THE FUTURE OF WORK

A GUIDE FOR TRANSATLANTIC POLICYMAKERS

Bertelsmann FOUNDATION

ITIF | INFORMATION TECHNOLOGY & INNOVATION FOUNDATION

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ABOUT THE ORGANIZATIONS

Bertelsmann FOUNDATION

The Bertelsmann Foundation, established in 2008, is the North American arm of the Germany-Based Bertelsmann Stiftung. It was created to promote and strengthen the transatlantic relationship. Through its research, debate forums and multimedia tools, the Foundation provides analysis and solutions to the most pressing economic, political and social challenges impacting the United States and Europe.

ITIF | INFORMATION TECHNOLOGY & INNOVATION FOUNDATION

Founded in 2006, ITIF is an independent 501(c)(3) nonprofit, nonpartisan research and educational institute—a think tank—whose mission is to formulate, evaluate, and promote policy solutions that accelerate innovation and boost productivity to spur growth, opportunity, and progress. ITIF's goal is to provide policymakers around the world with high-quality information, analysis, and recommendations they can trust. To that end, ITIF adheres to a high standard of research integrity with an internal code of ethics grounded in analytical rigor, policy pragmatism, and independence from external direction or bias.

ACKNOWLEDGEMENTS

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OUR ELEVATOR PITCH

The changing nature of work and labor markets — and how best to prepare society and people for the jobs and tasks of the future — is one of the most crucial public policy challenges that countries and policymakers will face over the coming years. While it is far too early to be able to predict the pace and extent of future automation, we do believe that jobs, tasks, and work itself will evolve at a more rapid pace. We also believe that the future of work will affect each country, region, worker, and student differently. For these reasons, this guide seeks to build a bridge from the voluminous future of work research to the core ingredients of future of work policy that will need to be weighed over the coming years. Through our cross-country comparison of future of work dynamics across four case studies — France, Germany, Spain, and the United States — we highlight core factors and key takeaways. We also make the case for more agile public policies that tailor future of work policies to the specificities of countries, regions, and individuals. Ultimately, this guide serves as a resource for policymakers and citizens everywhere who are interested in exploring the essential elements of future of work policy.

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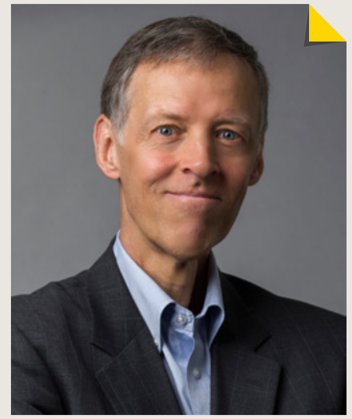
ABOUT THE AUTHORS



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As founder and president of the Information Technology and Innovation Foundation (ITIF), recognized as the world's top think tank for science and technology policy, Robert D. Atkinson leads a prolific team of policy analysts and fellows that is successfully shaping the debate and setting the agenda on a host of critical issues at the intersection of technological innovation and public policy.

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Atkinson's books include Big is Beautiful: Debunking the Mythology of Small Business (MIT Press, 2018); Innovation Economics: The Race for Global Advantage (Yale, 2012), and The Past And Future Of America's Economy: Long Waves Of Innovation That Power Cycles Of Growth (Edward Elgar, 2005).

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Jeffrey obtained his master's degree in political science and European studies from the University of North Carolina, Chapel Hill (UNC-CH) in May 2015, where he participated in the TransAtlantic Masters program. While studying at UNC-CH and Sciences Po Paris, he completed an internship with the U.S. Department of State in Tbilisi, Georgia, where he analyzed political developments in Abkhazia and South Ossetia and implementation of Georgia's free trade agreement with the European Union. Jeffrey also completed internships with the U.S. Commercial Service in Paris and Lisbon.

Prior to joining the Bertelsmann Foundation, Jeffrey worked in local government elections, international legal compliance and as a university instructor in Besançon, France. He holds a bachelor's degree in political science from St. Olaf College. He speaks French and Portuguese.

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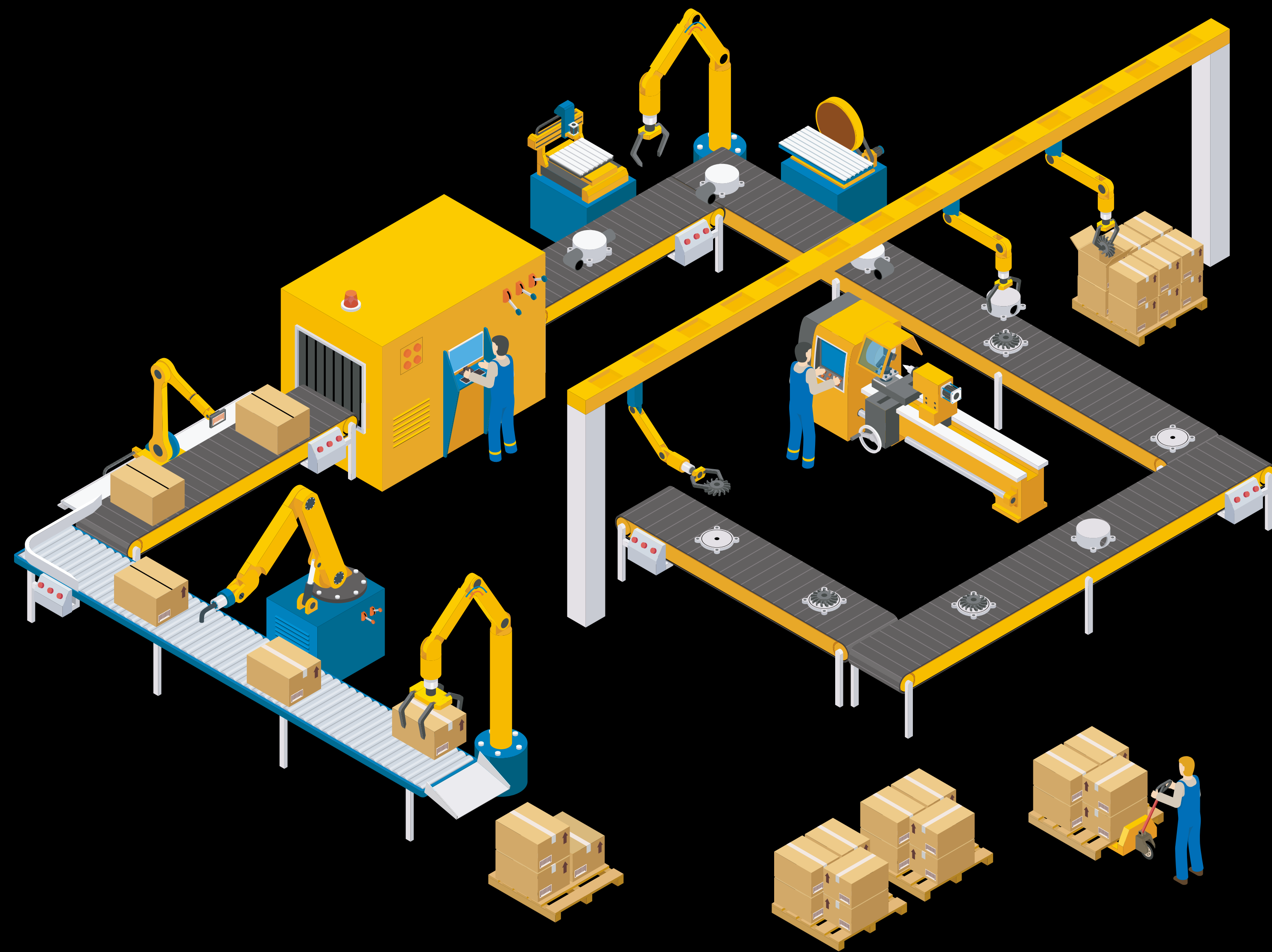
SECTION ONE

FIVE REASONS WE WROTE THIS GUIDE



Mounting concern over the impact of technology and automation on economic, social, and political systems has induced slow-moving panic among many policy-makers — and a growing percentage of the public — on both sides of the Atlantic.

In response, some pundits and media outlets have suggested policy "solutions" that range from the wholesale implementation of Universal Basic Income (UBI), to the taxation of "job-killing" robots.[1]

While it is possible, and even likely, that technological innovation, especially automation, will have a greater impact on production and work than at present, the speed and depth of this transition are not clear. Yet, as with any technological or in-

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dustrial transition, we are seeing a proliferation of dueling visions for the future. The doomsday camp warns of technological unemployment that will breed Dickensian conditions. The diametrically opposed side predicts rosy scenarios in which technology and automation create wealth and frees workers to explore what they say is gainful "work," divorced from drudgery and wage slavery.

Through its analysis of labor market conditions and trends in Europe and the United States, this guide eschews the Manichean conception outlined above. Instead, it offers a third way for thinking about — and designing a sound policy framework around — technology and the future of work. The labor market implications of technology and automation, so often viewed with a grumbling sense of creeping inevitability, can and will be shaped by policymakers and their constituents in the decades to come. Put simply, nothing about the future of work is inevitable.

However, facing pressure from their constituents, or at least from a vocal minority of advocates and elite opinion shapers, policymakers are increasingly called upon to "do something." They face a delicate balancing act: safeguard gains in employment and occupational "capital" accrued since World War II, without snuffing out future engines of growth such as robotics, the Internet of Things (IoT), blockchain, autonomous systems, and machine learning/artificial intelligence (AI).

In order to capitalize on the opportunities — and withstand the short-term challenges — brought by the potentially rapid introduction of new technologies and automation, policymakers must first prepare for a future in which the employment and labor market landscape is more turbulent than today's. They need a framework, including a menu of policy options and basic assumptions, from which they can derive sustainable and resilient solutions.

Many policymakers find traditional strategies inadequate for the supposed challenges presented by new technologies and automation, or they are underwhelmed by overly broad, one-size-fits-all future of work "solutions" proposed at the national or international level. Perhaps most worryingly, the current tone and direction of the future of work debate clouds the hunt for common definitions and jumping off points. With policymakers everywhere searching for viable approaches, even as they are hobbled by a plethora of conflicting and confusing information, the Bertelsmann Foundation North America (BFNA) and the Information Technology and Innovation Foundation (ITIF) have partnered to produce this future of work guide to provide clarity and a path forward. In doing so, we seek to reorient debate and discussion toward productive and sustainable solutions that will maximize economic growth and employment opportunity. We do this by:

REASON #1

ARTICULATING A BASELINE FOR POLICY GERMINATION

Policymakers need a set of guiding principles they can use to advance fruitful policy conversations about the emerging technology wave.

Building on previous work by BFNA and ITIF into skills,[2] industrial and technology policy,[3] artificial intelligence,[4] and the future of work itself,[5] this guide serves as a reference point as policymakers ramp up their analysis and exchange on a host of future of work topics. This baseline comparison contains three core elements:

A) A "taxonomy of the future of work," which purposefully mixes and matches definitions from the United States and Europe so as to bridge the gap that exists between how policymakers and citizens conceive the future of work. These definitions are malleable; they are meant to be added to, and subtracted from.

B) A comparison of labor market dynamics across four case studies: France, Germany, Spain, and the United States. This analysis includes background on the labor markets of each country and original analysis of current industrial, employment, and wage dispersion trends. Through this analysis, we show how technology and automation could impact these four highly developed economies. Ultimately, we highlight the blended, multi-vectored policy approaches that policymakers will have to adopt across different case studies and sub regions.

C) Key takeaways — framed as opportunities and challenges — for local, national, and international policymakers tasked with developing strategies vis-à-vis the future of work. Since so much about the future of work remains to be shaped, our analysis shies away from overly specific or, alternatively, overly broad policy recommendations that could quickly become outmoded as technology and automation reshape labor markets and work itself. Rather, we offer a new framework for thinking about — and designing sound policy around — the future of work.

REASON #2

RAISING AWARENESS AMONG POLICYMAKERS AND THE PUBLIC

To date, the policy conversation surrounding the future of work has been primarily elite-oriented, with governments, consultancies, research institutions, pundits, and the press taking the lead in framing and generating debate. Governments, corporations, and think tanks, as well as entrepreneurial cities, regions, and countries have already floated future of work policy solutions. While this has done much to kick off debate and catalyze responses in regions and cities already angling to capitalize on these changes, many places remain cut off from — or unaware of — the range and scope of the discussion. Perhaps most consequentially, many policymakers remain unaware of the topic and of the challenges — and opportunities — lumbering their way. This makes it difficult (if not impossible) to design sound policy to support and respond to the future of work.

This is precisely why this guide is as much about raising awareness as it is about sharing its reservoir of facts, definitions, and policy approaches.

This guide is aimed not only at those who may already hold a fixed conception of the future of work, but those in cities and rural areas in need of a concise game plan to advance future of work conversations in their communities.

REASON #3

ADDRESSING MISINFORMATION & REALIGNING DEBATE

Relatively new to the scene, the future of work debate is replete with misunderstanding and confusion. Discussion regularly crosses concepts, definitions, and topics. For example, talk of upskilling morphs into platforms, which then bleeds into the role of robots and the need for updated social protections. Attempts to isolate variables and concepts to advance concrete policy discussions often end in abject failure, making it difficult for policymakers to formulate and advance meaningful policy responses.

Policymakers, overwhelmed or frustrated, sometimes exacerbate the situation by advocating singular solutions meant to protect some of their constituents from the consequences of transitioning to the future of work, even though they remain largely unknown. By advocating for singular policy solutions (such as UBI) policymakers stunt creativity without considering the totality of policy approaches on offer and fail to bake the essential ingredient of flexibility into the policymaking process. This further engenders path-dependency on a range of narrow "solutions" whose viability and efficacy are as yet unproven.

In short, there is a great deal of misinformation and a lack of understanding of the complexities and nuance surrounding the transition to the future of work.

That is why this guide addresses several misconceptions, while also providing policymakers with an overview — and a menu — of possible policy approaches.

REASON #

4

CATALYZING THE SHIFT FROM THEORY TO PRACTICE

At high-level future of work conferences in the United States and Europe, speakers invariably list the challenges facing labor markets and workers, even as they rehash overly broad problem statements that are not applicable to most contexts. Attendees are bombarded with interdisciplinary research into skills, industrial and labor market policy, new technologies, taxation, urban planning, and even legal aspects related to the future of work.

Sometimes the research is cutting edge and thought-provoking (though often flawed), but it pays little attention to how policymakers, firms, and citizens can make the connection between future of work theory and their lived contexts. Attendees often depart with newfound appreciation for a set of challenges, but without the essential toolkit for developing policy that would combat these existential challenges.

Assuming that technology and automation transform labor markets and boost currently anemic productivity growth rates, policymakers will have to develop actions and policy that fits their nation's individual circumstances. And they will have to do so much more nimbly than they have done in the past, largely due to the fact that new technologies could have wide impact more rapidly than past transitions.

Policymakers and their constituents will need new tools that allow them to rapidly create and prototype innovative future of work solutions.

To further the cause of inclusive policymaking, the Bertelsmann Foundation, in partnership with The Governance Lab, has developed a methodology for "People-Led Innovation"[6] that can be applied to a range of future of work challenges. The methodology gives citizens greater say in the policymaking process and allows political leaders to build legitimacy into their future of work solutions. It will also be important for policymakers to devise mechanisms for the "upload" of successful bottom-up or worker-level solutions to the national or international level.

This guide seeks to catalyze the shift from theory to practice in two ways. First, we take stock of the future of work debate to date by providing a set of common topics and approaches. Second, we make the case for why policymakers should broaden their conception of the future of work to include the types of policy exchange detailed above.


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REASON #5

EXPLORING NEW REALMS OF TRANSATLANTIC COOPERATION

Since World War II, the transatlantic relationship has been undergirded by two main pillars of collaboration: security and economic ties. While their importance has waxed and waned over the years, policymakers have repeatedly turned to them in times of uncertainty to jumpstart U.S.-Europe leadership and solutions. This narrow focus has, for the most part, successfully engendered peace, prosperity, and fruitful collaboration. But the transatlantic alliance is facing fresh challenges that require a broadening of the conversation to include the relatively unexplored economic, social, and political consequences that stem from technological transformation and the future of work.

However, administrations on both sides of the Atlantic find themselves increasingly at odds when it comes to developing public policy around new technologies (and their resulting impacts), with transatlantic skirmishes breaking out over everything from taxation of "Big Tech," to differences in antitrust enforcement, to the recent imposition of the European Union's (EU) General Data Protection Regulation (GDPR).[7] Given that substantive cooperation on technology-related topics is off to a rough start, this guide reemphasizes the imperative of forging transatlantic approaches to next-generation challenges.

There are two primary reasons for policymakers to consider strengthening their collaborative frameworks now. First, the rapid introduction of new internet-based platforms and the potential transformations from the internet of things and AI have caused waves of consternation and uncertainty on both sides of the Atlantic. Policymakers have been caught flat-footed, but they are increasingly searching for ways to maximize productivity and workers' incomes, while transitioning workers dislocated by technological change. Since this next wave of technologies will initially be implemented principally across developed economies, Europe and the United States should take the lead in figuring out how to accelerate and broaden this transformation, while ensuring that workers have the skills and tools they need to adapt and thrive. They should draw on their collective wisdom and knowledge to design sound policy.

While the contexts are admittedly different on both sides of the Atlantic, technology and automation will likely affect labor markets and workers in very similar ways.

Ricardo Gomez Angel on Unsplash

Second, the rise of left- and right-wing populism in Europe and the United States has revealed deep-seated economic anxiety among large swathes of the electorate. If the United States and Europe fail to respond to the economic anxiety workers are feeling and the workforce challenges they face, particularly greater occupational churn and wage stagnation, these highly developed economies risk falling victim to short-term political whims and prejudice that result in bad policy. In this case, the bad policy is likely to hinder, rather than speed, the rate of change from new technologies. By combining forces, both sides can improve citizens' lives and prevent further social, economic and political instability.

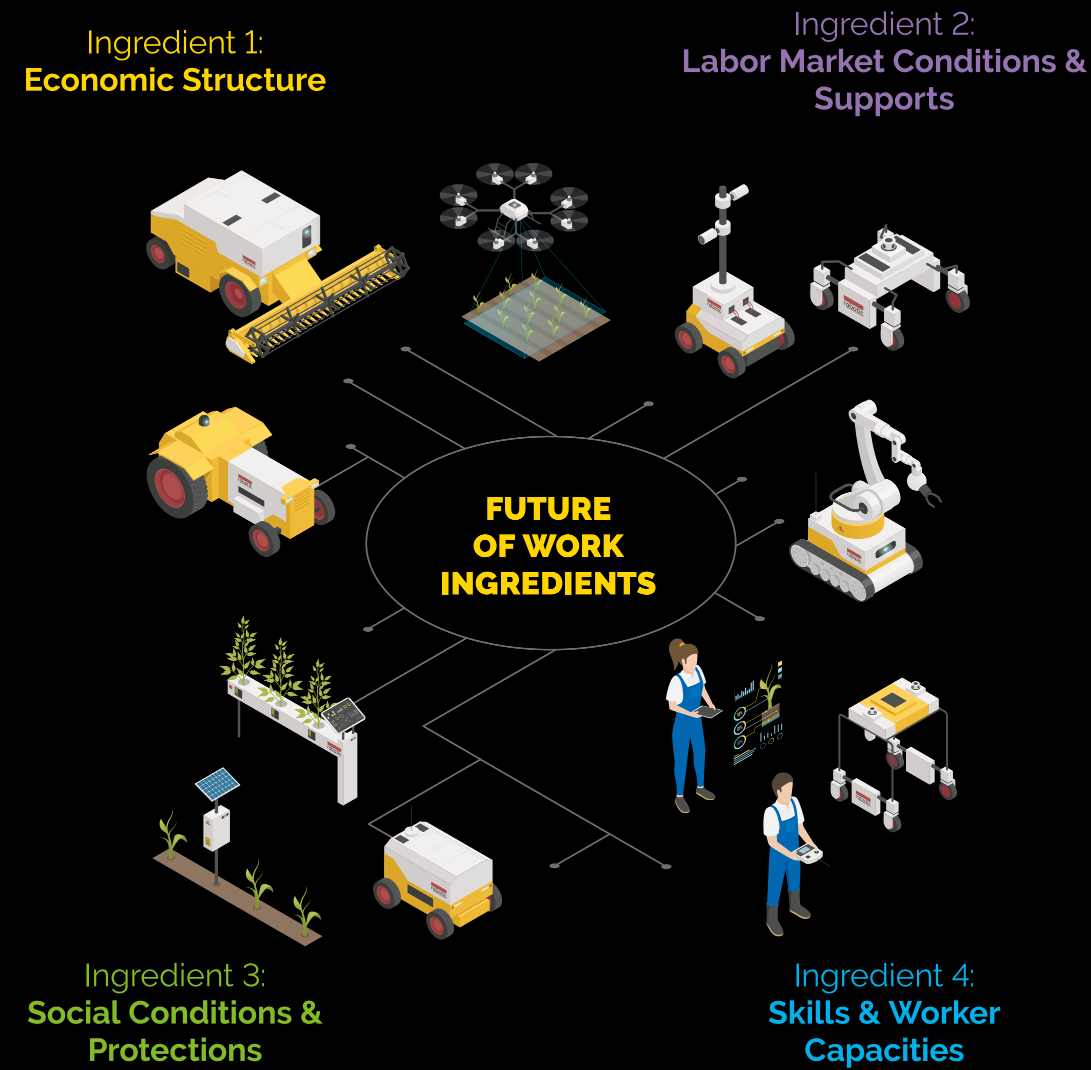
Indeed, as Harvard's Benjamin Freidman writes in *The Moral Consequences of Economic Growth*: "Economic growth – meaning a rising standard of living for the majority of citizens – more often than not fosters greater opportunity, tolerance of diversity, social mobility, commitment to fairness, and dedication to democracy." In contrast, when an economy stagnates, "the resulting frustration generates intolerance, ungenerosity, and resistance to greater openness of individual opportunity. It erodes people's willingness to trust one another, which in turn is a key prerequisite for a successful democracy."[8]

Finally, from our vantage point at think tanks active in policymaking, we have witnessed the insatiable demand to learn more about how technology and automation are transforming transatlantic relations, economic growth, labor markets, and work itself. We have also heard from a range of stakeholders interested in exploring how the U.S. and Europe can work together to forge new ways of collaborating vis-à-vis the future of work. The Bertelsmann Foundation and the Information Technology and Innovation Foundation recognize the imperative of transatlantic cooperation; we hope that this guide provides not only new insight, but also a platform from which collective transatlantic action can be launched.

SECTION TWO

MAKING SENSE OF COMPETING VISIONS

DIALOGUE OVER TECHNOLOGY AND THE FUTURE OF WORK



Debate over the future of work swings between a vast array of estimates, variables, rough suppositions, and overall orientations, with various think tanks, consultancies, and governments all staking claim to "accurate" estimates for what the future of work entails. This makes it almost impossible for policymakers to disentangle competing visions at play in the debate. Perhaps most consequentially, it slows their ability to generate sustainable policy capable of growing alongside exponential advances in technology.

In this section, we identify and isolate four key future of work "ingredients" that policymakers should use as guideposts as they develop future of work policy.

These four ingredients align roughly with the baseline comparison of labor market dynamics conducted in Section IV.

INGREDIENT # 1

ECONOMIC STRUCTURE

The number of jobs gained by or lost to technology and automation is the oft-cited variable in the future of work discussion.

In particular, an impassioned debate has emerged around a singular, central question: how will technological change affect the net number of jobs?

This is a one-sided and troubling way to look at the issue because economic growth depends on raising productivity, which in turn is largely achieved through automation or other kinds of efficiencies. The emerging wave of innovation will most likely (and hopefully) lead to somewhat higher productivity growth rates over the coming decades. European and U.S. labor productivity growth rates might, if we are lucky, reach the growth rates enjoyed in the 1950s and 1960s of around 3 percent a year. Policymakers should see this as wonderful news, given that productivity rates in the U.S. and Europe have been growing anemically. Without productivity growth to create a "bigger pie," there is no way for living standards to increase, especially given that the worker-to-retiree ratio will decline in both regions over the next two decades as baby boomers retire en masse.

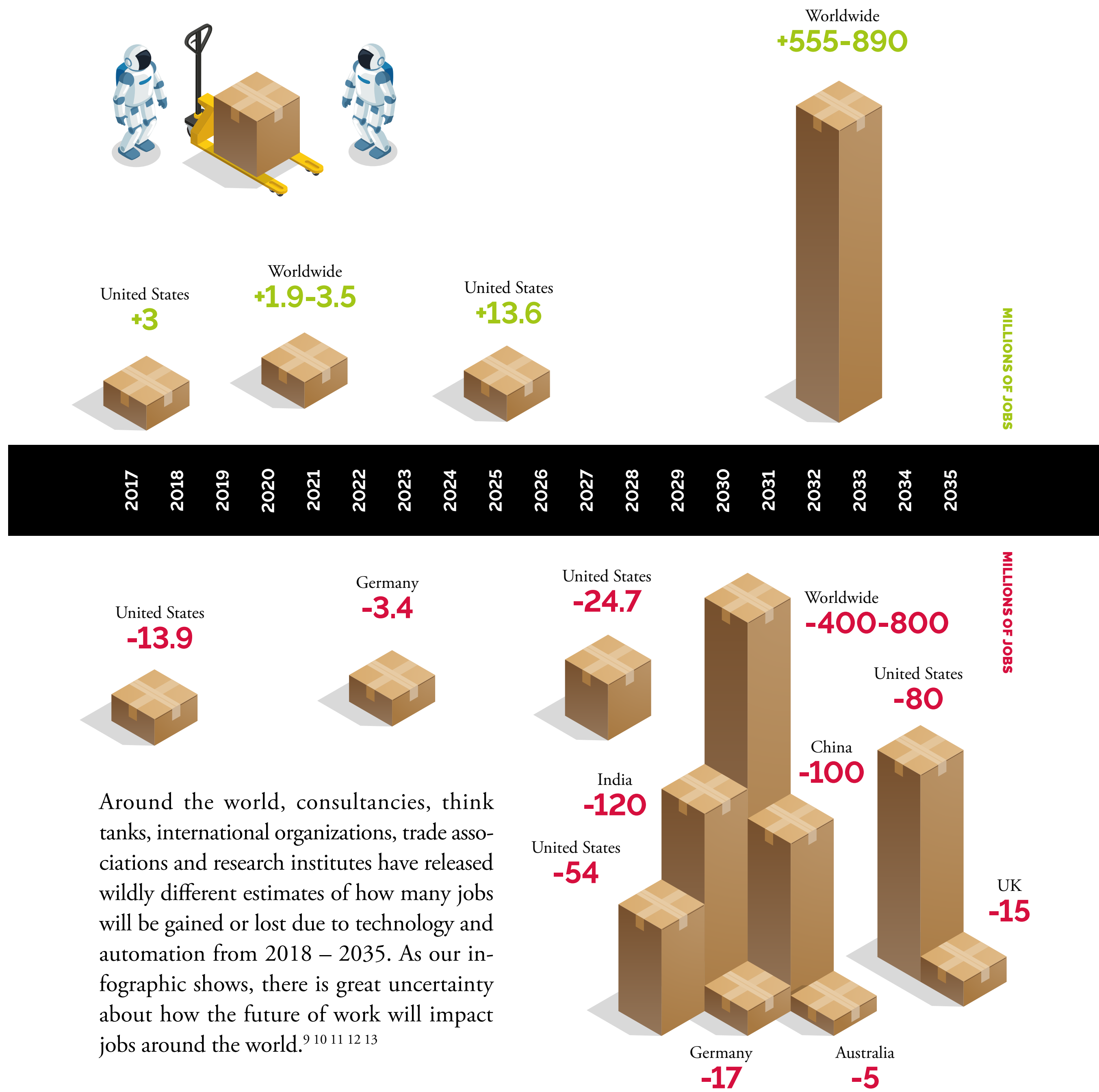
An expected rise in productivity rates from the next wave of innovation does not preclude some negative impacts, but most fears concerning mass and rapid job loss are unwarranted. Job dislocation surely will increase, but it can and should be addressed with smart policies that help workers gain increased competencies and obtain better support to make transitions.

A growing share of policymakers worry that boosting productivity will come at the expense of needed job growth, because so many pundits, activists, journalists, and academics warn that the next wave of innovation will lead to massive job loss and elevated unemployment. The frequently repeated, though unproven, narrative is that productivity growth driven by increasingly powerful IT-enabled "machines" is the cause of today's slow employment growth, which is poised to accelerate technological change, leading to more job losses.

Uncertainty around what to expect from technology and automation has led to a great deal of variation and disagreement between studies that

GEOGRAPHY OF GAIN OR PAIN?

HOW MANY MILLIONS OF JOBS WILL BE LOST OR GAINED IN THE FUTURE?



Around the world, consultancies, think tanks, international organizations, trade associations and research institutes have released wildly different estimates of how many jobs will be gained or lost due to technology and automation from 2018 – 2035. As our infographic shows, there is great uncertainty about how the future of work will impact jobs around the world.[9 10 11 12 13] estimate the raw number of jobs that might be lost to automation and technology. As the "Geography of Pain or Geography of Gain" infographic below illustrates, estimates for jobs gained/lost vary wildly by country, year, and methodology.

Academic studies, historical data, and logic all suggest that increased rates of productivity growth will not lead to higher unemployment.[14] Historically, there has been a negative relationship between productivity growth and unemployment rates, i.e., higher productivity meant lower unemployment. This correlation is shown in the 2011 McKinsey Global Institute report, "Growth and Renewal in the United States: Retooling America's Economic Engine."[15] McKinsey looked at annual employment and productivity change from 1929 to 2009 and found that increases in productivity were correlated with increases in subsequent employment growth, and that the majority of years since 1929 feature concurrent employment and productivity gains.

Higher productivity growth in nations has been associated with, if anything, lower rates of unemployment. The reason is simple: companies invest in process innovation (innovations to boost productivity) to cut costs, and because of competitive markets they pass most of those savings onto consumers in the form of price cuts (and some to workers in the form of higher wages). This added purchasing power leads to increased consumer spending, which creates additional jobs. This dynamic is the same whether productivity grows at 1 percent or 5 percent a year.

Virtually all academic studies have found that increased productivity does not cause a rise in unemployment. If anything, the opposite is true. Economist Bharat Trehan has found that "empirical evidence shows that a positive technology shock leads to a reduction in the unemployment rate that persists for several years."[16] The Organization for Economic Cooperation and Development (OECD) finds that, "Historically, the income-generating effects of new technologies have proved more powerful than the labor-displacing effects: technological progress has been accompanied not only by higher output and productivity, but also by higher overall employment."[17]

While skeptics might acknowledge that past productivity gains has not caused higher unemployment, they argue that the future will be different. Their view is based on the historical evolution of work, where automation reduced agricultural jobs, which led to a shift to manufacturing jobs. As they see it, when manufacturing jobs were automated, the service-sector became the primary employer of unskilled workers, but once robots replace service providers, employment options will have run out.

These techno-pessimists make three crucial mistakes. First, they wrongly assume that current technological trends will continue or even accelerate. A recent study found that the productivity rate of technological innovation (e.g., the number of researchers needed to produce a particular unit of innovation) has been falling for decades.[18] This suggests that an unprecedented pace of innovation going forward is unlikely.

Second, they overstate the extent to which digital innovation is transforming occupations. One of the most widely-cited studies on this matter, from Oxford's Carl Benedikt Frey and Michael A. Osborne, found that 47 percent of U.S. jobs *could* be eliminated by technology over the next twenty years.[19] But they appear to overstate this number significantly by including many occupations that are very unlikely to be automated (e.g., fashion modeling). Osborne and Frey rank industries according to the risk of their workers being automated. One would, therefore, expect positive correlation between their risk of automation score and recent productivity growth in the industry; instead, their study shows a negative correlation of 0.26. In other words, industries they assessed as having a higher risk of automation actually demonstrated lower rates of productivity growth — not higher.

METHOD	Occupation Based Approach	Task Based Approach	Occupation + Task Based Approach	Occupation + Task Based Approach	Occupation + Activity/Capability-based approach	Occupation + Task Based Approach
STUDY	Frey and Osborne (2013)[20]	Arntz, Gregory & Zierahn, OECD (2016)[21]	Gownder, Koetzle, Condon, McNabb, Voce, Bartels, Goetz, Hoar, Garberg, Lynch PwC (March 2017)[22]	Berriman, Hawksworth, Kelly, Foyster, Forrester (April 2017)[23]	Manyika, Lund, Chui, Bughin, Woetzel, Batra, Ko, Saurabh Sanghvi, McKinsey Global Institute (November 2017)[24]	Nedelkoska and Quintini, OECD (2018)[25]
DATA SOURCE(S)	2010 O*NET[26] data supplied by the U.S. Department of Labor	Programme for the International Assessment of Adult Competencies	Programme for the International Assessment of Adult Competencies Automatability data from Frey and Osborne (2013)	Programme for the International Assessment of Adult Competencies Ernst & Young survey of entrepreneurs	2014 O*NET and World Bank data breaking down 800 occupations and 2,000 activities.	Programme for the International Assessment of Adult Competencies Estimates of training data at individual level
PRONOUNCEMENT	"47 percent of U.S. employment at high risk of automation within the next 10-20 years."	"9 percent of jobs across 21 OECD countries, on average, will be replaced by automation."	"38 percent of U.S. jobs will be replaced by robots and AI by the early 2030s."	"7 percent of U.S. jobs will be replaced by AI and robotics by 2027."	"Across 46 countries between zero and one-third of work activities could be displaced by 2030, with a midpoint of 15 percent." "Up to 375 million people may need to switch occupational categories."	"14% of jobs in 32 OECD countries… are highly automatable."
APPROACH	Asked machine-learning experts to classify occupations as "automatable" or "not automatable" Created a machine-learning algorithm to estimate probability of automation across each U.S. occupation.	Dissected entire occupations into tasks: for example, manual tasks, routine tasks, computational tasks, social skills, and literacy skills.	Built on the task based approach adopted by Arntz, Gregory & Zierahn (2016). Added details about workers completing tasks (level of education, training, etc.).	Divided occupations into three types of tasks: physical, intellectual, and customer service. Estimated percentage of job tasks reduced by automation each year.	Adapts and updates methodology used in January 2017 McKinsey Global report "A future that works: Automation, employment, and productivity."[27] Further broke down 'activities' in to 18 'capabilities,' and then assessed their automation potential.	Adopted Arntz, Gregory & Zierahn's (2016) of variation in tasks within occupational groups model. Amassed 4,656 individual observations of job skills to overcome "bottlenecks" encountered by Frey and Osbourne.

MAKING SENSE OF FUTURE OF WORK STUDY METHODOLOGIES

Studies on projected job loss or creation over the coming years have employed not only vastly different assumptions about the pace and power of future technologies, and also different methodologies, with wildly varying results. When reading studies cited in the press, policymakers should pay close attention to the underlying approaches used to derive these estimates.

We see three key takeaways in comparing these methodologies: First, researchers and consultancies have used Frey and Osbourne's seminal 2013 study as a springboard to estimate the number of jobs gained by or lost to automation. As the table below shows, researchers are clearly iterating on the methods and approaches adopted by their colleagues. Second, these estimates have only proliferated within the last five years, signaling that researchers are still in the process of refining the best way to go about measuring net job loss or gain. Third, and perhaps most significantly, these estimates show that job and task disruption will be far more significant than job loss (or gain) itself.[28]

Rather than 47 percent, a more likely estimate is that only about 15 to 20 percent of U.S. jobs will be easily automated over the next decade or two, with about 50 percent difficult to automate, and the remaining 30 percent extremely difficult to automate.[29] Frey and Osborne assert that job creation in the service sector is threatened primarily by automation, despite the earlier expectation of it becoming a substantial job engine.[30] They assert that office and administration jobs, in particular, are most likely to be computerized, followed by service and sales occupations.[31] In fact the next wave of technology will have a larger impact on task performance within a given occupation, rather than the occupation as a whole.[32] In other words, the impact of technology will be seen more in job redefinitions and opportunities to add more value, rather than outright job destruction.

But even if Osborne and Frey are correct in their predictions, elimination of 47 percent of jobs by technology over the next 20 years would be equivalent to an annual labor productivity growth rate of 3.1 percent a year. This rate is lower than the rate of productivity growth the U.S. economy enjoyed in the 1960s, when unemployment was low and job creation was high.[33] Similarly, if a recent McKinsey Global Institute study proves correct, the high-end estimate of 30 percent (15 percent was their expected estimate globally) job loss would mean a productivity growth rate of just 2 percent per year.[34] By historical standards these are relatively modest rates of productivity growth; in the past they have been associated with low rates of unemployment, not high.

The third mistake of those who see automation as a net job destroyer is that in claiming that massive automation of service sector jobs will create a lumpenproletariat with no options, the doomsayers fail to recognize that even if productivity were to increase ten-fold (including in services), people would not run out of things to buy. As noted above, as long as fiscal and monetary policy work to keep unemployment rates relatively low, higher productivity will not lead to higher rates of unemployment. It will, however, lead to higher incomes (goods and services become relatively cheaper) and people with higher incomes spend their money on nicer vacations, larger dwellings, luxury items, more restaurant meals, more entertainment (like concerts and plays), and more personal services (e.g., accounting, yard work, etc.). This is exactly what European researchers found when they examined the impact of automation technologies in Europe from 1999 to 2010. They found that the technologies indeed eliminated jobs – 1.6 million. But net job growth, after accounting for increased spending due to lower prices and growing local incomes was 1 million greater, meaning that these technologies led to a net increase in employment.[35]

Unless machines can do every job – something that will never be possible – this added spending will lead to job creation. Another potential benefit of a steep rise in productivity could be fewer workers working two jobs, plus a shorter workweek and more vacation days, as people seek to enjoy the benefits of prosperity.

This brings us to the essential reason that unemployment as a consequence of technology should not be a source of worry — Say's Law. Named after nineteenth century French economist Jean-Baptiste Say, Say's Law holds that

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supply creates its own demand. In this case, the supply of labor creates demand for labor. While Say's Law does not hold in the short-run if the economy is in a recession (where there is unemployment), in a period of full or close to full employment it does hold. Assuming macro-economic policies that are expansionary when unemployment increases, the size of the labor force will, therefore, determine the number of jobs, which is predominantly determined by changes in the working age population and changes in the propensity of women to work outside the home. To summarize, people have been worrying about machines replacing humans and causing mass unemployment since machines were invented, and they were wrong then and will almost surely be wrong going forward.

INGREDIENT #2

LABOR MARKET CONDITIONS AND SUPPORTS

Since the impact of technology and automation will very likely depend on context — differing between regions, sectors, and occupations — metrics other than the raw number of jobs gained or lost will be needed to assess the full impact of technology and automation on labor markets. In other words, policymakers must also consider the qualitative measures of work.

This section weighs some of the more nuanced topics related to labor market conditions and support in order to paint a fuller picture of the dilemmas that policymakers will encounter over the coming years. At the forefront of the debate is the impact of non-standard forms of employment (NSE) on overall labor market conditions and the quality of work.[36] NSE has become a catch-all for flexible working arrangements comprising temporary employment, part-time work, contract work, and so called platform or gig work. NSE jobs have made at least modest inroads some of countries we reviewed over the past several decades.[37]

There is strong disagreement as to whether there will be a large increase in NSE. The data seem to suggest that while some NSE occupations have grown (for example, driving for companies like Uber), overall, at least in the United States, NSE employment is stable if not falling. Diana Farrell and Fiona Greig of JP Morgan Chase argue that U.S. employment growth in online platforms (a subset of NSE) peaked in 2014 and has been slowing ever since.[38] Lawrence Katz and Alan Krueger found some increase in alternative-work arrangements from 2005 to 2015 that included workers in temp agencies, independent contractors, and contract workers.[39] But a more recent study by the U.S. Bureau of Labor Statistics found that the share of workers holding contingent and "alternative" jobs has actually fallen over the last decade.[40]

Some of the growth in "gig economy" work has been a fallout of the Great Recession when full time, permanent work was scarce. Other growth has come from emergence of work sharing platforms like Uber. But these platforms employed only about 600,000 people in 2015, even with their rapid growth. Katz and Krueger find that gig economy employment through online platforms accounted for only around 0.5 percent of jobs in 2015, and some of these workers are either students or full-time workers who use gig work to supplement their incomes.[41] In addition, the share of the U.S. workforce that was self-employed in 2016 was at an all-time low of less than 7 percent.

Still, there are those who speculate, with little evidence, that NSE will increase sharply overall, with, for example, freelancers performing as much as 40 percent of the work in the United States by 2020.[42] However, the rate of self-employment will probably not rise significantly — unless there is a recession. Most organizations still value the stability of permanent workers, and most workers value the stability of ongoing employment relationships. One reason is that, while employers might unlock immediate cost savings by relying on NSE jobs, they will suffer longer-term productivity losses if workers do not gain skills or knowledge.[43] Policy makers will need to continually assess these developments. For many workers, NSE provides wanted flexibility and freedom. For others, it represents suboptimal working relationships. The goal for policy is to ensure that the overall balance of types of work is dictated largely by technology and worker choice, and that in all cases, workers receive appropriate protections and benefits.

A much more likely labor market challenge is not the growth of NSE jobs, but rather the potential growth of labor market turbulence. Active labor market policies (ALMPs) are government initiatives to help unemployed workers effectively transition back into the job market by addressing structural issues (rather than cyclical trends) caused by undulations in the business cycle, like recessions.[44] ALMPs are an essential means of dealing with upheaval in the labor market. ALMPs contrast with passive labor market policies (PLMP), such as unemployment insurance and early retirement benefits.

ALMPs can be divided into public employment services, job search assistance, training schemes, employment subsidies, and even targeted assistance to encourage entrepreneurship among the jobless.[45] These programs help workers find jobs and acquire new skills that increase their earnings over the long term.

In the case studies, we see that the amount of public money invested in ALMPs varies dramatically from country to country. France invests nearly 1.01 percent of its GDP on ALMPs annually, while the United States allocates just 0.11 percent.

PUBLIC EXPENDITURE ON ACTIVE LABOR MARKET POLICIES, PERCENTAGE OF GDP[46]

FRANCE	1.01 percent
GERMANY	0.63 percent
SPAIN	0.60 percent
UNITED STATES	0.11 percent

It is likely that technological change will lead to increased labor market churn, which will in turn necessitate innovative policies and programs to help workers transition between jobs and occupations.

INGREDIENT #3

SOCIAL CONDITIONS AND PROTECTIONS

Technology will create a wealth of opportunities for workers who have traditionally been underrepresented in the labor market, but they will also put governments under immense pressure to "do something" to preserve longstanding forms of social protection.

Governments will face pressure to either counteract disruptive impacts of technology and automation by: slowing down the implementation of technology and automation that is instrumental to increasing productivity, or, creating new forms of social protection.[47] This section provides early examples of both approaches (and the pitfalls of the former) in order to illustrate common public policy questions that policymakers will face over the coming years. We zero in on two popular (yet flawed) proposals aimed at bolstering current forms of social protection.

Some policymakers have begun to search for ways to broaden revenue streams to reinforce existing social protections. The taxation of data, robots, and other emerging technologies has been floated as a way to generate revenue to support the expansion of social protection systems, and also to slow the rate of productivity growth and labor market disruption. In 2017, the European Parliament debated — and ultimately rejected — a proposal to tax robot owners as a means of funding worker retraining schemes.[48] Similarly, the city of San Francisco debated extending their payroll tax to robots and using the funds to help displaced workers.[49] Shifting the tax burden from labor to machines would reduce the relative cost of labor while increasing the relative cost of new technologies, thereby reducing investment in productivity-boosting machines, equipment, and software, and severely truncating the productivity growth that is so crucial to increased living standards.

Another popular proposition aimed at bolstering social protections involves a modern-day reboot of Thomas Paine's 1795 proposal to introduce a form of Universal Basic Income (UBI), which, in theory, would reduce or eliminate the need for paid work by granting citizens unconditional (guaranteed) income. Yet most UBI advocates succumb to what economists call the "lump of labor" fallacy, that once a job is gone (from automation or other causes) it is gone for good. Therefore, for them the only answer is to provide the large pool of unemployed workers with permanent income from the state.[50] UBI is a solution in search of a problem because, as noted above, technology and automation will not significantly increase overall unemployment rates. Instead, UBI will keep more workers out of the labor market and in a state of dependency and skill atrophy. Moreover, any effective UBI system would be incredibly expensive. A 2015 study estimated that if UBI were introduced in the United States, its cost would be $3.4 trillion per year – nearly twice the federal budget.[51] In this case, employed workers would be paying other workers to be unemployed.

We hold that the taxation of robots and UBI – while a modestly politically popular position that reflects the zeitgeist – is precisely the wrong way to conceive of social protection within the future of work context. While many policymakers would agree that the world of work is changing and requires institutional innovation, few would find it politically feasible to advocate for policies that would slow economic growth, massively increase taxes, and lead to a large, permanently unemployed class.

Rather than attempting to contort existing forms of social protection to the rapidly changing nature of work, policymakers should collaborate with a broad range of stakeholders to forge a new compact for the delivery of social protections. Just as technology and automation will redefine work, policymakers, employers, and citizens themselves will have to be reimagine future iterations of social protection systems.

Technology and automation are here to stay, and their impact will only be felt more deeply in the years to come. The great irony, of course, is that in an environment in which digital technologies have enabled unprecedented professional and personal freedom and portability, social protection systems remain stubbornly immobile: bedrocks of personal and familial well-being such as health insurance, unemployment insurance, and workers' compensation (for on-the-job injuries) remain bound to specific employers (at least in the United States).

The idea of injecting flexibility into existing forms of social protection is being discussed. One example that has gained traction is a system of portable benefits that could encompass the entire range of social protections – healthcare, training, pensions, etc. For example, Spain, through its "*protección por cese de actividad de los trabajadores autónomos*" (unemployment benefit for the self-employed) has decoupled entitlements from fixed employer–worker relationships.[52] In the United States, the House and Senate have introduced legislation that would create a $20 million fund to help states and local government pilot portable benefit schemes.[53]

If policymakers fail to develop and support new forms of social protection for the modern economy, they run the risk of seeing workers fear, rather than embrace, technological change. Ensuring that workers have the basic supports necessary to participate in the economy of today and the future should be a first order policy priority along with topics such as skill acquisition and lifelong learning.

INGREDIENT #4

SKILLS AND WORKER CAPACITIES

In the coming years, technology and automation will alter both the tasks performed by workers and the skills demanded by employers.[54 55] These changes will affect workers at all skill and education levels,[56] but particularly in lower-skilled occupations.[57] More workers will have to cultivate not just skills in their conventional area (e.g., machinist, accountant, graphic designer), but also digital skills, such as statistics or the ability to calibrate a robot. In other words, more workers will need "double-deep" capabilities.[58] This will in turn create demand for a new class of vocational skills that will be used to scale, operate, and optimize emerging digital technologies.[59] And, perhaps most importantly, these new technical and vocational skills will have to be complemented with new kinds of "21st century skills."[60] As economist Manuel Trajtenberg writes, "the skills employers desire and demand are poorly related to the competencies taught in school. Employers want workers with strong analytical, creative, and adaptive capabilities, which are competencies few secondary or collegiate schools impart."[61] Workers proficient in all three areas (a conventional skill, digital skills, and 21st century competencies) will be more able to "future-proof" their jobs. Workers who lack them will face a raft of challenges.

Preparing workers for tomorrow will require much more institutional and pedagogical innovation at all levels of education. As a small but illustrative example, in the United States only around one-quarter of high schools teach computer science.[62] More high school students in California take a class in pottery than in computer science.[63] Governments will need to increase support for technical education in both primary and secondary education, which will increasingly have to be complemented by more and better technical and vocational education and training. Perhaps not surprisingly, tried and true vocational education systems such as dual apprenticeships will have to adapt by updating and iterating on their curriculum so that it aligns with the next-generation skills being demanded by employers.[64]

Rather than copying and pasting dual vocational/apprenticeship models pioneered in Germany and Switzerland, policymakers should instead take a step back to consider how the blueprint can be updated to fit the realities (and funding models) of their individual digital transformations. In other words, policymakers should cast their gaze beyond the confines of specific (and politically popular) efforts to reskill at-risk workers through coding boot camps or traditional apprenticeships. But whatever institutional form new and improved programs and initiatives take, officials need to make sure they are targeting limited public funds at apprenticeship and training programs that will lead to the jobs of the future.

Australia and the United Kingdom are already financing next-generation digital apprenticeship programs that train students in areas such as big data and web development.[65 66] Going forward, formalized training programs will have to be designed and carried out more nimbly, and they will have to incorporate new instructional technologies, such as e-learning and massive open online courses (MOOCs), that could democratize and enrich vocational and technical education beyond the classroom or shop floor.

While investment in basic education and technical and vocational training will remain a core component of developing and maintaining a skilled workforce, policymakers and workers must also recognize that it will be impossible to "frontload" skills and training that will remain relevant during an entire lifetime of work. In the future, new jobs and tasks requiring digital skills will appear — and evaporate — as new technologies burst onto the scene and disappear. For example, Burning Glass Technologies, a Boston-based company that analyzes labor markets by scraping job advertisements, found that, from 2012- 2017, demand for data analysts skyrocketed by 372 percent, with a subset within that job grouping (data-visualization specialists) growing by a whopping 2,574 percent.[67]

Initially, governments will have to take the lead in designing and incubating lifelong learning programs and funding mechanisms that can retrain workers and upgrade their skills throughout their working lives. Singapore is already providing its citizens with "learning credits" of around $367 a year, which permit access to 18,000 courses that contribute to the constant upgrading of skills.[68]

At the individual level, the proliferation of e-readers, online courses, MOOCs, podcasts, conferences, and professional development programs has enabled workers to take charge of their own personal development by making lifelong learning a habit rather than a chore.[69] While it may be difficult to accurately predict the specific skills of the future, equipping workers and students with the ability to learn and adapt – in combination with technical training and lifelong learning – can help insulate them from disruption caused by new technologies and automation.

However, employment services, which have traditionally been financed by the public purse, will come under considerable pressure as technology and automation hit legions of workers. Take, for example, unemployment insurance, which is usually disbursed to the already unemployed. Rejiggering these programs as "employment insurance," through learning credits or personal spending accounts, allows workers to engage in retraining *before* a job loss occurs, making them more resilient in the face of shocks caused by the introduction of technology and automation.[70] Such programs are not without precedent: in 2015, France introduced a (portable) "personal training account" wherein workers accrue the right to a number of hours of training per year. In November 2017, *France Stratégie*, a think tank funded by the French government, proposed a new (EU-wide) lending system to fund training and vocational education.[71]

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However, just as new technologies and automation are starting to transform skills and education, public spending on workforce training is in decline across the OECD.[72] This means that policymakers will have to identify new formulas to build, fund, and incentivize next-generation skill-builders, such as lifelong learning and technical training. These decisions will no doubt be complicated by the rapidly evolving nature of the employer-work relationship itself. With worker tenure in decline, employers may take on even less responsibility for the upgrading of skills. Whereas workers previously depended on government and employers to provide constant access to retraining and skilling, in the future, individual workers will be pushed to assert more agency over their own technical and professional development.

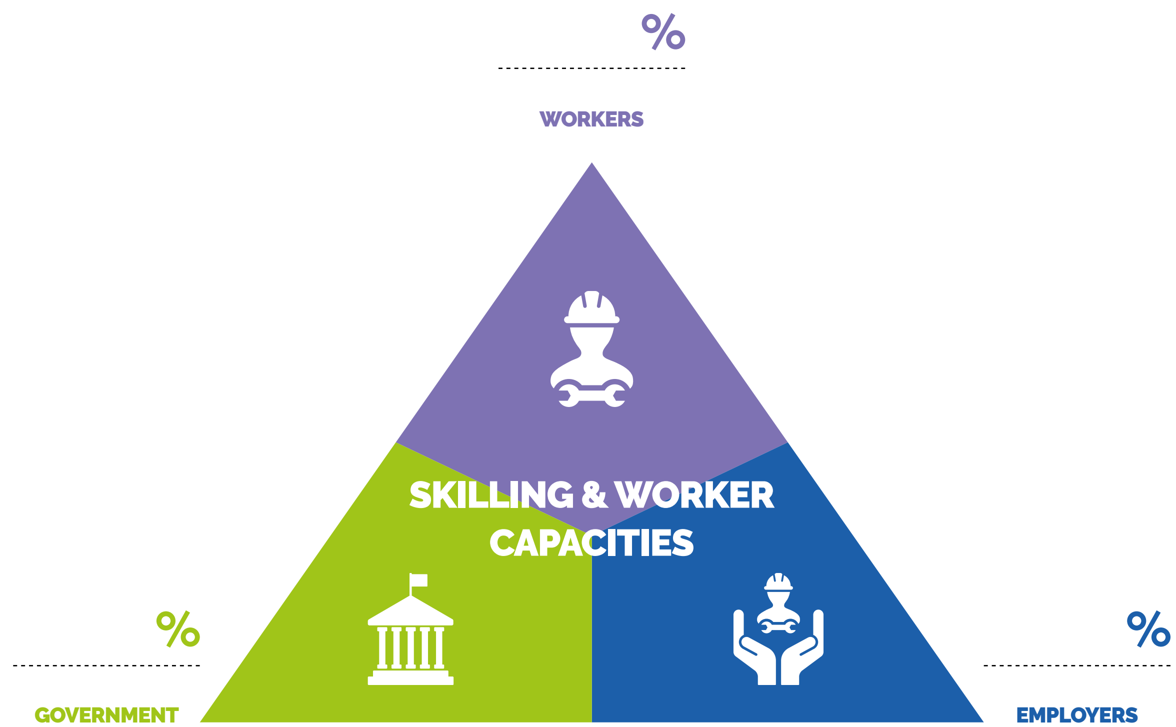
Therefore, working out new funding formulas for retraining and reskilling could end up being just as crucial as devising specific training and lifelong learning programs. Skills development strategies pursued by governments, employers, and individuals across all four case studies will have to adapt alongside the changes brought by the rapid implementation of technology and automation. But what will the optimal balance be?

In the United States, there is evidence that workers recognize that they will bear greater responsibility in developing their own skills.[73] In 2016, ManpowerGroup found that 93 percent of millennials were willing to spend their own money on further training. And a 2016 Pew Research study found that "72 percent of Americans say 'a lot' of the responsibility falls on individuals to make sure that they have the right skills and education in today's economy."[74]

But the issue is not just funding; it is also innovation. In too many cases, employment and training programs seem like a "DOS" system in a "cloud world." Governments need to work, often in partnership with the private sector, to modernize workforce systems, including through greater use of self-service, information technology-based solutions.

Finally, in addition to technology and automation, demographics will also play a large part in dictating skill requirements of existing workers and those demanded by employers. The median age will increase across all case studies by 2050, with raw population increasing only in the United States and France. These demographic shifts will impact the skills profiles demanded in each case study. Workers will have to train and retrain (using lifelong learning) to stay in the labor force longer, and policymakers will have to pay attention to new demand for services such as care work for the elderly.[75]

WHO SHOULD BEAR THE BURDEN FOR BUILDING, MAINTAINING, AND INCREASING WORKER CAPACITIES?



POPULATION AND MEDIAN AGE, 2015 - 2050

	2015[76]	2050 (projected)	Median age, 2015	Median age, 2050 (projected)
FRANCE	64.4 million	71.1 million	41.2 years	44.3 years[78]
GERMANY	81.2 million	74.5 million	45.9 years	50.3 years[79]
SPAIN	46.1 million	44.8 million	43.2 years	52.3 years[80]
UNITED STATES	322 million	398.1 million[77]	37.8 years	50.8 years

SECTION THREE

III

THE FUTURE OF WORK: A TAXONOMY

Any discussion of technology and work, particularly a transatlantic one, must begin with shared definitions of key issues as a jumping off point.

These definitions are meant to buttress and contextualize the four future of work "ingredients" outlined in Section II. In this section, we bring together key concepts and terms related to the future of work from the United States and Europe. In doing so, we frame our later baseline comparison while setting the stage for a granular policy discussion on the transatlantic dynamics of the future of work. Definitions are broken down into four overarching categories: technology, economic concepts, social support, and skills and training.

A

TECHNOLOGY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ARTIFICIAL INTELLIGENCE (AI)

Artificial intelligence is a field of computer science devoted to creating systems that perform tasks much as a human would, particularly those that involve learning and decision-making.[81] As a new factor of production, AI has the ability to replicate cognitive processes in machines, thus allowing them to learn and adapt autonomously. AI has many functions, including but not limited to learning, understanding, reasoning, and interaction. There are two very distinct types of AI: narrow and strong. Narrow AI, also known as weak AI, refers to machine intelligence able to perform a specific narrow task for which they have been programmed, such Apple's Siri virtual assistant, which interprets voice commands.[82] Strong AI, also referred to as artificial general intelligence (AGI), is a hypothetical type of AI that can meet or exceed human-level intelligence and apply this problem-solving ability to any type of problem.[83] With AI expected to contribute up to $16 trillion to the global economy by 2030, countries have begun to erect regulatory framework that will profoundly affect the development of their AI industries, such as China's 2030 initiative or the European Union's GDPR. In fact, more than three-quarters of Europe's tech elite believe that AI also has the potential to boost profitability across 16 industries, as found by Accenture's recent research.[84] Many of the dystopian fears about AI —that it will eliminate most jobs or go out of control and wipe out humanity — stem from the notion that strong AI is feasible, imminent, and uncontrollable.[85] But computer systems that can fully mimic the human brain will, at least for the foreseeable future, be found only in Hollywood movie scripts, and not labs in Silicon Valley.

ALGORITHMIC DECISION-MAKING

Algorithmic decision making uses a game-theoretic framework to maximize gains and minimize losses. Different decisions that can be made with algorithms include classification, association, and filtering. Uses for it include fraud-detection systems and dynamic product pricing.[86] In many cases, however, these tools will be used to complement, not replace, human decision makers.

AUTOMATION

Automation is a particular kind of process technology. The engineering division of Ford Motor Company coined the term in 1945 to describe the operations of its new transfer machines, which mechanically unloaded stamping from the body presses and positioned them in front of machine tools. Today, it refers to any production process that is controlled by a machine with little or no input from an operator.


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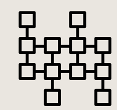
AUTONOMOUS DEVICES

Autonomous devices are mechanical devices that have some ability to interact with their environment to change its physical actions in response. The most widely known autonomous device is a self-driving vehicle, a vehicle that has the ability to navigate its surroundings partially or completely autonomous from human control. Full autonomy for many devices at an affordable price point and with high reliability is still some time off, but it appears to be coming. We can envision many different applications for autonomous devices, including tractors and other farm equipment, mining equipment, freight vehicles (trucks, rail, ships, drones), passenger vehicles, delivery "robots," garbage trucks, street sweepers, and lawnmowers.



BLOCKCHAIN

Blockchain is a digital ledger technology in which immutable transactions are recorded digitally and made available across a network of computers. This enables decentralized generation, storage and transfer of information. While still an early stage technology, blockchain technologies have been used for currency (e.g., Bitcoin); shipping and supply chain integration, including smart contracts; financial services; digital identification and certification; and public records.

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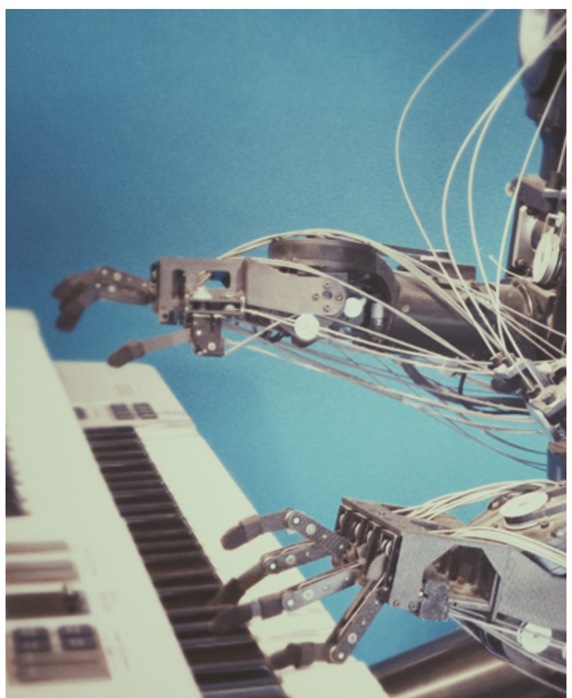
INDUSTRY 4.0/SMART MANUFACTURING

Industry 4.0/smart manufacturing represents an emerging era of "smart manufacturing" that integrates advanced digital technologies more completely into production systems. These technologies include wireless communication technologies, the Internet of Things, cloud computing, easily (re)programmable robots, machine intelligence, and other next-generation digital technologies to create a direct, real-time interface between the virtual and physical world.[87] [88]



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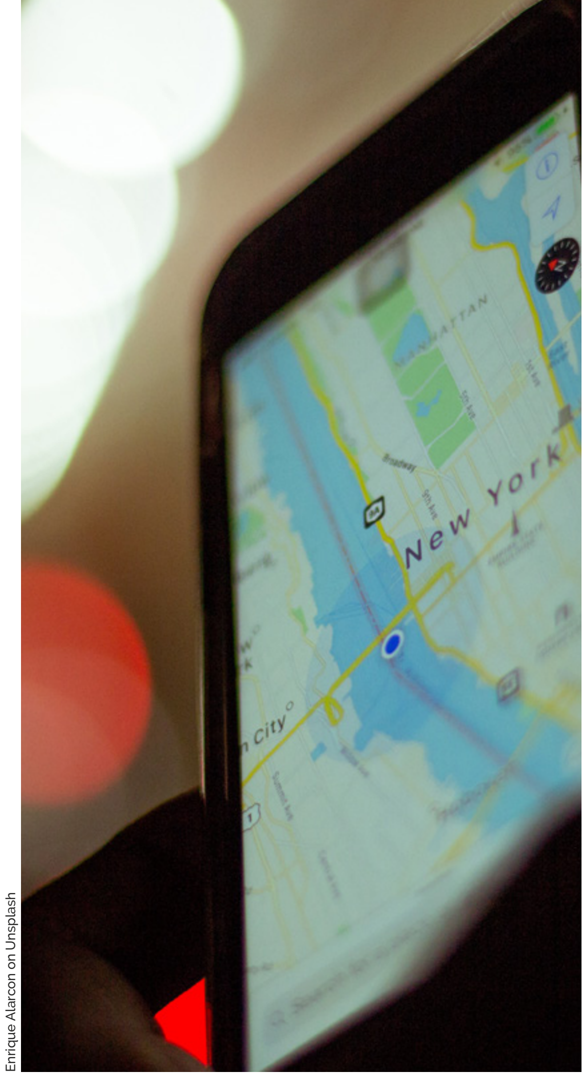
INTERNET OF THINGS (IOT)

Refers to the concept that the Internet is no longer just a global network for people to communicate with one another using computers, but it is also a platform for devices to communicate electronically with the world around them. The result is a world that is alive with information as data flows from one device to another and is shared and reused for a multitude of purposes. A combination of technologies, including low-cost sensors, low-power processors, scalable cloud computing, and ubiquitous wireless connectivity, has enabled this revolution. Increasingly, companies are using these technologies to embed intelligence and sensing capabilities in machines and their products, thereby allowing everyday objects to sense, learn from, and interact with their environment. In industry verticals, this is known as "Smart x" (smart manufacturing, smart transportation, smart agriculture, etc.).

MACHINE LEARNING

Machine learning is an AI application that is based on the science of computers being able to act without being explicitly programmed to do certain tasks. Essentially, it is based on the idea that machines will learn autonomously if given access to data. Machine learning can be accredited to innovations such as self-driving cars, practical speech recognition, and effective web searching.[89]



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PLATFORMS

A poorly defined term, platforms refer to Internet-based applications that create value by bringing people (or companies) together.[90] Platforms enable the gig economy (e.g., Uber) and the sharing economy, but there are also information sharing platforms (e.g., Facebook, Google, and Twitter) and e-commerce platforms (e.g., eBay and Amazon marketplace enable sellers to connect with customers). But a company that provides software is not necessarily a platform. Microsoft, for example, is not a platform.

PROCESS TECHNOLOGIES

There are two main kinds of technologies — product technologies (e.g., a new car, a new smart phone) and process technologies (e.g., AI software, a new machine tool, etc.). Process technologies help organizations produce a good or service more efficiently or effectively. In other words, they relate to how to produce things, rather than what is produced.

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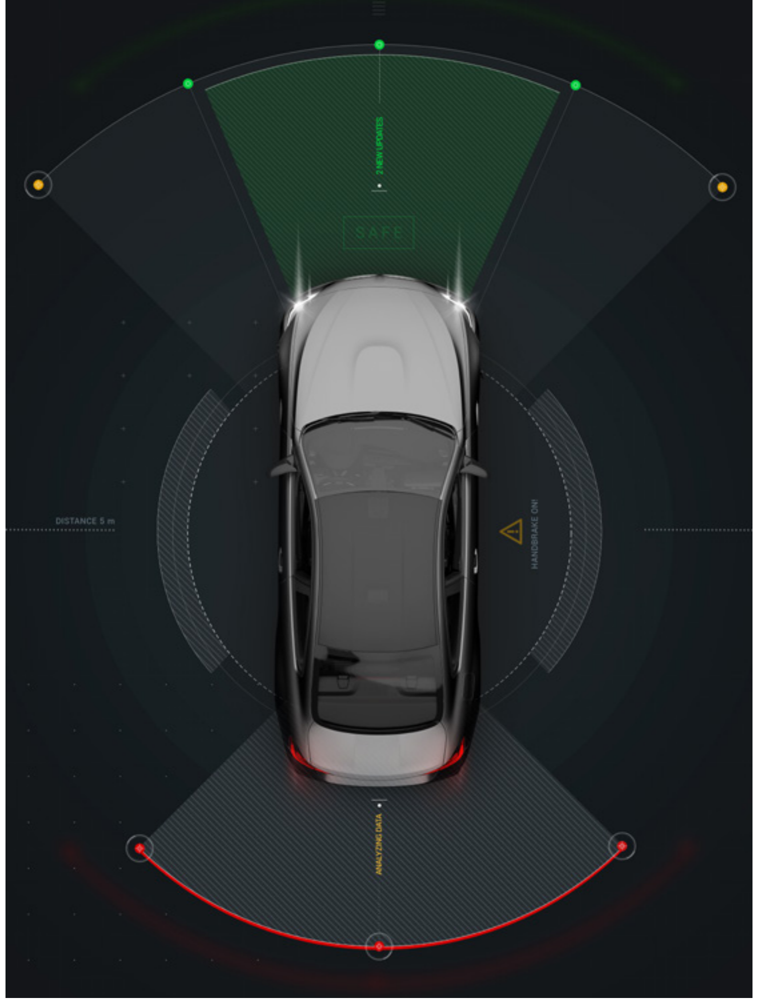
ROBOTICS

There are many different technologies that can enable a production process to be automated, and robotics is one of those. While it is difficult to establish a single definition of a robot, the term generally refers to physical machines that can be programmed to perform a variety of different tasks, with some level of interaction with the environment and limited-to-no input from an operator. Whether a robot looks like a human is irrelevant to whether it is a robot. Robots are getting cheaper, more flexible, and autonomous, in part by incorporating artificial intelligence. Some robots will substitute for workers; others (cobots) will complement workers.

B

ECONOMIC CONCEPTS



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FOURTH INDUSTRIAL REVOLUTION

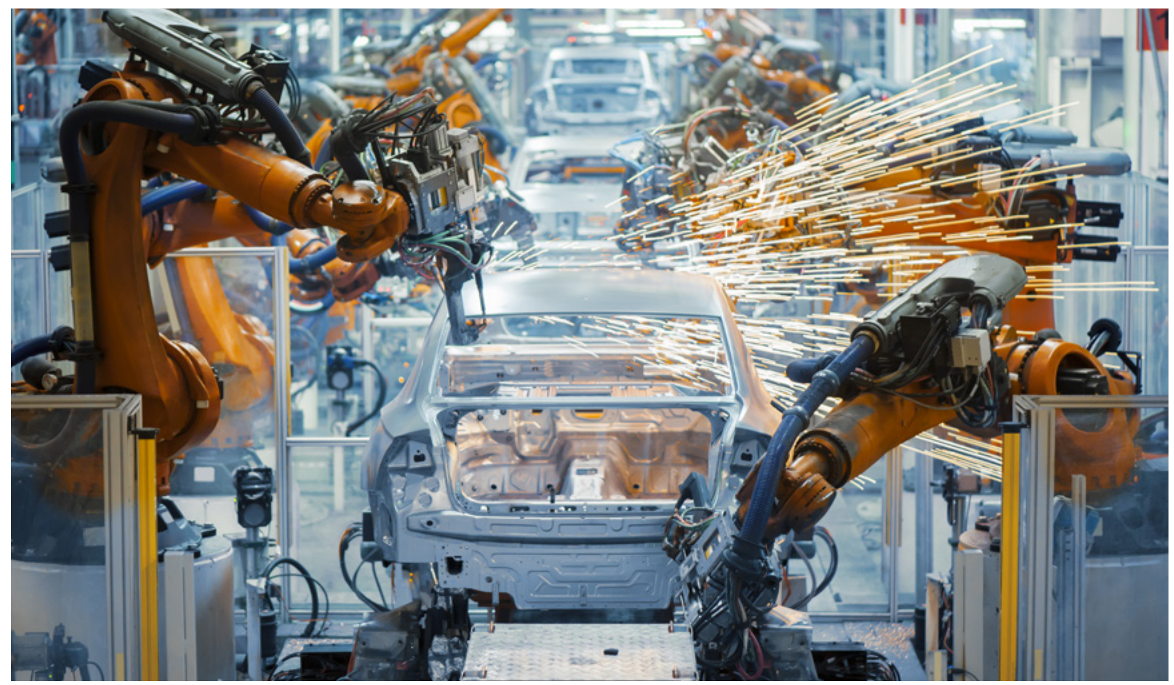
Coined by Klaus Schwab, head of the World Economic Forum, the term “fourth industrial revolution,” refers to coming economic transformations grounded in technologies such as artificial intelligence, autonomous vehicles, robots, new materials, and other breakthroughs. For Schwab and other advocates of this periodization, the first industrial revolution of steam power was in the late 1700s. Electric power followed in the early 1900s. The early 1990s saw the advent of digital technologies. Some assert that we have been, over the last several years, in the midst of the Fourth Industrial Revolution. According to this theory, the pace of change of the Fourth Revolution will be vastly more rapid than prior transitions. However, as discussed below, while such periodization makes for a nice sound bite, it is poor economic history.

GIG ECONOMY

The gig economy refers to a subset of workers who work on ad hoc basis, rather than working part time or full time for a single employer.[91] The labor force has always had “gig” employees. Some of these were teenagers and part-time workers trying to make some extra money while juggling school, homecare, or retirement. Others were traditional tradesmen or consultants who had their own businesses. Today, the internet enables digital labor-matching platforms that link workers with buyers, whether it is for drivers (e.g., Uber and Lyft); business consultants (Hourly Nerd and Upwork); and household and related work (Task Rabbit). While most internet-based gig economy workers are self-employed, the business model of a few platforms is to hire workers as employees.

LABOR FORCE VS. WORK FORCE

The labor force refers to the number of people aged 18-65 who are able and willing to work (therefore excluding children, prisoners, and the elderly). The labor force excludes people not willing to work (voluntarily left the labor market) although they are able. The labor force also excludes people who left the labor market for reasons such as disability, sickness, maternity/paternity leave, early retirement, and education. On the other hand, workforce refers to people who are actually engaged in commercial productive activity. The difference between workforce and labor force is unemployment.[92]



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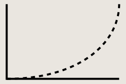

MOORE'S LAW

Believers in an exponentially increasing rate of technological growth cite Moore's Law for their optimism. Named after Gordon Moore, one of the founders of Intel, Moore's Law predicts that the speed of computer processing will double every 18 to 24 months, while the price of that computing power halves. But processing speed progress has actually slowed by half over the last 12 years, compared with the previous three decades. The pace of IT advancement could slow even more going forward. Silicon-based IT systems are likely nearing their limits — even Gordon Moore has said that Moore's Law is dead. Intel recently announced that it was moving away from its past development process and that this shift will "lengthen the amount of time [available to] utilize... process technologies."[93] It is possible that at some point a radically different technology will replace the current silicon-based IT system — perhaps quantum computing. But it is unlikely that this replacement system will be ready for commercialization just as the miniaturization constraints of silicon reach their limits. An intervening period of at least a couple of decades of slow innovation and slow growth until the next technology system fully emerges is likely. Thus, it is certainly possible, if not likely, that exponential growth in IT, something that has enabled rapid digital progress, could slow down going forward, making many of the assumptions about the pace of technology-based job loss overly optimistic.

OCCUPATIONAL CHURN

Occupational churn refers to the process by which the number of jobs in particular occupations grows or declines (in particular, it is calculated as the sum of the absolute values of jobs added in growing occupations and jobs lost in declining occupations). In the U.S. context, over the last 165 years, the present-day U.S. labor market is not experiencing particularly high levels of job churn. Occupational churn results from three main drivers. Trade can change the occupational mix as some industries grow and others decline. Technology can also eliminate jobs by enabling increased productivity in some occupations. Technology clearly creates jobs when it enables the creation of whole new industries and occupations. Finally, occupational churning stems from changes in the types of goods and services demanded by consumers — whether these are businesses, governments, or individuals. Various factors can alter the composition of demand, including demographics, culture, and government spending.

SHARING ECONOMY

Often confused with the gig economy, the sharing economy refers to the use of digital platforms to match spare capacity and demand. This includes both peer-to-peer sharing, whereby people share their own goods (e.g., parking spaces, power tools.); and business-to-consumer sharing, such as bike and car share applications (e.g., Car To Go), and housing (e.g., Airbnb).

PRODUCTIVITY

Productivity is a measure of economic outputs relative to units of input. Labor productivity is the output of workers divided by the number of hours of work. Total factor productivity is a broader measure of the productivity of all factors of production, including workers, energy, and machines. An economy might increase labor productivity by adding more machines, but total factor productivity could rise or decline depending on whether the machine's output justifies its cost. Technology affects productivity in four different ways. The first is when technology completely replaces workers (e.g., automatic elevators replacing elevator operators). The second is when technology makes workers more productive (e.g., carpenters using pneumatic nail guns instead of hammers). The third is when technology improves the quality of the worker's output (e.g., artificial intelligence aiding doctors in making more accurate diagnoses). The fourth is where new technologies reduce the need for work (e.g., long lasting concrete reduces the need to resurface roads). The notion that the second is better for jobs than the first does not hold — labor productivity increases in both cases and fewer workers are needed.

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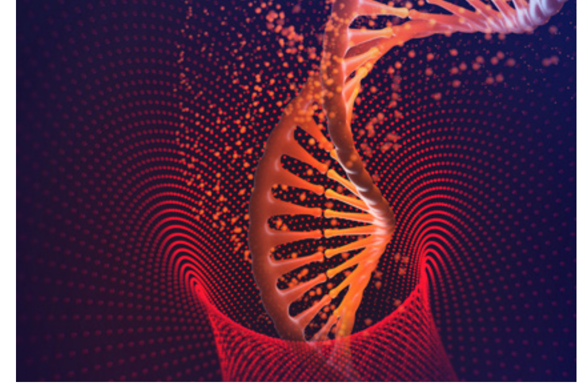

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THE SIXTH LONG WAVE

Economists, especially students of innovation economist Joseph Schumpeter, pioneered the idea that innovation progresses in regular cycles, or waves, approximately half a century long, with initial modest growth, followed by a period of robust adoption and growth, followed by stagnation.[94] According to this periodization there have been five waves to date, not three: the steam engine in the 1780s and 1790s; iron in the 1840s and 1850s; steel and electricity in the 1890s and 1900s; electromechanical and chemical technologies in the 1950s and 1960s; and information technology and communications technology in the 1980s and 1990s.[5] According to this periodization, a sixth wave will emerge, likely grounded in AI, robotics, and perhaps nanotechnology and biotechnology, but not before an intervening period of relative stagnation of perhaps as long as 20 to 25 years, a period the global economy appears to be in right now. Indeed, the current fifth wave digital technology system has reached a spot near the peak on the "S-curve" where it is difficult for it to continue to drive productivity at a robust rate. This, more than any other factor, explains the slowdown in global productivity over the last decade.[96] In this formulation, the next wave will drive growth, but at rates consistent with past waves.

III

C

WELFARE STATE AND SOCIAL SUPPORT

GENERAL DATA PROTECTION REGULATION (GDPR)

GDPR is an EU data privacy law that harmonizes individual data privacy laws across Europe and is designed to limit the use of consumers' personal information that is collected, processed, and stored by organizations. It also allows for a consumer's "right to be forgotten," upon request, meaning that data collectors and third parties must delete any data relating to a certain individual or face heavy fines for noncompliance.[97]

PORTABLE SOCIAL BENEFITS

Portable social benefits are intended to serve as a form of support for modern workers who fall through the gaps of the social safety net. Portable benefits are not tied to any particular job or company; instead, workers "own" their social benefits. In today's economy, the reality of work is that many people derive their income from multiple sources simultaneously or switch jobs or employers regularly. Portable social benefits would allow workers to select and maintain their social benefits from year to year, and their protections would be independent of the company/companies they work for.[98]

Didier Weemaels on Unsplash

PERSONAL SPENDING ACCOUNT

A personal spending account, stemming from French and German innovation, is an instrument of a work-centric social policy focused on individual needs. As proposed, this type of lifelong account is set up for all individuals entering the workforce. An initial credit of, for example, 20,000 euros is made available to people regardless of their social background. Personal spending accounts allow the beneficiary to attend university, invest in their professional development, or start a business.[99]

RELOCATION VOUCHERS

Relocation vouchers are an incentive provided by the government or the private sector aimed at promoting geographic labor mobility. Since job churn spurred by technology and automation may reduce work in some areas and create it in others, reallocation vouchers enable workers to move to where the jobs are. Reallocation vouchers could help to overcome structural unemployment within regions affected by high levels of automation. However, a potential downside could be the further development of relatively prosperous super-clusters at the expense of economically depressed regions.[100]

Mirza Babic on Unsplash

UNIVERSAL BASIC INCOME

Universal basic income (UBI) is a proposed system whereby the state grants regular income to all adults, whether they are working or not, poor or rich. While proposals vary in scope and generosity, the goal is to provide an income floor for all workers, premised on the assumption that there will not be enough gainful work for everyone who wants to work.

D

SKILLS AND TRAINING

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APPRENTICESHIP

An apprenticeship is a job that requires substantial and sustained training, leading to the achievement of an apprenticeship standard set by employers and the development of transferable skills.[101]

CONTINGENT WORKERS

Contingent work is an employment relationship between the worker and employer that is not considered permanent. This can be for temporary workers (either through the final employer or an intermediary "temp agency"); workers provided by contract firms; independent contractors and consultants who do not expect their contract to last more than a year (which include freelancers, including those who find work over the Internet); and on-call workers (workers who only show up to work when called to work).

HIGH-PERFORMANCE WORK ORGANIZATIONS

High-performance work organizations are organizations that use advanced production technologies, give workers more say in the design and operation of work and invest heavily in workforce development.

LEARNABILITY

Learnability is the desire and capability to develop "in-demand" skills to be employable for the long-term. A person's willingness to learn and ability to change based on learning more can help them find success on their own terms and lead a more rewarding life. All humans are capable of learnability, though some people are born with it while others must acquire it.[102]

LIFELONG LEARNING

The concept of lifelong learning exemplifies a shift away from the idea that individuals spend their formative years learning and their rest of their life working or in retirement. Lifelong learning is the notion that learning continues throughout adulthood, often to improve or complement skills needed at work.[103]

LUMP OF LABOR FALLACY

In the debate over technology and jobs, many postulate that if technology eliminates a job, that job is gone for good. Economists have a term for such fuzzy thinking; they call it "the lump of labor fallacy" which refers to the view that there is only a fixed amount of work to be done, and that once a job is gone no others are created. Economists rightly point out that no organization adopts automation technology unless it will reduce overall costs; these savings are not put under a mattress, but are spent — and this spending creates demand, which creates jobs.

Alvaro Reyes on Unsplash

Raoul Ortega on Unsplash

NON-TRADITIONAL WORK

This is the broadest subcategory of work that is not full-time and long-term. It includes contingent workers, part-time workers, and multiple jobholders.

SKILLS FORECASTING

Skills forecasting refers to systematic means of determining future skill needs. Typically, skills forecasting is based on economic modeling of future labor demand in an economy from which estimates are derived about the level of skill demand associated with the change in labor demand. Usually, future skills demand is measured with reference to occupations or qualifications.[104]

UPSKILLING

Upskilling is an increase in skill level resulting from technical change or job redesign. Optimistic theories of post-industrial society posit a general upskilling across the workforce as the economy shifts from manufacturing to services.[105]

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VOCATIONAL TRAINING

Vocational training refers to organized educational programs that offer a sequence of courses that prepare individuals in paid or unpaid employment, in current or emerging occupations requiring other than a baccalaureate or advanced degree.[106]

Christopher Burns on Unsplash

SECTION FOUR

IV

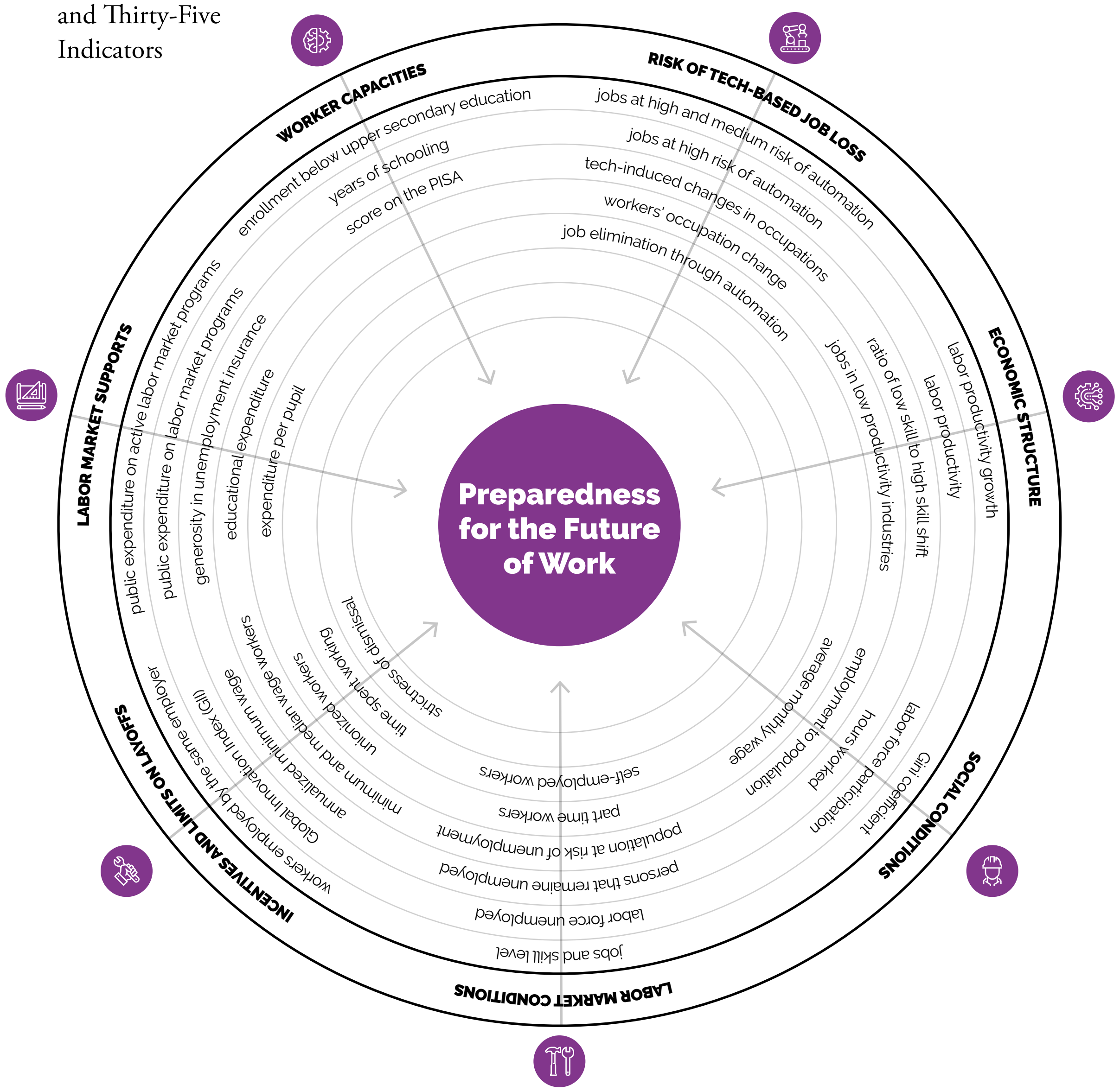
BASELINE COMPARISON OF LABOR MARKET DYNAMICS

Because technology is global, the next technology wave will affect national labor markets in similar ways, at least in developed nations with similar industrial structures and wage levels.

But even still, economies will be affected differently from country to country; those variations are predicated on a range of factors. This report examines seven factors (and 35 indicators) that are likely to affect the rate of technology-induced productivity growth and job loss and the prospects for workers faring well from these changes.

LABOR MARKET INDICATORS

The Seven Buckets and Thirty-Five Indicators



RISK OF TECH-BASED JOB LOSS

Indicators include an estimate of jobs at high and medium risk of automation; an estimate of the current share of jobs at high risk of automation; an estimate of occupations that will face technologically-induced changes to current job tasks; an estimate of the share of current workers that will have to change to a different occupations; and an estimate of the current share of jobs that will be eliminated through automation by 2030.

ECONOMIC STRUCTURE

Indicators measure labor productivity growth between 2011 – 2016 across all case studies; labor productivity in 2016 adjusted by purchasing power parity (PPP); the ratio of low skill to high skill shift in the twenty years from 1995 – 2015; and the share of jobs in low productivity industries.

SOCIAL CONDITIONS

Indicators include Gini coefficients, which measures the skew of income distribution within a given country; labor force participation rates in 2017; number of hours worked per year per worker; employment to population ratio, which measures total employment as a share of the total working-age population; and the average monthly wage per worker (in dollars).

LABOR MARKET CONDITIONS

Indicators include the percentage of workers employed in jobs that require less than their actual skill level; the percentage of the labor force that was unemployed in 2016; persons that have remained unemployed for greater than one year; share of the population at risk of unemployment; share of part time workers; and share of self-employed workers.

INCENTIVES AND LIMITS ON LAYOFFS

Indicators measure the strictness of individual and collective dismissal; rank on the Global Innovation Index (GII) concerning how many weeks wages' it costs a company to lay off a redundant worker; annualized minimum wage adjusted by PPP; ratio between minimum and median wage workers; percentage of unionized workers as a share of total employment; median length of time spent working at current place of employment; and the share of total workers employed by the same employer in excess of ten years.

LABOR MARKET SUPPORTS

Indicators measure public expenditure on active labor market programs as a share of gross domestic product (GDP); public expenditure on total labor market programs (active and passive) as a share of GDP; generosity in unemployment insurance; educational expenditure as a percentage of GDP; and expenditure per pupil as measured by rank on the GII.

WORKER CAPACITIES

Indicators measure score on the Programme for International Student Assessment (PISA); average years of schooling; and the share of students enrolled below upper secondary education as a share of all workers.

METHODOLOGY

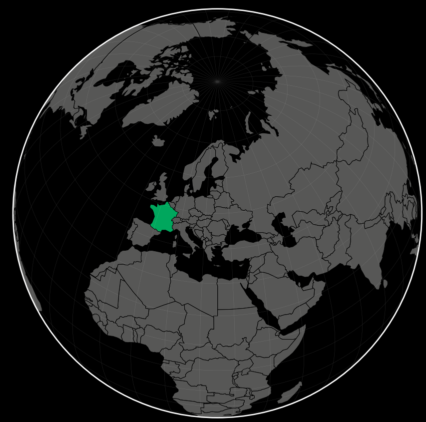
The methodology is such that low scores (closer to 0) indicate that the nation's economy is better positioned, and high scores (closer to 10) indicate it is not well positioned. To simplify case study comparisons, we have scaled and standardized all scores from one to 10.

Total aggregate scores suggest that of the four nations, Germany is best positioned for change stemming from technology and automation with a score of 4.2. The United States follows with a score of 4.7. Next is France at 4.9. At 6.2 Spain ranks last, suggesting that of the four nations Spain's workers could face the most difficult challenge in adjusting to the new production revolution.

COMPARISON OF LABOR MARKET STRUCTURE AND DYNAMICS

BY COUNTRY

FRANCE



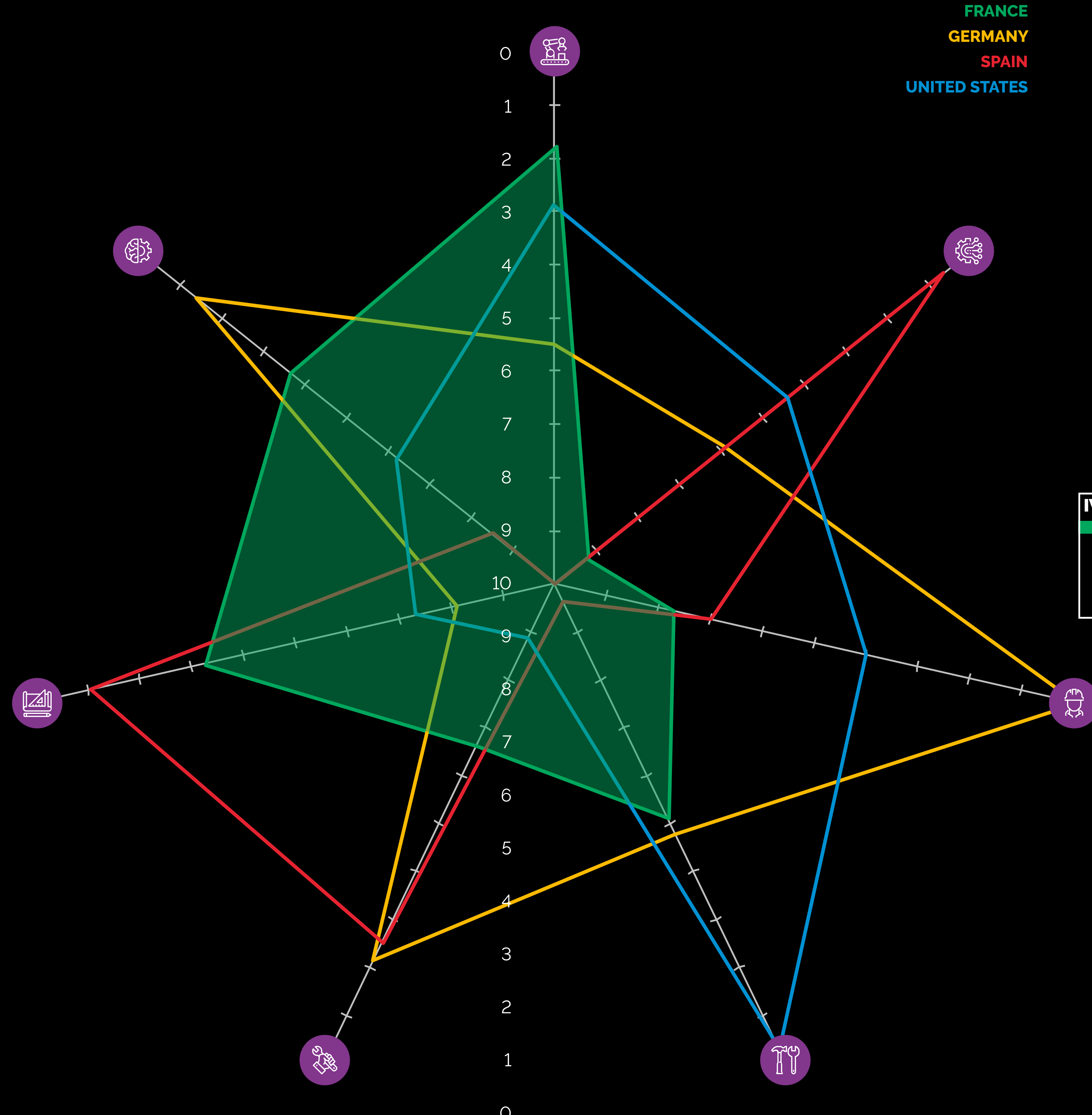
OVERALL SCORE

GERMANY	4.2
UNITED STATES	4.7
FRANCE	**4.9**
SPAIN	6.2

- Tech-Based Job Loss **1.9**
- Economic Structure **9.3**
- Social Conditions **7.8**
- Labor Market Conditions **5.2**
- Incentives and Limits on Layoffs **6.7**
- Labor Market Supports **3.3**
- Worker Capacities **3.7**

Minimum Risk **0** – **10** Maximum Risk

Overall, France ranks third (behind Germany and the United States, but ahead of Spain) in preparedness for labor market change brought by technology and automation, scoring 4.9. France scores poorly in three buckets: economic structure (9.3), social conditions (7.8) and incentives and limits on layoffs (6.7). By comparison, France scores relatively well in worker capacities (3.7), labor market supports (3.33), and risk of tech-based job loss (1.9).



IV

GERMANY

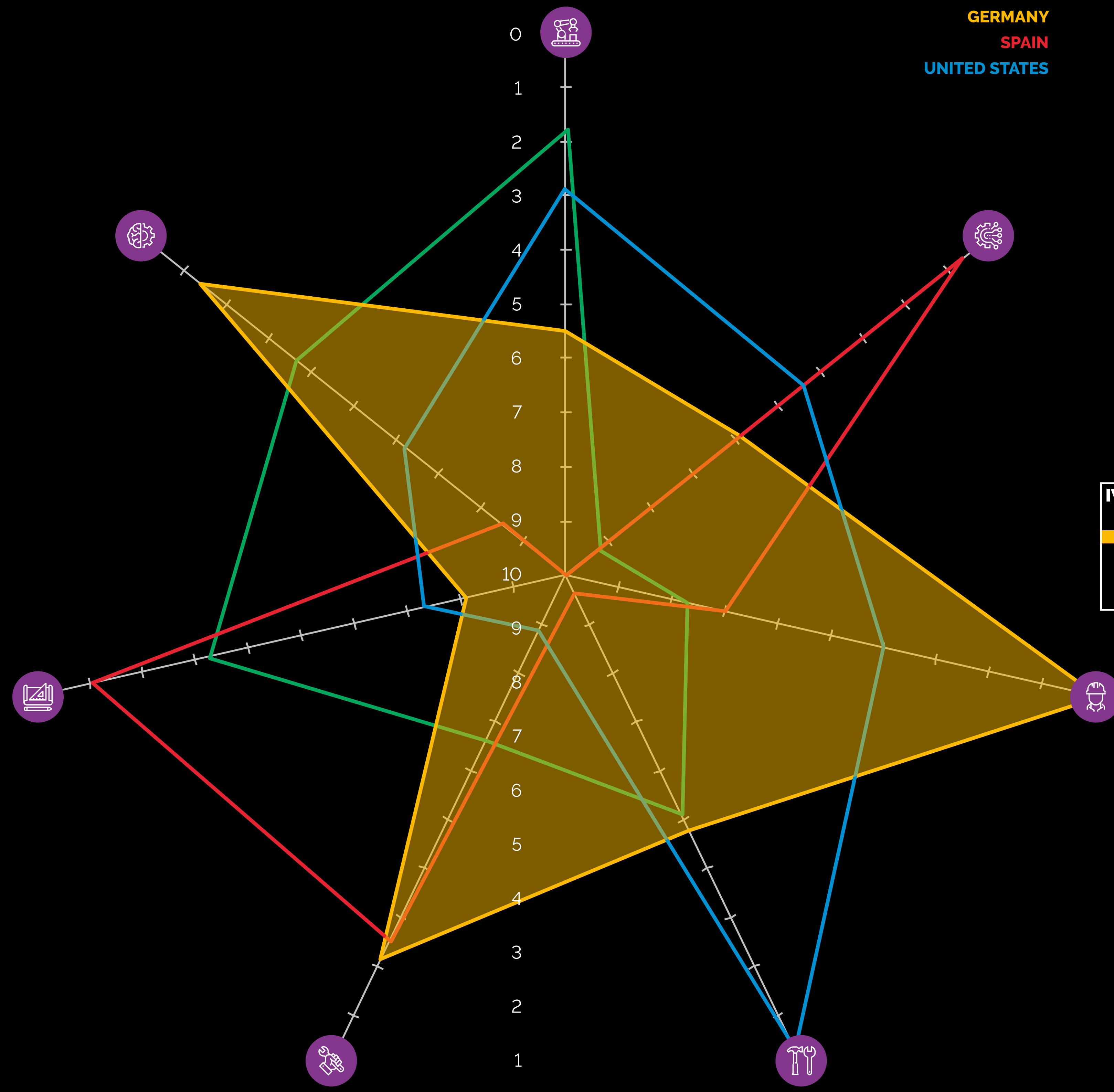
OVERALL SCORE

GERMANY	**4.2**
UNITED STATES	4.7
FRANCE	4.9
SPAIN	6.2

- Tech-Based Job Loss **5.6**
- Economic Structure **5.9**
- Social Conditions **0.0**
- Labor Market Conditions **4.8**
- Incentives and Limits on Layoffs **2.2**
- Labor Market Supports **8.1**
- Worker Capacities **1.5**

Minimum Risk **0** — **10** Maximum Risk

Overall, our analysis shows that, of the four case studies, Germany is most prepared for labor market change brought by technology and automation, scoring 4.2 overall. Germany scores favorably in three categories — social conditions (0), worker capacities (1.5), and incentives and limits on layoffs (2.22). By contrast, Germany scores poorly in three buckets: risk of tech-based job loss (5.6), economic structure (5.9), and labor market supports (8.1).



IV

SPAIN

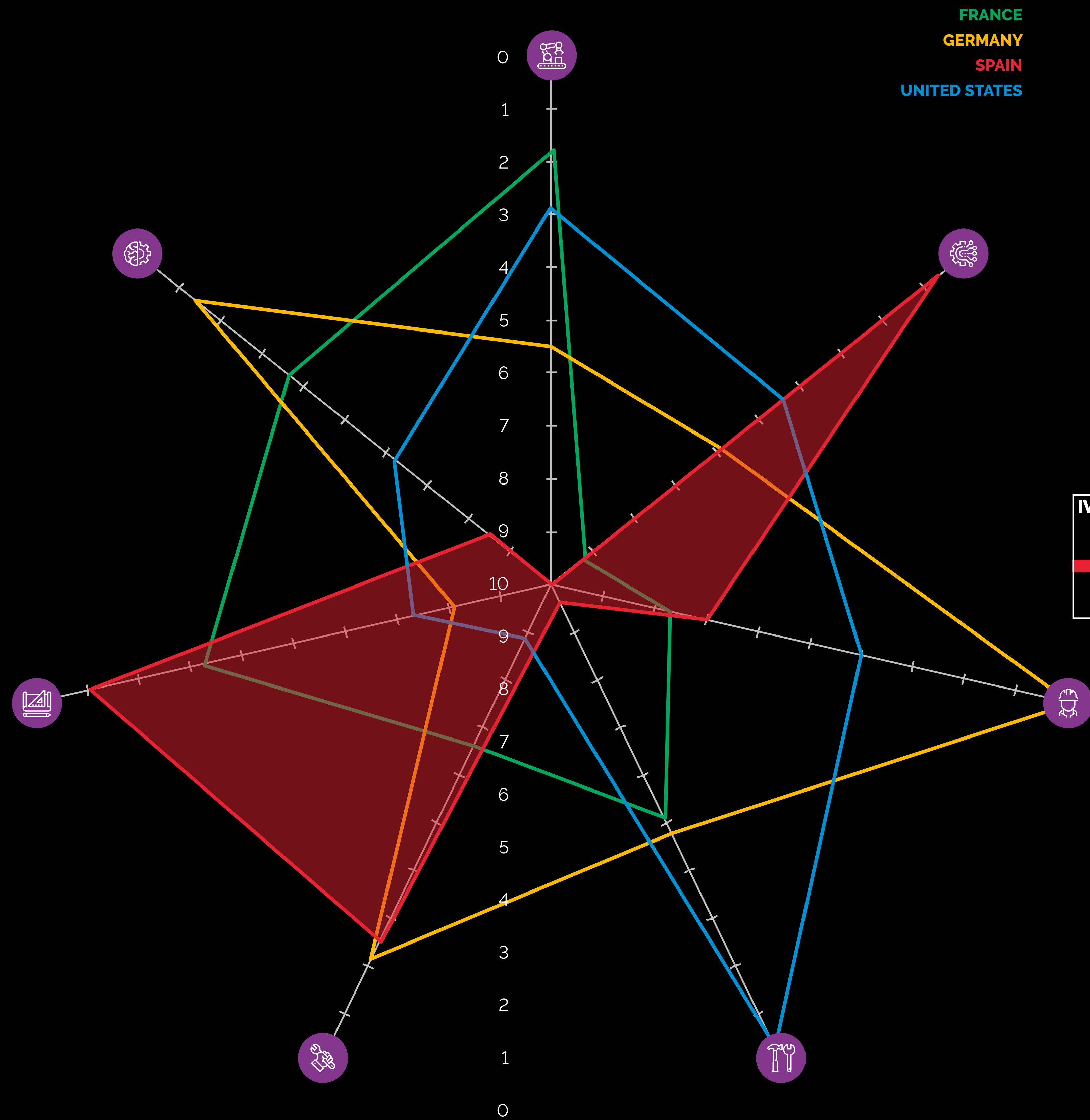
OVERALL SCORE

GERMANY	4.2
UNITED STATES	4.7
FRANCE	4.9
SPAIN	**6.2**

Tech-Based Job Loss	**10.0**
Economic Structure	**0.7**
Social Conditions	**7.0**
Labor Market Conditions	**9.6**
Incentives and Limits on Layoffs	**2.6**
Labor Market Supports	**1.1**
Worker Capacities	**8.5**

Minimum Risk **0** — **10** Maximum Risk

Overall, our analysis shows that, of the four case studies, Spain is least prepared for labor market change brought by technology and automation, scoring 6.2 overall. Spain scores poorly in three buckets: risk of tech-based job loss (10), labor market conditions (9.6), and worker capacities (8.5). However, Spain scores favorably in economic structure (0.7), labor market supports (1.1), and incentives and limits on layoffs (2.6).



IV

UNITED STATES

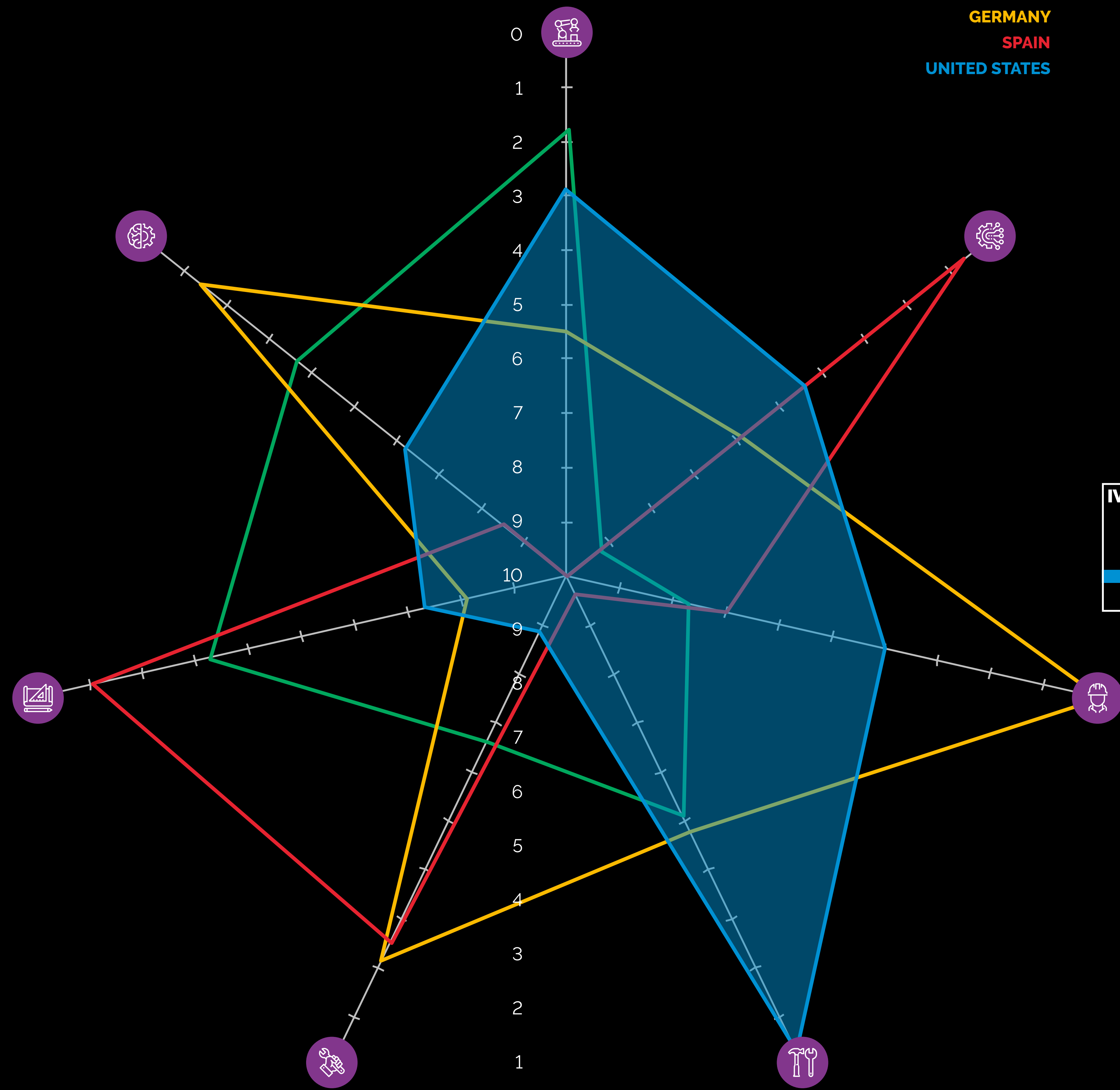
OVERALL SCORE

GERMANY	4.2
UNITED STATES	**4.7**
FRANCE	4.9
SPAIN	6.2

Tech-Based Job Loss	**3.0**
Economic Structure	**4.4**
Social Conditions	**4.1**
Labor Market Conditions	**0.4**
Incentives and Limits on Layoffs	**8.9**
Labor Market Supports	**7.4**
Worker Capacities	**6.3**

Minimum Risk **0** — **10** Maximum Risk

Of the four countries, the United States ranks second (behind Germany, but ahead of France and Spain) in preparedness for labor market change brought by technology and automation, with an overall score of 4.7. The United States scores particularly well in three areas: labor market conditions (0.4), risk of tech-based job loss (3.0), and social conditions (4.1). The United States scores poorly in worker capacities (6.3), labor market supports (7.4), and incentives and limits on layoffs (8.9).



COMPARISON OF LABOR MARKET STRUCTURE AND DYNAMICS

BY CATEGORY

This section examines seven categories (and 35 indicators): risk of job displacement from technology, economic structure conditions that may affect productivity growth, social conditions, and labor market conditions related to unemployment and labor market conditions related to employment.

RISK OF TECH-BASED JOB LOSS

The risk differs between nations in part because of differences in industrial and occupational structure. Economies with more jobs in industries and occupations more likely to be transformed with automation face a higher risk of tech-based job loss, and an opportunity for higher productivity growth. When it comes to individual measures related directly to the risk of automation, the four nations face similar likely dynamics. Overall, France scores best at 1.9, followed by the United States at 3.0, and Germany at 5.6. Spain faces the highest expected rate of job loss at 10. However, despite the large differences in scores (based on standard deviation differences in scores), overall, the nations are relatively closely grouped in terms of actual risk of job loss raw scores. For example, according to an OECD study, the share of jobs at risk of automation is eight percent for France and the United States, but 12 percent for Germany and Spain. McKinsey's estimates for risk of job loss from automation by 2030 are similar, with Germany slightly higher at 25 percent, the United States and Spain at 24 percent, and France at 21 percent. In contrast, a Price Waterhouse Coopers study estimates that Germany is the lowest at 35 percent, with the United States at 38 percent, and France and Spain at 40 percent. Since these numbers are so close in different series, they suggest that all four nations will face roughly similar — essentially the same — process and scope of technology-led productivity growth and job loss. Combining all five variables, taking the standard deviations and summing them, shows that of the four nations, Spain has the highest risk of jobs lost to automation, with Germany next, the United States following, and finally France. However, the differences are not large; for example, according to McKinsey, 21 percent of jobs are at risk in France, compared to 25 percent in Germany.

ECONOMIC STRUCTURE

For economic structure, we examined four indicators: labor productivity growth from 2011 to 2016; labor productivity in 2016, adjusted by purchasing power parity (PPP); the ratio of low skill to high skill shift in the twenty years from 1995 to 2015; and the share of jobs in low productivity industries.

Stronger labor productivity in an economy should lead to less risk of economy-wide job loss, given that economies with higher productivity have already picked the "low-hanging fruit" – the easier activities to automate and otherwise improve productivity. Therefore, future productivity gains in these economies will be harder to achieve relative to nations with lower levels of productivity. Likewise, a greater share of workers in higher-skill industries and higher productivity industries should also be associated with lower risk of job loss, given that there is a negative correlation between risk of occupational job loss and skill levels.[107]

Overall, Spain ranks first at 0.7, followed by the United States at 4.4, Germany at 5.9, and France at 9.3.

SOCIAL CONDITIONS

For social conditions, we examined five factors: Gini coefficients, which measures the skew of income distribution within a given country; labor force participation rates in 2017; number of hours worked per year per worker; employment to population ratio, which measures total employment as a share of the total working-age population; and the average monthly wage per worker. Higher inequality is associated with higher risk, while high scores on the other variables are associated with lower risk.

Germany is best positioned, with a scaled score of zero. The United States is next at 4.1, while France and Spain, at 7.8 and 7.0 respectively, are most at risk; this is largely the consequence of low rates of labor force participation and low numbers of hours worked.

LABOR MARKET CONDITIONS

Economies with stronger labor markets are better positioned to manage higher rates of automation. For labor market conditions, we examined six indicators: percentage of workers employed in jobs that require less than their actual skill level; the percentage of the labor force that was unemployed in 2016; persons that have remained unemployed for greater than one year; share of the population at risk of unemployment; share of part time workers; and share of self-employed workers.

Higher scores are related to elevated risks for workers from technological disruption. Here, the United States is best positioned by a significant amount (0.4), with Germany (4.8) and France (5.2) following. Spain is least well positioned (9.6), in large part because of high rates of unemployment.

Government policies can affect not only the likelihood that enterprises will lay off workers, they can also influence the quality of the transitions of affected workers to new employment. This section examines three factors: policy factors affecting risk of layoffs, labor market support policies, and worker capacities.

INCENTIVES AND LIMITS ON LAYOFFS

For incentives and limits on layoffs, we looked at six indicators. For two, real minimum wage and ratio of minimum wage to median wage, higher scores were associated with higher risks of layoffs, as higher minimum wage increases the rate of return on labor displacement equipment. For the other four, strictness of dismissal rules, the global rank on the costs to firms of redundancy regulations, unionization rates, median worker tenure, and the percentage of workers employed with the same employer for more than 10 years, there exists an association with a lower risk of job loss from automation. These are also associated with a lower rate of automation, since the economic case for it will be weaker.

Germany and Spain lead here, with scores of 2.2 and 2.6, respectively. France and the United States lag behind considerably with scores of 6.7 and 8.9, respectively. The U.S. score is high because of limited restrictions on layoffs and job tenure that is shorter overall, suggesting a more fluid labor market.

LABOR MARKET SUPPORTS

We examined five variables related to labor market support policies. Variable one, unemployment insurance generosity, is associated with higher risk as workers can be out of the labor market for longer periods of time. The other four variables are public expenditure on active labor market programs as a share of gross domestic product (GDP); public expenditure on total labor market programs (active and passive) as a share of GDP; educational expenditure as a percentage of GDP; and expenditure per pupil as measured by rank on the GII.

These variables are associated with a lower risk for workers. Surprisingly, Germany ranks last here, in part because of its generous unemployment insurance and relatively low spending on labor market adjustment policies — especially compared to France and Spain — and education. For labor market supports there is a wide spread in scores, ranging from 1.1 for Spain, to 3.3 for France, 7.4 for the United States, and 8.1 for Germany.

WORKER CAPACITIES

The last set of variables assesses worker capacities, predicated on the understanding that nations whose workers have stronger skills should be better positioned to handle adjustment from automaton. Three indicators were examined: score on the International Student Assessment (PISA), average years of schooling, and the share of students enrolled below upper secondary education as a share of all workers.

Germany ranks first (1.5), largely due to its high test scores and high average years of schooling, which is due in part to the nationwide apprenticeship system. France ranks second (3.7), followed by the United States (6.3) and Spain (8.5).

V

SECTION FIVE

SIX OPPOR-TUNITIES & CHALLENGES

In considering technology and the future of work, there are at least three main opportunities policymakers should focus on maximizing and three challenges they should focus on addressing.

THREE OPPORTUNITIES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1. HIGHER PRODUCTIVITY

higher rates of productivity growth are the single greatest benefit likely from the next wave of innovation. Economies cannot increase living standards sustainably without increased productivity. But U.S. and EU productivity has been growing at anemic rates. Without productivity growth to create a "bigger pie" there is no way for living standards to increase, especially given that the working age to elderly ratio in Europe will drop from its current 3.5 to 2.2 by 2040. Higher rates of productivity will produce an array of benefits, including higher incomes and higher government tax revenues. The next wave of technological innovation will hopefully enable a revival of productivity growth. But policy makers will need to support policies that enable greater productivity, including through technology-based automation, and resist regulations or taxes that would make it more difficult for organizations to adopt new technologies.

2. IMPROVEMENT IN AVERAGE JOB QUALITY

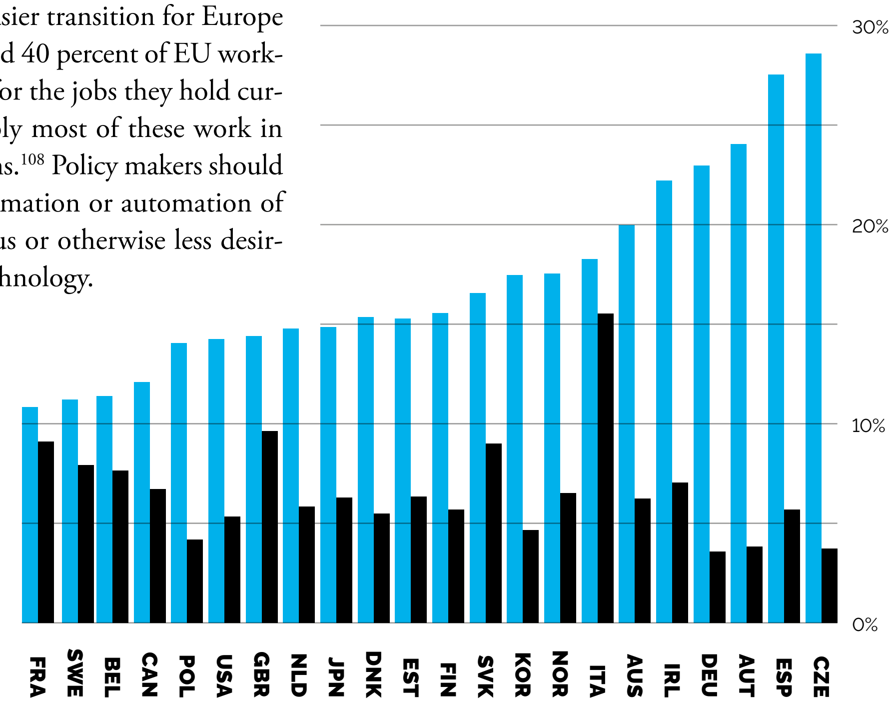
The impact on wages and job quality from the next innovation wave is not yet clear, but there is a good chance that the wave of automation will have a bigger impact on lower-wage, lower-skill jobs. This means that as the surplus from higher productivity is spent creating jobs, the result will be a relatively lower share of low-wage jobs and a higher share of medium and higher-wage jobs (which are harder to automate). Assuming that workers in low-wage occupations can effectively transition to middle or even upper-wage jobs – something that labor market policy will need to play a key role in – then not only will their incomes increase, but so will their job satisfaction. This should be somewhat of an easier transition for Europe given that an estimated 40 percent of EU workers are overqualified for the jobs they hold currently, and presumably most of these work in lower-skill occupations.[108] Policy makers should welcome the transformation or automation of low paying, dangerous or otherwise less desirable jobs through technology.

3. IMPROVEMENT IN PRODUCT AND SERVICES QUALITY

Much of AI will complement workers' skills, rather than replace them. For example, AI is improving the ability of physicians to make accurate medical diagnoses; it is also enabling multi-lingual customer support services, and personalized education, as well as boosting energy efficiency.[110] Policymakers should enable the development and adoption of AI for key sectors, including health care and education.

Percent of Workers over-skilled or under-skilled, by OECD Country

Source: OECD[109]



THREE POTENTIAL CHALLENGES

Government's role is not to protect businesses from risk; it is to enable new business models that increase consumer welfare.

1. INCREASES IN LABOR MARKET CHURN

Labor market churn is likely to prove the biggest challenge of the coming technology wave. While ITIF has shown that recent rates of occupational churning in the United States are at historically low levels, rates will probably rise in the United States and Europe.[111] This means that an increased number of workers will be forced to make transitions between jobs or even occupations. The United States and EU nations would benefit from sharing their experiences and knowledge, together with global leaders like Singapore, for best practices in worker training and worker adjustment assistance.

2. HIGHER UNEMPLOYMENT

While there is no economic rule stating that higher productivity leads to higher unemployment, and in fact many studies suggest just the opposite, some nations, particularly in Europe, do a poor job of ensuring full employment.

This is partly due to weak overall economic competitiveness, as in the case of Spain. But in some cases it is due to labor market policies that pay unemployed workers for long periods of time, as is the case in France. These policies discourage unemployed workers from returning to the labor force, which reduces labor supply. Another effect of enabling extended unemployment is to limit growth in labor demand. Higher unemployment insurance payments mean higher unemployment taxes, which are borne by employed workers who experience lower after-tax incomes. This means that employed workers are consuming less, which also reduces labor demand. Frequently, monetary policymakers prioritize fighting inflation over ensuring full employment. If productivity rates increase from new technologies, policymakers on both sides of the Atlantic will need to do more to ensure full employment, including, in Europe's case, developing more flexible labor markets, and, in both regions' cases, ensuring that monetary policies tilt toward full employment.

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3. BUSINESS DISRUPTION

Just as internet platforms today are disrupting a range of industries – taxi, retail, lodging, and telephone and cable TV, among others – emerging technologies could very well disrupt even more industries. For example, "fintech" could disrupt the traditional banking industry. But government's role is not to protect businesses from risk; it is to enable new business models that increase consumer welfare. It is also to help regions and workers adjust to business disruption. If for-profit businesses, big or small, are happy to reap the profits of success, they should be willing to accept the losses from competition. Policy makers should not protect companies from technology-based disruption, which fundamentally help consumers, but rather help workers make transitions to new employment.

V

VI

SECTION SIX

KEY TAKEAWAYS FOR TRANSATLANTIC POLICYMAKERS

1. THERE ARE NO "ONE SIZE FITS ALL" POLICY RESPONSES

to the challenges and opportunities brought by the future of work. While our analysis finds that all four case studies cluster together when it comes to risks associated with tech-based job loss, there is little uniformity across the other six categories. In other words, even among this select group of highly developed case studies, there is significant variation in structural conditions and preparedness for the rapid introduction of technology and automation. This phenomenon can be witnessed in the country visualizations, where, despite a great deal of overlap, we witness dramatic differences between the strengths and weaknesses of countries across categories.

This leads us to two key conclusions. First the pace of change will be driven not just by technology, but by a host of other quantitative and qualitative variables, including some we used in our analysis, such as labor market supports and social conditions. Going forward, policymakers will have to catalogue and weigh these non-traditional variables when formulating policy.

Second, geography will play a huge role in shaping the future of work. The costs and effects associated with the rapid introduction of technology and automation will not be felt evenly across case study countries, and not all geographies are equally well prepared for such change. Change will occur at different speeds, intervals, and intensities across countries, occupations, skill levels, and communities. And, given their varying degrees of preparedness for the future of work, the capacity to respond will differ wildly.

In response, future of work policy will have to be highly place-specific. Policymakers will have to develop varied policies and mechanisms for funding and coordination based on preexisting structures that may have little to do with technology and automation. This is also precisely why policymakers should be wary of copying and pasting approaches that may have worked in other cities, regions, or countries. Success or failure will depend greatly on adapting any future of work policy to be hyper local. And, as new winners and losers are born, policymakers will have to target and support geographies suffering from disparities brought by technology and automation.

2.

THE FUTURE OF WORK IS AS MUCH ABOUT THE HERE AND NOW

as it is about the future. In this field guide, we have argued that there is little consensus regarding what the future of work entails. It remains notoriously difficult to predict job losses or gains, or, for example, the specific jobs, tasks, and skills that will emerge in the future. This is precisely why policymakers should avoid moonlighting as futurists and instead focus on the challenges and opportunities confronting their national or local labor markets. Boosting productivity or improving education may turn out to be a far more productive use of finite human resources and political capital than policy interventions that may be easily outmaneuvered by the rapid implementation of technology. In addition, the labor market challenges of the present are likely to weigh on productivity and job growth into the future. Developing sound policy that addresses today's problems may the first best step to inoculating labor markets and workers against the rapid introduction of technology and automation.

3.

AVOID THE LURE OF PREMATURE FUTURE OF WORK "SOLUTIONS"

such as perennially popular UBI and the taxation of productivity-enhancing technologies, such as robotics and AI. All case study countries are in the very early days of a decades-long transition fueled by technology and automation. All-encompassing policy proposals like UBI – while headline grabbing and politically expedient – choke off lively debates that are the hallmark of sound policymaking. It is conceivable, if unlikely, that the time for these "solutions" may come. However, it is difficult to justify their immediate deployment when so much about technology and automation and its effects on workers and labor markets remains to be decided.

Furthermore, there are a host of unintended consequences associated with one-tracking policy conversations surrounding the future of work. In the short term, these "solutions" might be more about demobilizing localized political instability generated by technology and automation rather than providing viable solutions that actually benefit citizens. In the long term, singular policies forestall the generation of sustainable solutions that remain off the radar of most policymakers as they pursue UBI or the taxation of robots at all costs. In other words, riffs on UBI and adjustments to tax policy might be needed in the future, but they should flow from a process of inclusive policymaking rather than political short-termism. Instead of making halfhearted attempts to decouple income from wage earning through the introduction of UBI pilot projects, policymakers at all levels in all four countries should consider the real value of future of work dialogues that result in more grounded policy. Comprehensive dialogue undertaken by Germany's Ministry of Labor and Social Affairs between 2015 and 2017 could serve as a model and best practice.[112]

4.

START PLANNING FOR THE FUTURE OF WORK NOW,

during a period of sustained economic growth. Policymakers increasingly recognize the long-term challenges and opportunities created by technology and automation. But they face a paradox when it comes to developing future of work policy — low unemployment undergirded by sustained, albeit low, rates of economic growth. These conditions create an environment that enables policymakers to implement tried and true methods of economic development like job creation and wage growth — for example, by pursuing tax abatements over long-term investments in education and training. But these traditional engines of growth will not be up to the task of spurring industries and jobs that are capable of withstanding the changes of technology and automation.

The Economist Intelligence Unit recently published an Automation Readiness Index showing that no country in the world is prepared to address the changes brought by technology and automation.[113] Some countries such as Germany and Singapore fare better than others, but our analysis of all four case studies shows where policymakers can start preparing their economies and labor markets for the future of work today. Spain can improve workers' capacities by investing more in education and increasing the number of years pupils spend in school. The United States can support active labor market policies like support for training while a worker is unemployed.

If policymakers fail to take advantage of the rare breathing room afforded by current macroeconomic and labor market conditions, they will be making a colossal mistake. The time is ripe to pilot innovative responses to the future of work. This makes raising awareness – a core goal of this guide – crucial to gaining increased support for long-term solutions in an era of economic expansion.

5.

THE FUTURE OF WORK IS NOT JUST ABOUT JOBS,

but a range of other factors that have little to do with traditional ideas about jobs and employment. The health of the labor market is most often judged through surveys of the raw *number* of jobs created or lost during periods of economic growth and decline. Perhaps not surprisingly, this conception has spilled over into the roaring debate around the future of work, with experts making various estimates for the impact of technology and automation on the number of jobs created or lost (see our analysis in Section II).

However, our case studies provide evidence for a broadening of labor market analysis to include variables such as inequality, wages, job quality, social conditions, culture, and attitudes toward individual or collective responsibility for skilling and workforce development. Since the rapid introduction of technology and automation will augment productivity and worker capacities in the long run, it will also change the tasks and wages associated with jobs. Policymakers should be mindful of non-traditional labor market indicators, as these might be the best proxy for how workers are adapting to the change brought by technology and automation. In other words, technology and automation necessitate not only rethinking of jobs and tasks themselves, but the system with which we measure the effect of technology and automation on the labor force.

6. DEVELOP NEW MODELS OF WORKFORCE DEVELOPMENT

In all case studies analyzed for this guide, workforce development initiatives skew toward opposite ends of the labor market. On one end of the spectrum, workers employed in low-wage, low-skill positions make use of the most basic forms of workforce development assistance, furnished in large part by the public purse. But access to such services is often means-tested, meaning that workers who could benefit from workforce development services are shut out of the system. On the opposite end of the spectrum, highly skilled (and highly paid) workers in the private sector often have access to a smorgasbord of continual training and retraining options provided by employers.

Policymakers and workforce development officials should acknowledge that technology and automation will transform not only jobs, tasks, and wages, but the very nature of workforce development itself. However, relatively little funding is targeted at workers in mid-skill, mid-wage jobs that will be most subject to automation and technology. These workers are increasingly forced to seek and find the means of paying for their own skilling and training.

Since new technologies and automation will affect a wide range of activities and industries in quick succession, it is imperative to create new – and far more nimble and sophisticated – models of workforce development. These new models could include coaching workers to be more resilient to labor market disruption, by, for example, furnishing them with individualized skills forecasting and career coaching tools. Communicating the hard and soft skills needed by employers will be especially crucial, because the jobs created by technology and automation will require more education and training than the jobs that are eliminated by technology and automation.

Beyond fresh workforce development models, policymakers must engage in larger, more philosophical conversations about where the responsibility for training, skilling, and retraining lies as technology and automation affect not only workers and jobs, but entire models of taxation that have undergirded publically-financed workforce development systems.

7. INNOVATIVE APPROACHES TO THE FUTURE OF WORK

will emerge from cities, regions, and states, not national governments, but these governments need to build on such innovations in order to help scale the best policies nationally. It is evident that technology and automation will affect each community – and worker – differently. Policymakers at the local level are not only best placed to gauge the local economic and social impacts of technology and automation, they will also be most capable of developing agile policy that is responsive to local labor market conditions. For example, cities with large populations of tech workers will require different future of work policy responses than post-industrial cities or rural areas. As technology and automation hit all facets of the economy and society, areas that have engaged in dialogue, planning, and the development of policy around the future of work may be capable of leapfrogging those that have ignored the process. In other words, cities and regions that seem well prepared today may find that they are woefully unprepared in ten years if they write off the challenges and opportunities brought by the future of work.

Perhaps most consequentially, policymakers at the local level are ideally positioned to muster the political will and funding to drive future of work solutions in their communities. Local leaders must seize leadership over the future of work policy domain – much in the same way that certain mayors have led on climate change or autonomous vehicles. Establishing ownership over the issue might prove a challenge given the short-term political realities that many policymakers face, but they can transform it from a political liability to an opportunity by engaging in a wide-ranging dialogue with the private sector, educational institutions, organized labor, government, and workers themselves. As solutions are developed, cataloguing and raising awareness of their existence will be crucial. And at the same time, national workforce development and adjustment programs need to be able support and encourage the scaling up and broadening out of innovative programs.

8. FOCUS ON THE CORE INGREDIENTS OF FUTURE OF WORK POLICY

instead of getting bogged down in the effects of specific technologies and fleeting trends. In part, this is aimed at realigning debate toward core elements of policy that transatlantic policymakers can act upon today. These include: economic structure, labor market conditions and supports, social conditions and protections, skills and worker capacities. While it will be up to policymakers to determine the weight given to each of these variables based on their local labor market conditions, these indicators should provide the basis for the germination of sound policy responses.

VII

SECTION SEVEN

A FINAL WORD

In authoring this future of work playing field guide, we have made the case for why transatlantic policymakers should be engaged in the construction of sound future of work policy. While the topic is currently centered on emerging technologies and new forms of automation and how they will impact workers, jobs, and tasks, the policy domain will undoubtedly touch entire, social, and political systems in the years to come. While the future of work is often treated with a sense of awe and inevitability, policymakers and their communities must realize that they have a great deal of agency in shaping policy that "works" for them and their communities.

But time is of the essence, and there is no better time to act than *before* technology disrupts (positively or negatively) workers and communities.

This is precisely why policymakers should avoid the perils of futurism and should instead be at the vanguard of designing inclusive policy that takes into account the core elements of policy detailed in this guide.

FIRST,

we make the point that debate over the future of work swings between a dizzying array of estimates and variables, rendering it impossible for policymakers to identify the key elements of future of work policy. After we make the case for why policymakers should be wary of future of work estimates for job loss or gain, we identify four key future of work "ingredients:" economic structure, labor market conditions and supports, social conditions and protections, skills and worker capacities.

SECOND,

in order to identify preparedness for the future of work among case studies – France, Germany, Spain, and the United States – we conducted a transatlantic comparison of future of work dynamics. This analysis points to wide variation in structural conditions and preparedness for the rapid introduction of technology and automation. Dramatic differences between the strengths and weaknesses of countries point to the need for policy that takes into account variables other than those related to tech-based job loss or gain caused by technology.

FINALLY,

we point to key takeaways gleaned from our work that should be taken into account by policymakers on both sides of the Atlantic. Going forward, both the Bertelsmann Foundation and ITIF envision using this playing field guide as a springboard for additional research and projects. For example, at the Bertelsmann Foundation, we have already launched our "Future of Work & Transatlantic Cities" project, which aims to capture how technology and automation are impacting local communities while seeking to source innovative future of work solutions at the local level. At ITIF, we are continuing work on how the emerging digital technology system can spur growth and what policy makers need to do to support it, including by helping workers make transitions.

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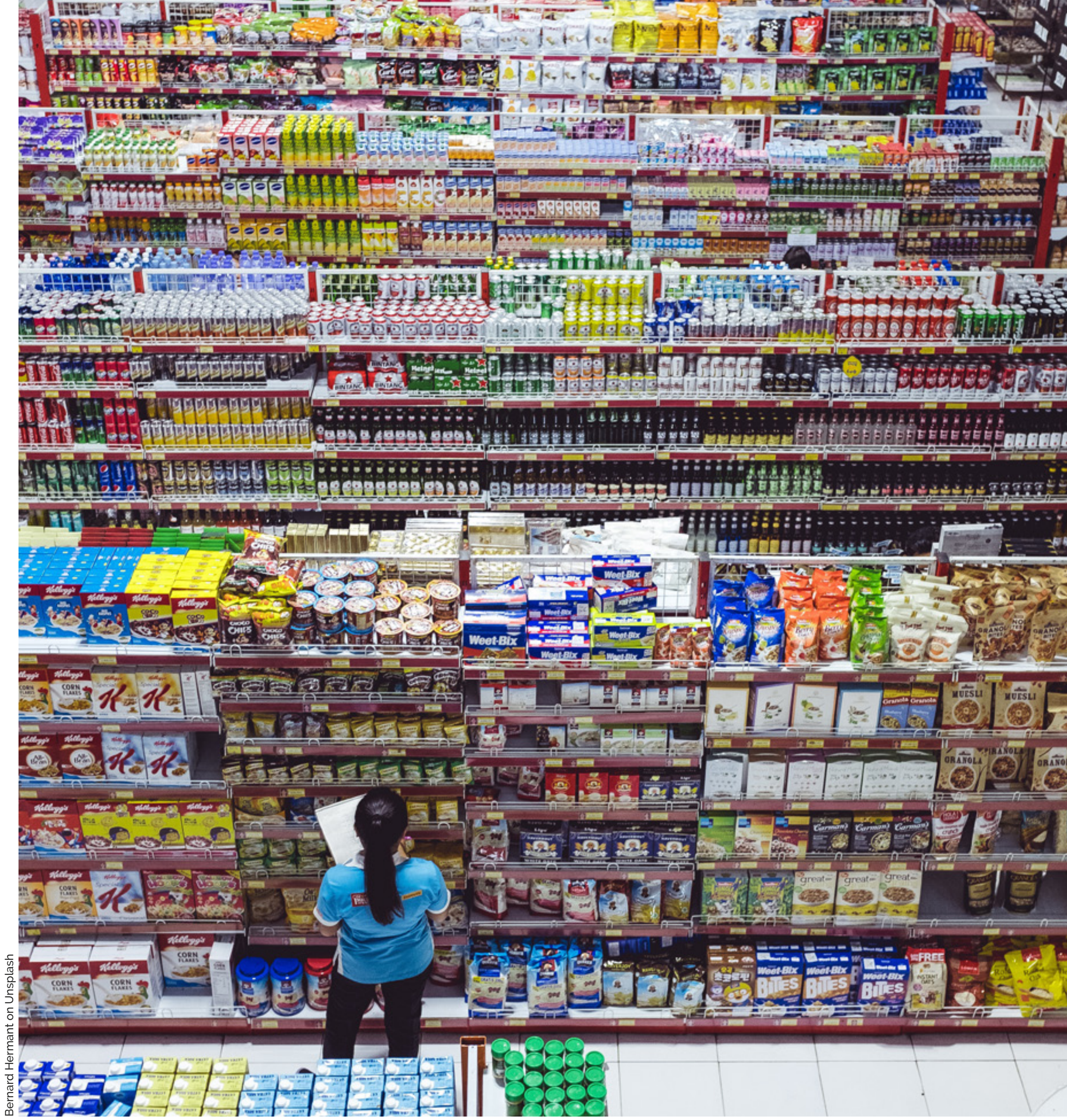

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APPENDIX

I. INDICATORS

Indicator	Weight
1. RISK OF TECH-BASED JOB LOSS	**4.25**
Risk of Automation	0.75
Share of Jobs With Change of Tasks from Technology	1.00
McKinsey Estimates of Share Needing to Switch Occupation	0.75
Share of Jobs At Risk from Automation	0.75
McKinsey Share of Jobs Lost by 2030	1.00
2. ECONOMIC STRUCTURE	**4.00**
Labor Productivity Growth	0.67
Labor Productivity, 2011 PPP	1.33
1995 to 2015 Ratio of Low Skill to High Skill Shift	0.80
Share of Jobs in Low Productivity Industries	1.20
3. SOCIAL CONDITIONS	**4.5**
GINI	1.00
Labor Force Participation Rate	0.75
Hours Worked Per Year	1.00
Employment to Population Ratio	0.75
Average Monthly Wage, PPP	1.00
4. LABOR MARKET CONDITIONS	**5.00**
Involuntary Unemployment	0.75
Unemployment Rate	0.75
Share of Unemployed More Than One Year	0.75
Unemployment Risk	0.75
Percent Part Time Workers	1.00
Percent Self-Employed	1.00
5. INCENTIVES & LIMITS ON LAYOFFS	**5.5**
Strictness of Individual and Collective Dismissal	0.75
Cost of Redundancy Dismissal	0.75
Real Minimum Wage	0.75
Radio Between Minimum and Median Wage	0.75
Unionization	1.00
Median Years for Worker Tenure	0.75
Workers employed by the Same Company	0.75
6. LABOR MARKET SUPPORTS	**4.00**
Public Expenditure on Active Labor Market Programs	1.00
Public Expenditure on total Labor Market Programs	0.50
Unemployment Insurance generosity	1.00
Educational Expenditure	0.75
Expenditure per Pupil	0.75
7. WORKER CAPACITIES	**2.5**
Program for International Student Assessment (PISA)	1.00
Average Years of Schooling	0.75
Students below Upper Secondary Education	0.75

II. INDEX METHODOLOGY

A country's overall risk of automation score consists of 35 indicators across seven categories. These composite scores measure automation risk relative to each of the four nations and *should not* be used as a standalone comparison against other countries. For each category, the raw data for each indicator was standardized then adjusted (by multiplying the standardized scored by -1) to reflect that a greater standardized score meant greater risk of automation. The standardized scores across each category were multiplied by their indicator weight and summed to produce a category score. All category scores (7 scores × 4 countries = 32 scores) were then arranged in ascending order, with the maximum score scaled to a value of 10 and the minimum core a value of zero.

To produce the overall score, each of the seven category scores were standardized, weighted (all categories were given a weight of one, except for "Risk of Tech-Based Job Loss," which was given a weight of two), then summed.

III. INDICATOR DESCRIPTIONS, METHODOLOGIES AND DATA SOURCES

1. RISK OF TECH-BASED JOB LOSS

Jobs at Risk of Automation (estimate one)

Description: Estimate of the current share of jobs at high and medium risk of automation
Methodology: A greater share corresponded to higher automation risk
Data Source: http://bit.ly/2LVK5n3

Jobs at Risk of Automation (estimate two)

Description: Estimate of the current share of jobs at high risk of automation
Methodology: A greater share corresponded to higher automation risk
Data Source: https://pwc.to/2tYGPwd

Tech-Induced Task Changes in Jobs

Description: Estimate of the occupations that will face technologically-induced changes to their current job tasks
Methodology: A greater share corresponded to higher automation risk
Data Source: http://bit.ly/2LVK5n3

Workers that Will Have to Switch Occupations

Description: Estimate of the share of current workers that will have to change to a different occupation
Methodology: A greater share corresponded to higher automation risk
Data Source: https://mck.co/2AMSQuM

Jobs Automated by 2030

Description: Estimate of the current share of jobs that will be eliminated through automation by 2030
Methodology: A greater share corresponded to higher automation risk
Data Source: https://mck.co/2Kxjasb

2. ECONOMIC STRUCTURE

Labor Productivity Growth (2011-2016)

Description: Annual growth in labor productivity from 2011 to 2016
Methodology: A greater growth rate corresponded to lower automation risk
Data Source: http://bit.ly/2vGltDV

Labor Productivity in 2016 (adjusted by Purchasing Power Parity)

Description: High productivity corresponded to lower automation risk
Data Source: http://bit.ly/2Ksj2KJ

Shift from Low-Skilled to High-Skilled Workers

Description: Change in the ratio between low-skilled and high-skilled jobs from 1995 to 2015
Methodology: A higher ratio corresponded to lower automation risk
Data Source: http://bit.ly/2M88c1o

Low Productivity Industries

Description: The share of jobs in low productivity industries
Methodology: A greater share corresponded to higher automation risk
Data Source: http://bit.ly/2KyYwYS

3. SOCIAL CONDITIONS

GINI Coefficient

Description: The GINI coefficient estimates the skew of income distribution in a country
Methodology: A higher coefficient corresponded to higher automation risk
Data Source: http://bit.ly/2M81gRI

Labor Force Participation Rate

Description: People available to work as a share of the total population
Methodology: A greater share corresponded with a lower risk of automation
Data Source: OECD (2017), Labor force participation rate (indicator). DOI: 10.1787/8a801325-en (Accessed on December 15, 2017)

Hours Worked per Year per Worker

Description: The number of hours worked per year for the average worker
Methodology: A greater number of hours corresponded with a lower risk of automation
Data source: http://bit.ly/2KvxpoU

Employment to Population Ratio

Description: Total employment as a share of total working-age population
Methodology: A greater share corresponded with a lower risk of automation
Data Source: http://bit.ly/2KvSxE8

Average Monthly Wage

Description: The monthly wage for the average worker adjusted by purchasing power parity
Methodology: A greater wage corresponded to a lower risk of automation
Data Source: http://bit.ly/2M5456i

4. LABOR MARKET CONDITIONS

Involuntary Underemployment Rate

Description: Percentage of workers employed in jobs that require less than their actual skill levels
Methodology: A greater share corresponded with a higher risk of automation
Data Source: http://bit.ly/2KwXw7n

Unemployment Rate

Description: Percentage of labor force unemployed
Methodology: A greater share corresponded with a higher risk of automation
Data Source: http://bit.ly/2MoZ5Q3

Unemployed Persons that Have Remained Unemployed

Description: Percentage of unemployed workers who have remained unemployed for greater than a year
Methodology: A greater share corresponded with a higher risk of automation
Data Source: http://bit.ly/2vCre5E

Risk of Unemployment

Description: Risk of becoming unemployed
Methodology: A greater share corresponded to a higher risk of automation
Data Source: http://bit.ly/2LYH31B

Part-Time Workers

Description: Part-time workers as a share of total employment
Methodology: A greater share corresponded with a higher risk of automation
Data Source: http://bit.ly/2vmJssH

Self-Employed Workers

Description: Self-employed workers as a share of total employment
Methodology: A greater share corresponded with a higher risk of automation
Data Source: http://bit.ly/2LXkQkr

5. INCENTIVES AND LIMITS ON LAYOFFS

Strictness of Individual and Collective Dismissal

Description: A composite score of regulation surrounding the dismissal of workers and temporary contracts
Methodology: A higher score corresponded to a lower risk of automation
Data Source: http://bit.ly/2OQIIEi

Cost of Redundancy Dismissal

Description: Rank on the Global Innovation Index on how many weeks wages it costs a company to lay off a redundant worker
Methodology: A higher rank corresponded to a lower risk of automation
Data Source: http://bit.ly/2vP4KP9

Real Minimum Wage

Description: Annualized minimum wage adjusted by purchasing power parity
Methodology: A higher wage corresponded to a higher risk of automation
Data Source: http://bit.ly/2OgrvCS

Ratio between Minimum and Median Wage

Description: The ratio between the minimum wage and the median wage
Methodology: A greater ratio corresponded to a higher risk of automation
Data Source: http://bit.ly/2OgrvCS

Unionization

Description: Unionized workers as a share of total employment
Methodology: A greater share corresponded to a lower risk of automation
Data Source: http://bit.ly/2M7EBVy

Median Years for Worker Tenure

Description: The median length of time spent working at the current place of employ across all workers
Methodology: A greater number of years corresponded to a lower risk of automation
Data Sources: http://bit.ly/2MpjSJQ; http://bit.ly/2KyMcb3

Workers Employed by the Same Company

Description: The share of total workers employed by the same employer for more than 10 years
Methodology: A greater share corresponded to a lower risk of automation
Data sources: http://bit.ly/2OLVXpu

6. LABOR MARKET SUPPORTS

Public Expenditure of Active Labor Market Programs

Description: Public expenditure on active labor market programs (e.g., training and employment incentives) as a share of gross domestic product
Methodology: A greater share corresponded to a lower risk of automation
Data Source: http://bit.ly/2vq6ajq

Public Expenditure on Total Labor Market Programs

Description: Public expenditure on all labor market programs (both active and passive programs) as a share of gross domestic product
Methodology: A greater share corresponded to a lower risk of automation
Data Sources: http://bit.ly/2vq6ajq

Unemployment Insurance Generosity

Description: A score that estimates effect of government transfers on workers' exposure to unemployment risk
Methodology: A higher score corresponded to a higher risk of automation
Data Source: http://bit.ly/2LX34hk

Educational Expenditure

Description: Public expenditure on education as a share of gross domestic product
Methodology: A greater share corresponded to a lower risk of automation
Data Source: http://bit.ly/2OMoYyk

Expenditure per Pupil

Description: Rank on the Global Innovation Index on the average amount of government support a student receives
Methodology: A higher rank corresponded to a lower risk of automation
Data Source: http://bit.ly/2vP4KP9

7. WORKER CAPACITIES

Program for International Student Assessment (PISA) Score

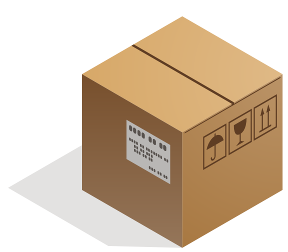
Description: Rank on the Global Innovation Index on the strength of the country's education system
Methodology: A higher rank corresponded to a higher risk of automation
Data Source: http://bit.ly/2vP4KP9

Average Years of Schooling

Description: The number of years spent in school for the average worker
Methodology: A greater number corresponded to a lower risk of automation
Data source: http://bit.ly/2OP1jRd

Students below Upper Secondary Education

Description: Students enrolled below upper secondary education as a share of all workers
Methodology: A greater share corresponded to a higher risk of automation
Data source: http://bit.ly/2M5ilXg



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