per capita as in 1810 and total demand, accounting for the growing population, grew 100-fold. This meant that the growth of demand outstripped the labor-saving effect of the automation and total employment grew in textiles. And this is what the doomsayers failed to anticipate.

But demand growth was not so robust forever. By the middle of the twentieth century, people had closets full of clothing and they had cloth draperies, upholstery, etc. Since then, a further decrease in the price of cloth has only had a very modest effect; people today simply do not buy much more cloth in response to a price decrease. Demand is satiated. In this case, automation is no longer offset by rapid demand growth and employment decreases, sharply so after the 1950s.

So automation can produce rapid job growth or rapid job losses or something in between in the affected industry. Employment will grow when there is large unmet demand in the product market; employment will shrink when the market is saturated.

But what is the story for the markets affected by computer automation? In order to understand the impact of the new technologies, the first thing to understand is the nature of demand in the relevant markets. And the evidence suggests that these technologies are addressing large unmet needs, so that computer automation is, overall, leading to job growth, not declines. In the 1980s, bar code scanners automated much of the work of cashiers in the US, but the number of cashiers increased. Electronic document discovery automated much of the work of paralegals, but employment of paralegals grew. The automated teller

machines (ATMs) took over cash handling tasks from bank tellers, but bank teller employment has grown in the US since the major adoption of ATMs. And the reason is a demand story. The ATM made it substantially less expensive for banks to open up a branch office; this led them to open up many more branch offices, increasing the demand for tellers on net, even though there were far fewer tellers per branch.

Moreover, this pattern appears to be rather general. Use of information technology is associated with faster employment growth in non-manufacturing industries—about 1.6% faster growth per annum on average. This is not true in manufacturing industries where, as the analysis of the textile industry suggests, markets are already relatively saturated. Thus automation that uses information technology has been very much like early 19th century manufacturing automation overall, increasing employment in response to increasing demand.

Of course most of the information technology used to date does not involve machine learning or artificial intelligence, so perhaps the impact of the new technology will be different.[1] However—and this is a key point—it is demand, not technology, that determines whether automation will increase or decrease employment. The new technologies are being used in markets and applications quite similar to those that use existing information technologies. Because the demand response will be the same and because the nature of demand only changes slowly, we can expect the response to be similar. That is, for the next 10 or 20 years, most applications of new information technologies in most industries will be associated with growing employment, not job losses.[2] And certainly not massive unemployment.

[1] Artificial intelligence applications have been in commercial use since the 1980s.

[2] There is an important exception to this logic: cases where the technology *completely* automates all of the tasks performed by an occupation. In those cases, employment will decline. There are some technologies that might completely automate some occupations over the next 10 to 20 years, such as self-driving trucks. However, most

Winners and Losers

Yet not all the news is good. New technology can benefit workers when they become more productive, leading to higher wages. But with information technology, not everyone has the opportunity to benefit. Some people are given opportunities to work with the new technology, others are not. Some jobs grow, but other jobs are displaced; some people see growing wages; others see stagnant wages.

Consider, for example, the impact of computer automation on the publishing process. Since the 19th century, text was prepared for publication by typesetters and compositors. During the 1980s, more and more text was prepared using desktop publishing software on low cost personal computers.

But this new way of publishing was performed not by typesetters and compositors, but by graphic designers. Because designers could make revisions directly and interactively on a computer, they could make the revisions faster and better. So the work shifted across occupations. The number of typesetters and compositors in the US fell by three-quarters in a little over a decade. But the number of graphic designers grew even more, offsetting the jobs lost by typesetters and compositors.

As a result, there was not a net loss of jobs. But there were winners—the graphic designers—and losers, the typesetters and compositors. This pattern appears more generally. Computer use is associated with growing employment in high wage, high skill occupations, but it is associated with job losses in low wage occupations. Although computer automation

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analysts see very few occupations being completely automated in the near future because there are very many tasks that artificial intelligence technologies cannot perform.

is not associated with a net loss of jobs, it *is* associated with disruptive transitions from some jobs to others, from some sets of skills to others.

New Jobs, New Skills

These transitions would not be a major social problem if workers could learn the new skills quickly and at low cost. For instance, if typesetters could take a two month course online to become graphic designers, then they could readily switch occupations. However, it appears that the new skills are much more difficult to acquire than that. Indeed, many graphic designers who have four year college degrees face difficulty acquiring the skills needed to use the newest technology and to earn high wages.

This difficulty arises from two related features of technological change: 1) new technologies change rapidly, and, 2) they are often not standardized. Continual and rapid change means that the needed skills are constantly changing. Workers have to become *continual* learners. And all too often there are many different versions of new technologies; the skills learned on one may not be applicable on another.

Consider the changing nature of the knowledge needed to prepare pages for publication. Initially, typesetters and compositors learned their trade through an apprenticeship program. Then desktop publishing came along and the key skills required training in print design—often taught in a four year program—and desktop publishing. But then the Internet came along and graphic designers needed to learn web design. And then smartphones came along and they needed to learn mobile design. And increasingly, as the web and mobile applications became more sophisticated, new specialties emerged such as user interaction specialists and information architects, each with specialized skills. Moreover, there were many standards that changed frequently. In 2012, Flash was seen as an essential

technology standard for many websites; today, Flash is obsolete, replaced by HTML5 and other standards.

These conditions mean that schools cannot keep up with the technology. When key knowledge is not standardized it cannot be written in textbooks or summarized in lectures easily. Instead, people must learn through direct experience on the job, that is, learning by doing. And teachers cannot keep up with the technology unless they are also able to acquire that experience on the job. Graphic design schools are struggling to keep up.

Furthermore, labor markets do not work well when technology is not highly standardized. Experience matters, but employers looking to hire workers with needed technical skills have a hard time telling who has the *right* experience. Without effective certification, employers have a hard time telling which prospective employees have the needed skills. This, in turn, means that workers are not fully compensated for the skills they have learned and they thus have diminished incentives to invest in learning new skills.

In such environments, some workers succeed. Some workers have the opportunity to work with the latest technologies, some can teach themselves new skills, and some develop reputations so their value is clear to prospective employers. But many or most workers struggle. So the top graphic designers today are seeing rapid wage growth, while the average designer has stagnant wages. And we see similar patterns in other occupations that use computers: top wages are growing, average wages are not.

The net effect is that information technology is contributing to growing economic inequality, a growing divide between those who have the skills to use the new technologies and those who don't. Some occupations lose out while other grow, yet it is difficult for workers to transition into the growing occupations. And even within occupations, not everyone can acquire skills and a reputation with new technologies, creating a growing gap in

wages. Although information technology is not creating massive unemployment, nor is it likely to do so in the near future, its impact is highly disruptive, creating winners and losers and a sense of growing inequality and unfairness. The growing digital divide poses a major problem, especially for the young.

The Challenge for the Young

Historically, young workers have often been in the forefront of those working with innovative technologies and acquiring new skills. In the US textile industry, literate teenage farm girls were recruited to learn the new power looms. Similarly, decades later, young women were brought to the textile mills in Japan and then later in China. Recent high school graduates also played a key role in the new industries fostered by electrification in the US during the early 20th century.

Today, many young people are able to acquire early familiarity with computers and smartphones. But it is less clear that they are gaining access to the critical workplace technologies. Many European countries have high levels of youth unemployment, so there is little way these people can learn new skills on the job. And even in the US, where youth unemployment is not above historical averages, young workers' access to new technology is often limited. Only about one third of US workers aged 16-24 use the Internet at work. In contrast, about two thirds of older workers do.

This evidence suggests that the obstacles to acquiring critical new skills related to information technology are particularly high for young workers.

What To Do

This is a difficult problem and it would be naïve to expect that it could be quickly resolved by a simple policy fix. Technology will continue to change rapidly and perhaps even

accelerate, making the challenge even more difficult. Nevertheless, individuals can take actions to acquire new skills, businesses can invest in training their employees, and government can put in place policies that remove some of the obstacles to learning as well as to foster new forms of education and labor markets.

Three sorts of beneficial actions are:

1. Encourage learning by doing. Because many of the skills cannot be easily taught in classrooms at this time, it is important to encourage other sorts of learning including hands-on vocational education, firm job training programs, apprenticeship type programs, and work-study programs that combine classroom learning with work experience. Industries need to establish certification programs so that skills learned on the job can be accurately represented in the labor market, encouraging higher pay. While higher education is important, it is not the right solution for everyone and less-than-college vocational education has been seriously underfunded in many countries. Similarly, while STEM skills and computer coding skills are important, many of the jobs require working with computers in a wide range of tasks that involve social, marketing, planning, and other skills.
2. Encourage strong labor markets. Labor markets will provide the strongest incentives for learning when workers can take their skills with them. Governments and firms should reduce obstacles to employee mobility such as employee non-compete agreements, overly broad trade secrecy restrictions on employees, overly strong exit protections, and excessive occupational licensing requirements. Europe in particular also has a problem with weak labor markets, especially for young people entering the workforce.
3. Encourage wide acceptance of open standards and knowledge sharing. The more that technologies are standardized the easier the associated skills are to learn.

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New artificial intelligence technologies are not likely to cause massive unemployment during the next 10 or 20 years. And they will generate new wealth and meet all sorts of unmet demand. Moreover, the new jobs may provide more fulfilling work than the old jobs. Computers tend to automate the most routine tasks. The new jobs—those that are most immune from automation—involve innately human tasks involving interpersonal, social, and creative skills.

But artificial intelligence technologies will nevertheless cause substantial social disruption, eliminating some jobs, while creating others; requiring new skills that only some people have the opportunity to acquire; and raising the wages of some, but keeping others behind. These new technologies have the potential to create new wealth, but that wealth will not be widely shared unless large numbers of working people have access to critically needed skills. The development of a skilled workforce is key to combatting rising economic inequality.

Moreover, workforce skills are also important in the longer run. In 30 or 50 years, the effect of new information technology on jobs may not be so positive as it is today. Indeed, if information technologies follow the same path as manufacturing technologies, then further technological advances may bring lower employment in many industries in the long term. It is, of course, difficult to predict the entire impact of technology on the economy and society that far in the future. However, developing a skilled workforce now may well be the best preparation we can have for dealing with those future challenges. Technology will develop along a path that depends on the existing economic resources. A population that is skilled at working alongside advanced information technologies will best promote the development of future technologies that augment human capabilities rather than replace them.