MERCER OLIVER WYMAN

THE TWIN THREATS OF AGING AND AUTOMATION

MARSH & McLENNAN COMPANIES | Global Risk Center

CONTENTS

EXECUTIVE SUMMARY

Workforces around the world have experienced a number of serious challenges in recent years – from rapid globalization, to significant business cycle troughs, to fights for gender equality. Two trends, however, are today unprecedented in their scope: widespread societal aging, and the automation of work by intelligent technologies.

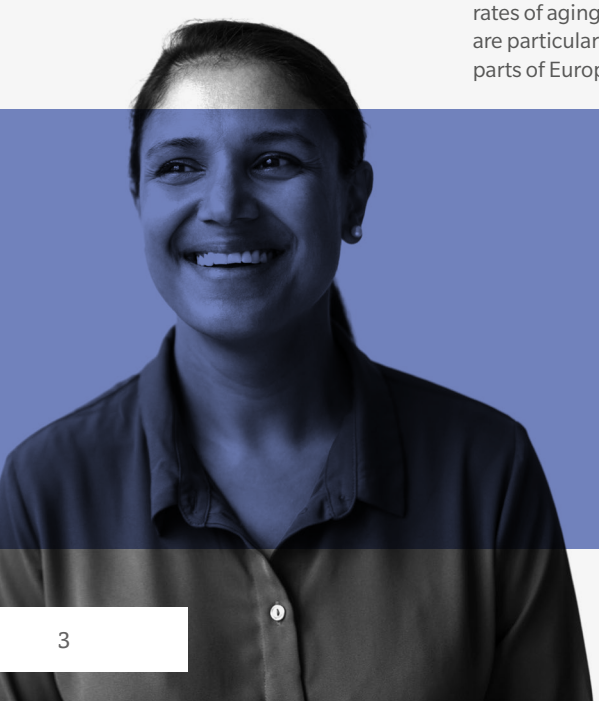
The confluence of these two trends raises one crucial question: What effect will increased workplace automation have on older worker populations? In an environment where the demand for particular kinds of labor is diminishing, older workers skilled in the work of yesterday might be at risk of being excluded from the economies of tomorrow.

This report finds that across several major economies, older workers are at mid-to-high risk of being displaced by automation. Using data on older workers from the United Nations (UN), and data on automation from Oxford researchers Carl Frey and Michael Osborne, this report puts forth estimates for the average risk of automation to older workers across a sample of 15 countries. Our results show that countries with higher rates of projected aging tend to also have larger proportions of older workers at risk of automation. China and Vietnam, for example, have the highest rates of aging and the highest risk scores in our 15-nation sample. Meanwhile, Canada and Australia have the lowest rates of aging and the lowest risk scores. The risks are particularly pronounced across Asia, as well as in parts of Europe such as Germany and Italy.

The report also explores potential explanatory factors behind the variation in automation risk to older workers. In investigating why some countries have more at-risk older workers than others, we have identified a variety of themes likely to be pertinent. In particular, education levels, the size of the manufacturing sector, the level of public spending, and the strength of legal rights around financial systems are found to be strong predictors of the automatability of older-persons' work in a nation.

This report also emphasizes that older workers tend to face unique difficulties in the labor market – such as high long-term unemployment and age discrimination – and so are prone to particularly harsh fallouts from displacement by new technologies. Concerted efforts on the part of governments and companies to devise strategies for encouraging and accommodating the older worker will be crucial in the coming decades.

As automation increasingly enables unprecedented levels of productivity, firms' capacity to invest in new revenue streams and new economies will expand. Investing in younger workers will become increasingly difficult as young populations shrink – but older workers in aging nations are increasingly willing and able to engage in meaningful work. Given the opportunities older workers present, this report aspires to start conversations around the risks older workers face in this age of automation and inspire discussions on overcoming them.



In an environment where the demand for particular kinds of labor is diminishing, older workers skilled in the work of yesterday might be at risk of being excluded from the economies of tomorrow.

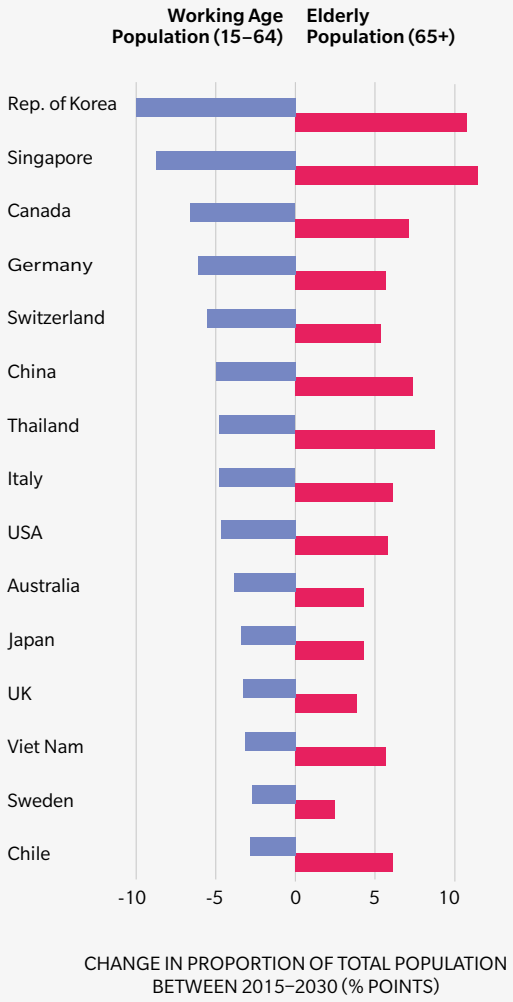
THE RISE OF THE OLDER WORKER

OLDER WORKERS ARE BECOMING A PROMINENT SOURCE OF LABOR

Increased life expectancies and decreasing birth rates across the world mean that working-age populations are shrinking in many major economies. For example, UN data shows that China's working-age population as a percent of the total population will shrink by 5 percent between 2015 and 2030, denoting a contraction in the size of the young labor force by the millions. Concurrently, the number of Chinese citizens aged 65 and above as a percent of the total population is projected to expand by over 7 percent into 2030 – a pattern that is taking hold around the world, both in developed and emerging markets. (See Exhibit 1.) Many economists have expressed concern over the combined effect of these demographic changes, positing that the erosion of younger workforces could result in slowed productivity and labor shortages. Marsh & McLennan Companies' Asia Pacific Risk Center (APRC) estimates, for example, that Singapore's fast-aging society could result in losses of $3.3 billion in GDP (1 percent of total) due to sickness absenteeism.[1]

But this demographic trend also implies a rapid increase in the number of older workers making up the potential global labor force. Many developed nations have already seen a steady increase in the median ages of their workforces, and this trend is largely expected to continue in the coming decade. UN World Population Prospects data projects that by 2050 more than a third of the entire world's population will be above the age of 50. In 1950, this age group made up just 15.7 percent of the world's population.[2] This presents an important workforce imperative for firms, as older workers[3] are rapidly rising in prominence in labor forces globally. (See Exhibit 2.)

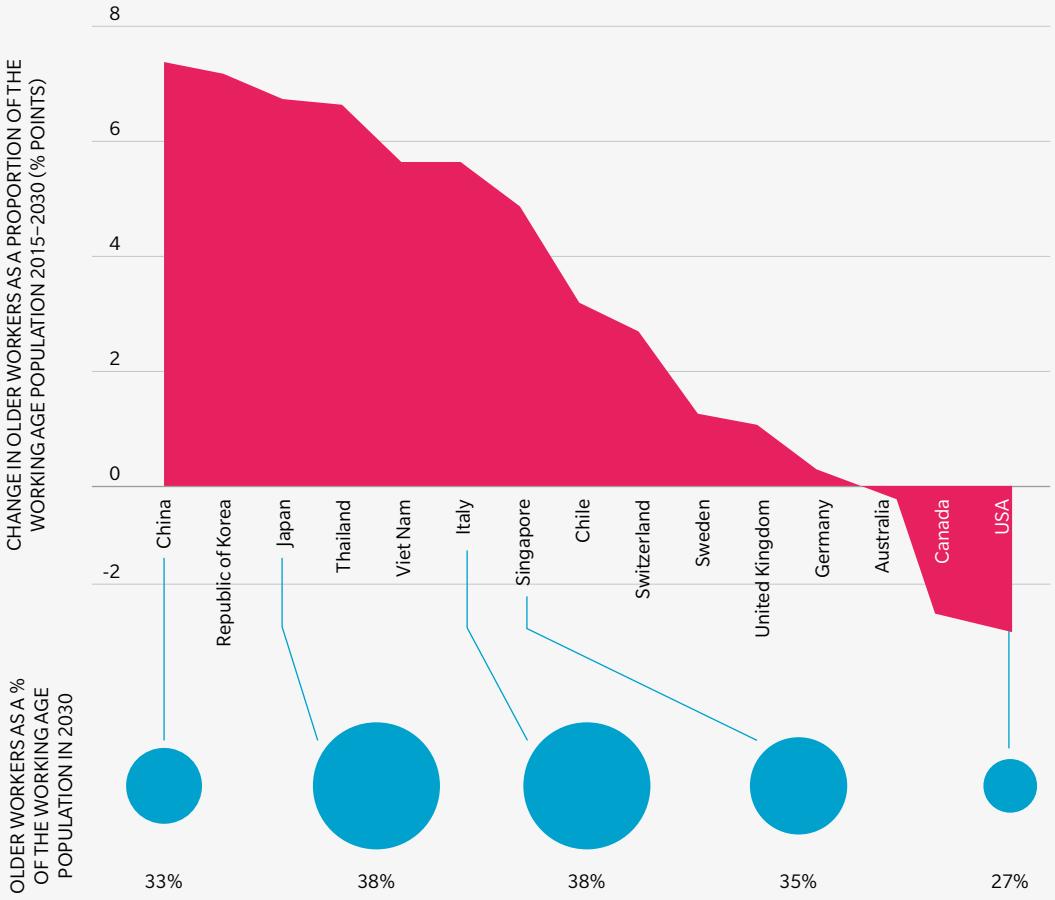
Exhibit 1: Changes in Age Compositions Across Major Populations Between 2015–2030



Source: APRC analysis of UN World Population Prospects dataset

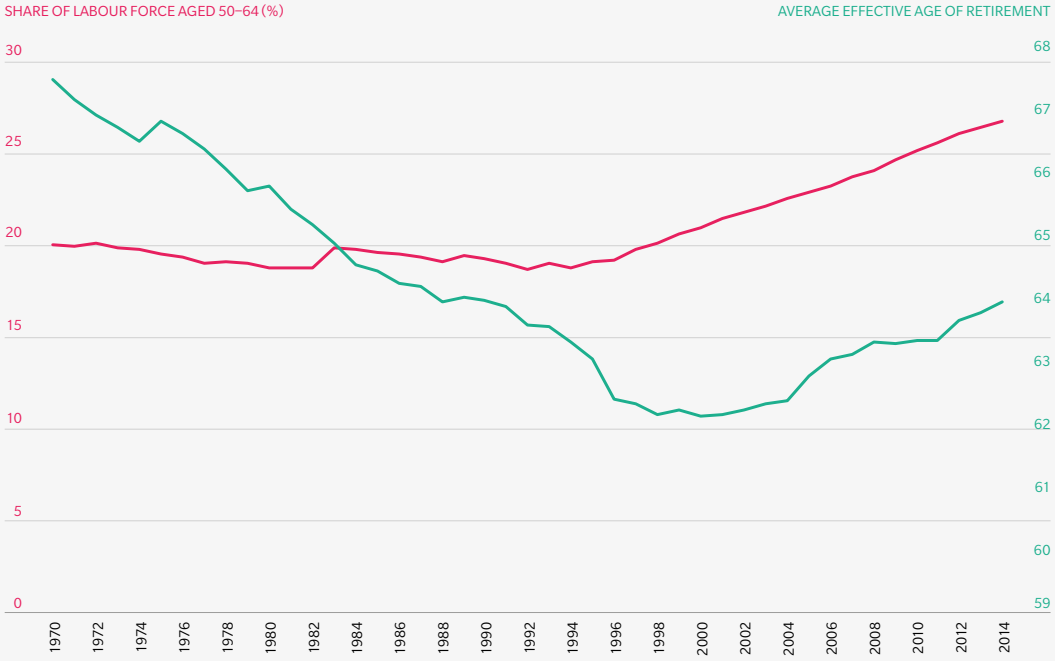
1. Asia Pacific Risk Center (2017). Aging Workforce
2. Data available for download online at the UN WPP webpage
3. We define older workers as those between the ages of fifty and sixty-four throughout this paper. Discrepancies in this age bucket in the data are noted in Appendix 3.

Exhibit 2: Changes in Older Worker Populations Between 2015–2030



Source: APRC analysis of UN World Population Prospects dataset

Exhibit 3: The Rise of the Older Worker in OECD Nations



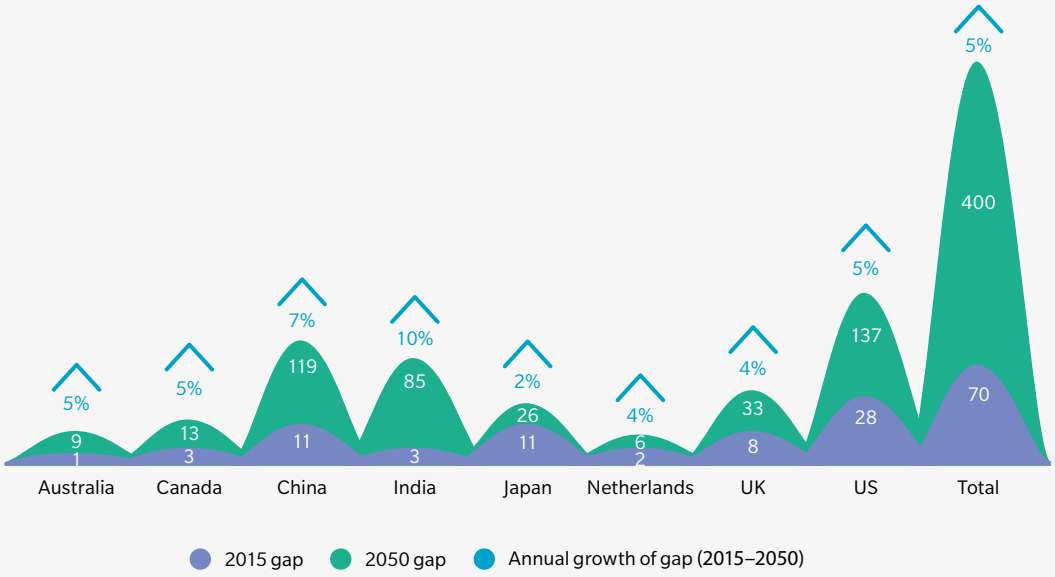
Source: APRC analysis of OECD datasets

The widespread re-initiation of older workers into the workplace has already begun in the developed world. Data compiled by the OECD shows that for the first time since the 1970s, older workers began to steadily increase as a share of the OECD labor force in the late 1990s. (See Exhibit 3.) Effective retirement ages similarly began to rise in the early 2000s for the first time in 30 years. Events of the past several decades have reversed previous older worker trends, and are encouraging the re-initiation of older workers into labor forces across the OECD. There are several notable socio-economic trends at play here that are making older workers more willing and able to work:

The financial motivation: Retirement-savings gaps (the difference between retirement costs-of-living and savings for retirement) are widening dramatically throughout the world, due to longer life expectancies and inadequate retirement savings programs. Mercer's analysis of this phenomenon shows that this gap stood at $70 trillion globally in 2015 and, based on a 5 percent average annual growth, is projected to reach $400 trillion by 2050.[4] (See Exhibit 4.) An upcoming report by the APRC notes that this gap could be particularly severe for women in Asia due to both the gender wage gap and the fact that, on average, women spend less time in the workforce. The average pension gap in Europe for women is around 40%.[5] These wide gaps are a powerful motivator behind older workers returning to or remaining in the workforce.

4. World Economic Forum (2017). We'll Live to 100 – How Can We Afford It?
5. European Parliament (2017). Gender Gap in Pensions: Looking ahead.

Exhibit 4: Size of the retirement savings gap ($ trillions, 2015)



Source: We'll Live to 100 – How Can We Afford It? WEF report, citing Mercer analysis

The non-financial, personal motivation: While financial reasons are the most common motivation, older workers also frequently cite numerous non-financial reasons for remaining in and returning to the workforce – such as the desire to stay healthy and active, and taking pride and finding self-fulfilment in their work.[6] In a widely acclaimed new book, The 100 Year Life[7], Professors Lynda Gratton and Andrew Scott cite survey results showing that almost 60 percent of workers aged 45-plus were investing in new skills for work, and the majority of them reported they were positive and excited about their jobs. Developments in healthcare and education levels over the past century have clearly increased older workers' propensity for extending their working lives.

As firms prepare themselves for uncertain times ahead, it is crucial they plan for demographic changes as well. As aging intensifies around the developed world, shrinking supplies of young labor will push firms to seek alternative sources of productivity. (See Box: Older Workers in the United Kingdom.) Older people are indeed becoming more willing and able to engage in meaningful work, and companies would do well to incorporate an older worker angle into their workforce of the future strategies.

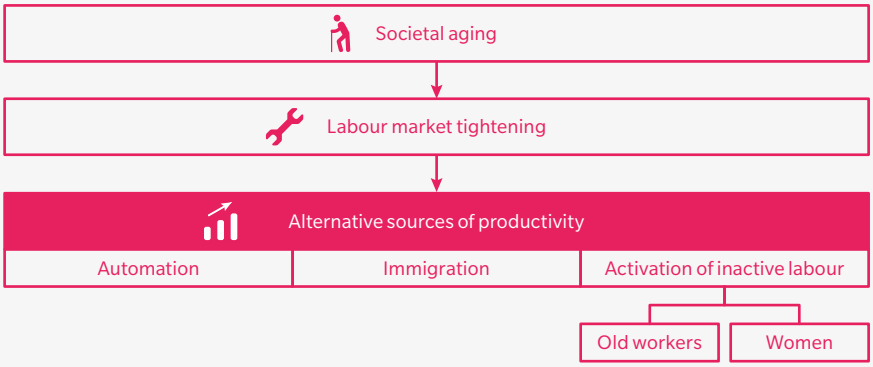
6. European Commission (2015). Employment of older workers; The Centre on Aging & Work at Boston College (2005). Older Workers: What Keeps Them Working?
7. Lynda Gratton and Andrew Scott (2016). The 100 Year Life

OLDER WORKERS IN THE UNITED KINGDOM

A recent Mercer report has noted how evolving political and demographic phenomena in the UK will push the British economy to rely significantly on older workers in the coming years. In this report, titled 'The Emerging UK Workforce Crisis,' Mercer highlights how the UK's dramatically aging population has been masked by a long history of inward migration. With Brexit negotiations underway and immigration from the EU potentially drying up, the UK will have to face the reality of its shrinking native-born workforce. Today, the only growing labor pool in the UK is the over-50 population.

The UK's labor force dynamics illustrate the intermingled trends that will affect much of our aging world. In years past, firms and governments addressed the UK's labor force shortages by importing labor from abroad, loosening the labor market. Today as the UK moves to limit immigration, it will need to turn to alternative sources of productivity to address its aging population issues. These will include women's participation in the labor force, automation, and older workers. The US will face a similar issue due to its own impending immigration controls. Indeed Japan, having already automated many of its jobs and being unable to increase immigration and female labor participation rates, now has one of the highest older worker participation rates in the OECD.

Exhibit 5: Societal aging pushes firms to seek alternative sources of productivity



Source: APRC analysis

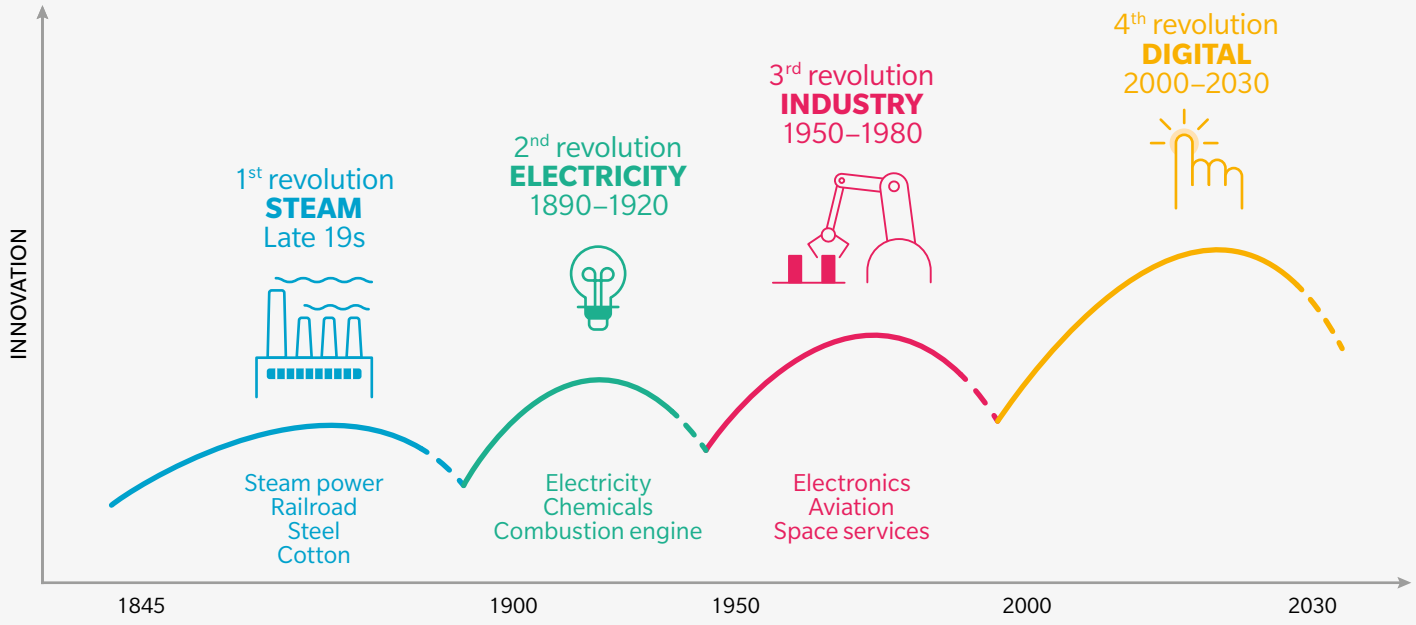
8. Mercer (2017). The Emerging UK Workforce Crisis; Mercer (2018). The New Imperatives for Financial Security, Global Report

THE RISE OF AUTOMATION

TECHNOLOGICAL DEVELOPMENTS ARE FUNDAMENTALLY CHANGING THE NATURE OF WORK

Along with the rise of the older worker, workforces are also reckoning with the rise of the digital worker. Unprecedented developments in computational power, the spread of connected data-gathering devices, and the rapid sophistication of self-learning algorithms have led to exponential growth in new technologies in recent years. (See Exhibit 6.) Such rapid developments are not only disrupting value chains and industries, but are revolutionizing the fundamental nature of work. Machine learning, artificial intelligence, and robotic process automation are just some of the myriad technologies emerging today. Many of these technologies are still in development, but will likely proliferate across global workplaces by 2030.

Exhibit 6: Acceleration into the 4th Industrial Revolution, powered by new technologies



Source: Oliver Wyman

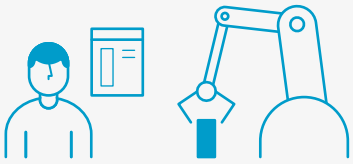
As the use of these technologies expands, their deployment in the workplace will severely impact repetitive, low-skill labor. Routine and manual work has been on the decline since the 1970s, and this decline will likely accelerate due to today's technological developments.[9] In a recent report on the Future of Jobs, the World Economic Forum estimated that between 2015 and 2020, 7.1 million jobs will be lost (largely in office and administrative functions, as well as in manufacturing and production), and just 2 million will be gained (spread out across several different functions, from financial operations to management to engineering)[10]. Factory workers, secretaries, and delivery staff are already seeing many of their tasks being taken over by computers and robots.

Mercer predicts three fundamental shifts in the workplace as a result of these developments: the concept of "work" becoming structured more around tasks rather than jobs; a rise in the importance of technology-related and cross-functional skills; and an increase in the cognitive complexity of human work. (See Exhibit 7.) Human work will need to evolve rapidly to keep pace – in fact, the WEF's Future of Jobs report warns that only 35 percent of today's skills will be applicable in 2020. The development of advanced technologies and the resulting skills gaps could indeed pose serious risks of displacement to workers with low or basic skills.

Exhibit 7: Mercer Technology Industry Analysis 2018

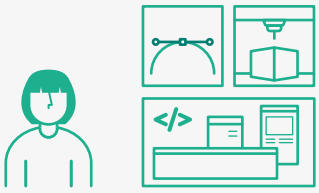
THREE SHIFTS ARE UNDERWAY

1. UNBUNDLING OF WORK FROM JOBS



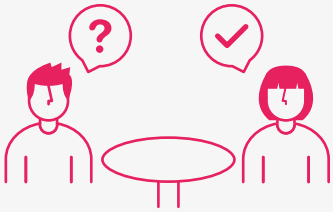
Jobs are no longer the organizing unit for work; rather, there is a redistribution of tasks between humans and machines, depending on who is best suited to do the job

2. NEW WORK, NEW SKILLS



With the rise of new technologies, we will see the emergence of new roles associated with the design, development and maintenance of new technologies

3. HIGHER COGNITIVE COMPLEXITY OF HUMAN WORK



The human workforce of the future will execute tasks requiring higher cognitive and emotive complexity, and activities requiring the application of general intelligence

Source: Mercer

9. Citibank (2016). Technology at Work v2.0
10. World Economic Forum (2016). The Future of Jobs.

THE SUSCEPTIBILITY OF OLDER WORKERS TO AUTOMATION

COUNTRIES THAT AGE TEND TO BE COUNTRIES THAT AUTOMATE

Significant research and analysis has been conducted on the implications of societal aging, but one result stands out: the association between higher rates of aging and higher rates of automation. Several studies have shown that the increase in the adoption of robots is greater in countries where aging has occurred more rapidly. These studies support the notion that shrinking prime-age working populations push firms to source for alternative injections of productivity beyond local labor, such as automation. (Refer back to Box: Older Workers in the United Kingdom.) South Korea, for example, boasted the highest level of robot density in the world toward the end of 2017,[11] and is concurrently projected to be the world's most rapidly aging country between now and 2050.[12]

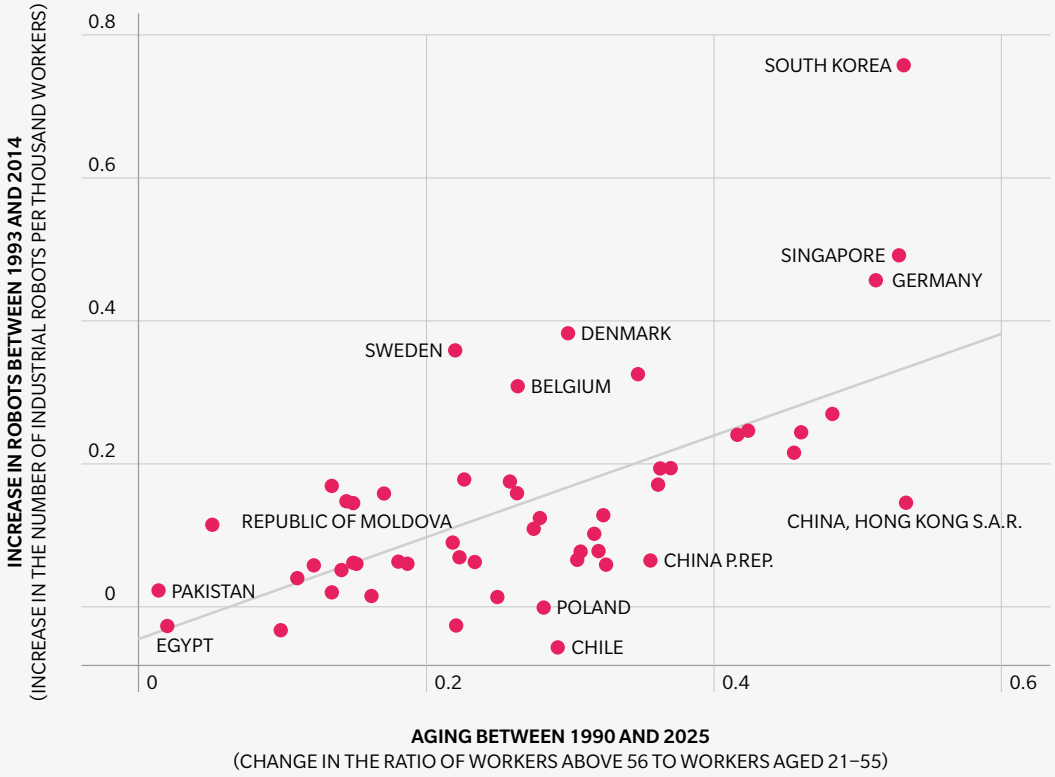
Acemoglu and Restrepo at the Massachusetts Institute of Technology (MIT) discovered the relationship between aging and automation while researching the "secular stagnation" hypothesis: the proposition that many developed nations will inevitably reach a "new normal" of low and declining economic growth due in part to increased rates of aging.[13] Acemoglu and Restrepo's research, however, showed that this hypothesis did not hold – aging nations did not experience any significant decline in GDP per capita as they aged. In fact, they found a slightly positive relationship between aging and GDP growth.

The researchers found that cross-country differences in automation could be explained, at least in part, by demographic trends. Using data on robot adoption from the International Federation of Robotics and data on aging from the United Nations, Acemoglu and Restrepo have shown that 40 percent of cross-country variation in the adoption of industrial robots can be explained by aging alone. Their results also show that productivity is likely to increase in industries amenable to automation as aging speeds up, while labor's share of income in these industries will likely decline.[14]

11. International Federation of Robotics (2017). IFR World Robotics Report 2017
12. UN World Population Prospects, change in percentage of total population aged 65+ between 2015–2050
13. Acemoglu and Restrepo (2018). Demographics and Automation; Acemoglu and Restrepo (2017). Secular Stagnation? The Effect of Aging on Economic Growth in the Age of Automation [Working Paper]
14. These relationships were found to hold true even after controlling for GDP

An appreciation of these relationships is crucial to understanding older workers' place in the labor markets of the future. Although automation has the potential to boost productivity, it also has the potential to diminish returns to labor and displace workers lacking specific skills. The confluence of the twin threats of aging and automation therefore raises a crucial question: **What effect will increased workplace automation have on older worker populations?**

Exhibit 8: Acemoglu and Restrepo's Association Between Aging and Automation



Source: Acemoglu and Restrepo, 2018

A BROADER LOOK: THE RISKS OF AGING AND AUTOMATION

Given the relationship between aging and automation, it is worth considering the potentially positive effects of their confluence. Shrinking populations could spell rising wages as labor shortages become exacerbated, for example. Also, given that automation tends to increase as aging increases, technology could act as a welcome replacement for the jobs left behind by retirees – and therefore not displace older workers at all. Additionally, increased rates of automation should raise overall economic productivity and spur the creation of new jobs. Much like the industrial revolutions of the 18th and 19th centuries, which created manufacturing jobs in an age of agricultural production, today's fourth industrial revolution may create new kinds of jobs as well.

However, for three key reasons the advent of automated work is unlikely to widen opportunities and increase returns to older worker labor, in spite of the arguments just discussed:

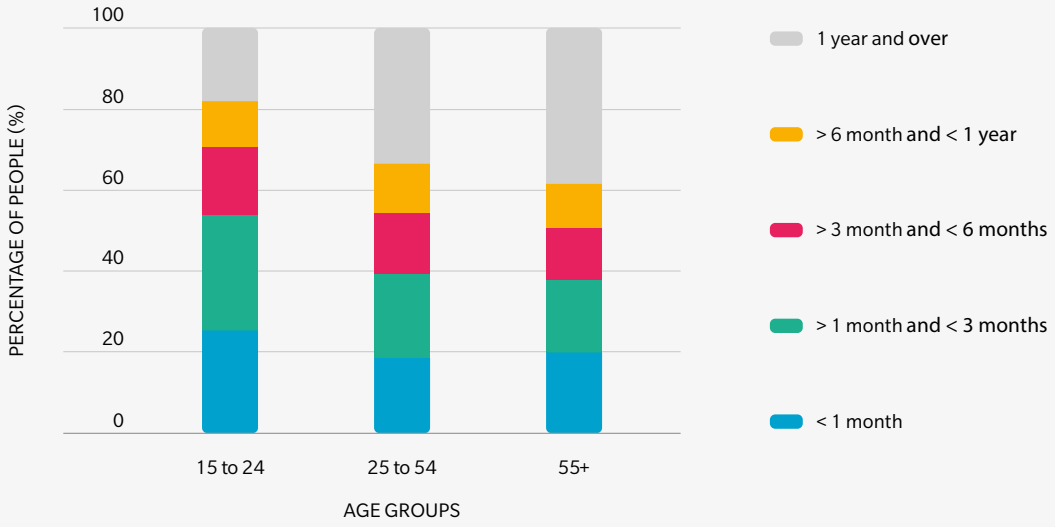
The divergence of productivity and wages. Many economists have noted that although advanced economies have experienced increases in productivity over the last several decades, these gains have not been equally shared with workers. In a recent IMF study, wages were shown to have not kept pace with the gains in productivity since the 1980s. Instead, greater amounts of income are being earned by capital rather than labor – meaning investors have secured the most gains.[15] Though this is a result of a series of factors, including globalization and the decline in the power of labor unions in some nations, the IMF notes that automation is a primary driver of this trend. As the fourth industrial revolution continues to take hold, automation is likely to further fuel the reallocation of returns from labor to capital across age groups unless interventionist action is taken.

Skills gaps amongst older workers. Unlike in industrial transitions of old where productivity rose while skill requirements remained similar between different kinds of low-skilled work (that is, skill discrepancies between older farm work and newer factory work were generally minimal), today's transition will require low and basic-skilled workers to face a far steeper learning curve in order to remain productive. Modelling workforce changes in the US between 2017 and 2027, CISCO estimates that the US will suffer a skills shortfall of basic programming skills by 59 percent of those required.[16] This learning curve will be particularly challenging for older workers, many of whom lack ICT skills (such as the ability to use, solve problems with and collaborate using a computer or tablet or a new software). According to a widely cited survey by the OECD, only 10 percent of adults aged 55–65 are able to complete new multiple-step technological tasks, compared with 42 percent of adults aged 25–54, for example.[17] There is therefore an additional societal cost at play here that will need to be shared by firms and governments: that of education and retraining.

15. International Monetary Fund (2017). World Economic Outlook, Chapter 3
16. Cisco and Oxford Economics (2017). The AI Paradox
17. OECD (2016). Skills for a Digital World. It is crucial to note that while several studies point to a lack of ICT skills amongst older workers, this lack is usually due in large part to cohort effects rather than cognitive ones. This indicates that these skills can indeed be acquired by older workers through education and training.
18. OECD (2013). Back to Work: Re-employment, Earnings and Skill Use after Job Displacement

Older workers face unique difficulties in the labor market. Despite often experiencing lower unemployment rates than their younger counterparts, older workers face a litany of obstacles to finding stable and meaningful work. Indeed they tend to face higher long-term unemployment than younger workers, and also often make up a lower proportion of all new hires in a given year according to OECD research and data.[18] (See Exhibit 9.) That is, when older workers lose their jobs, they find it more difficult than their younger counterparts to find new opportunities. An older worker made redundant due to automation is likely to find it more difficult to find appropriate new job opportunities – and be especially affected by automation displacement. OECD data also shows that older workers have trouble finding (or doing) stable work, and tend do part-time and irregular work as they get older. Misguided perceptions around older workers and age discrimination also play a powerful role in shaping these unfortunate labor dynamics.

Exhibit 9: Duration of Unemployment by Age (OECD Nations)



Source: APRC analysis of OECD Data

THE AVERAGE RISK OF AUTOMATION TO OLDER WORKERS

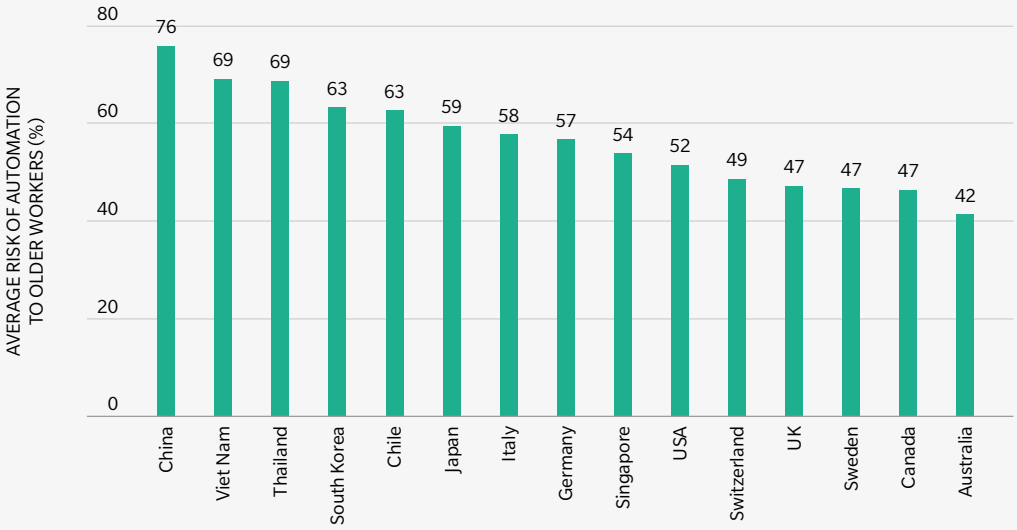
As noted, worker displacement at the hands of automation is likely to occur across occupations and age groups. However, the sub-category of workers that is likely to suffer the most is the low-skilled wage earner. Studies show that low-skill workers are likely to face the highest rates of displacement at the hands of new technologies – particularly those engaged in largely manual, repetitive, and non-dexterity-intensive tasks. Because of the steep evolution of the skills that will be required in future workplaces, workers with a low or basic skill base will also find it the most difficult to find new work after being displaced. Older low-skill workers will therefore face some of the harshest fallouts from workplace automation due to the age-associated difficulties they face in the labor market.

To examine the risk automation poses to older workers around the world, we measured the extent to which older workers are employed in low-skill work across a sample of countries. Using data from the UN, we calculated the number of older workers employed in each of the UN's nine categories of employment.

By mapping these nine categories to "probability of computerisation" values from Oxford researchers Martin Frey & Carl Osborne, we generated weighted-average scores for the automation risk to older workers for each nation (referred to henceforth as the Average Risk of Automation to Older Workers score).

The nature of this methodology means that in nations where older workers are largely employed in widely automatable occupations (such as repetitive office administrative work or manual machine operation work), the Average Risk of Automation to Older Workers score will be relatively high. In nations where older workers tend to do higher-skilled, less automatable work (such as managerial or professional work), the Average Risk of Automation to Older Workers score will be relatively low. The Average Risk of Automation to Older Workers score therefore tells us, on average, the percentage of tasks done by older workers that can be automated based on occupational composition data. (See Callout Box, "Measuring Automatability," and Appendix C for more information.)

Exhibit 10: Average Risk of Automation to Older Workers



Source: APRC Calculations, UN Data, Frey and Osborne (2017), National databases

THE AVERAGE RISK OF AUTOMATION TO OLDER WORKERS

A COUNTRY ANALYSIS

Our results show that across 15 major economies, the Average Risk of Automation to Older Workers generally sits in the mid- to high ranges of risk (scores of 30 percent and above). This indicates that older workers in these nations are doing work where 30 percent or more of all tasks are automatable on average. In fact, most of our selected nations have older-worker populations doing jobs where 50 percent or more of their tasks can be automated, indicating the acute vulnerability of older workers to automation. Older American workers, for example, are doing jobs that are on average more than 50 percent automatable. Separately, we found that the average risk of automation to older workers across all 35 OECD countries was 40 percent and above.

MEASURING AUTOMATABILITY

In 2017, researchers Carl Frey and Michael Osborne of the Oxford Martin school published a seminal study entitled, "The Future of Employment," measuring the "probability of computerization" for more than 700 jobs in the United States. Using a machine-learning algorithm, the researchers calculated a score between zero and one for each of these jobs – one indicating that all the tasks done in that occupation could be automated, and zero indicating that not a single task in that occupation could be automated.

In our report, Frey & Osborne's automation probabilities were mapped to age-based employment data from the United Nations and local databases to produce country-specific results describing the average risk of automation to older workers.

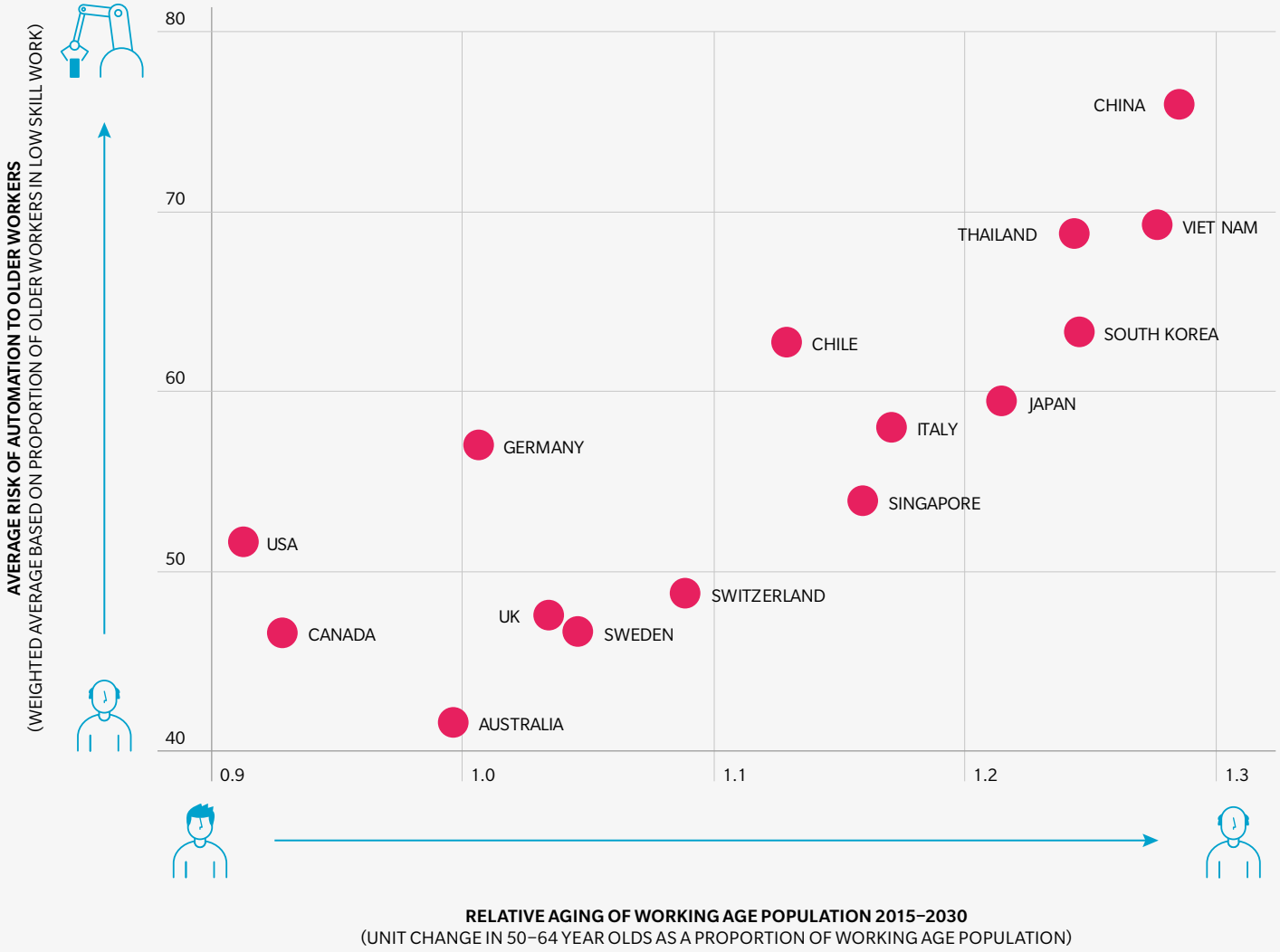
Our results reflect primarily older worker employment composition; however, it is important to note that Frey & Osborne's study has received some criticism for its methodology. Since the Frey & Osborne results were first released in 2013, other notable studies have offered divergent figures. Frey & Osborne's results have been said to overstate the risk of automation to workers by conducting their analysis at the occupation level rather than the task level, therefore losing some resolution.

We have used Frey & Osborne's results in this study because they allow us to map their automation probabilities to employment data from around the world, and because their methodology still serves as the conceptual basis for many of these competing studies. Frey & Osborne are also due to update their study on automation. Once these revised results are released, this study may be republished taking into account this new data.

19. Frey and Osborne define scores of 30 percent to 70 percent as "mid-risk" and 70 percent and above as "high-risk".

To analyze our results more closely, we charted them against the rate of aging in our sample nations, and the discrepancy between the average risk of automation to old and young workers. While older workers may be facing serious risks of automation in these nations, if older worker populations aren't projected to rise, then the overall risk of automation displacement to a nation may not be a serious overall concern. Similarly, if younger workers actually face higher levels of risk (that is, if young workers are employed in lower-skilled occupations on average compared to older workers), then concerns around older worker job displacement may be less severe.

Exhibit 11: Risks of Aging and Automation



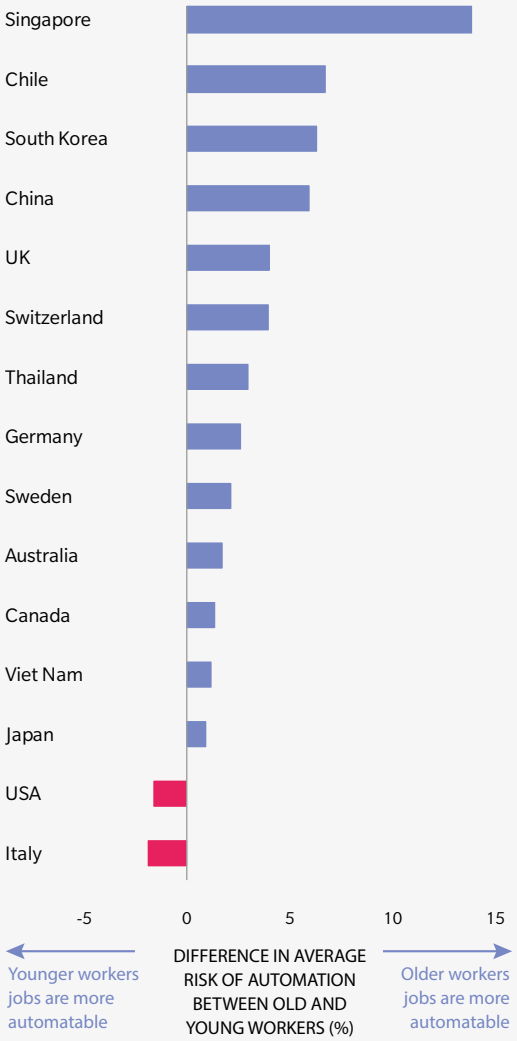
Source: APRC Calculations, UN Data, Frey and Osborne (2017), National databases

In charting the average risk of automation to older workers against the rate of growth in older worker populations, an important pattern emerges: Countries with more low-skilled older workers in automatable occupations tend to be ones where older workers are projected to grow the most rapidly. In China, older workers on average are doing work that is 76 percent automatable, and older workers are projected to increase rapidly as a proportion of the working age population. Between 2015 and 2030, the number of Chinese workers aged 50–64 will increase by more than 1.28 times. In Europe, Italy's older workers on average do work that is 58 percent automatable and this population are set to increase 1.17 times. Clearly, the confluence of these trends will therefore be all the more pronounced as both concurrently gain steam across the globe.

These country results are best evaluated by clusters, classified by region and risk exposure:

High-Risk Emerging Asia Pacific: China, Vietnam, and Thailand have extremely high rates of projected older worker growth, and concurrently have large swathes of older workers employed in highly automatable work. As manufacturing hubs, these nations are at a high risk of worker displacement at the hands of advancing technology; indeed, the average risk of automation scores were high across all age groups – but for older workers particularly so. With global manufacturers re-shoring and automating their operations, and with domestic industries in these countries shifting from manufacturing to higher-value goods and services, older workers in these countries are likely to face serious fallouts. In China and Thailand in particular, more than 30 percent of the working age population will be between 50-64 years of age by 2030,[20] meaning that these economies are likely to face serious repercussions from the displacement of older workers.

Exhibit 12: Difference in Average Risk of Automation Between Old and Young Workers



Source: APRC Calculations, UN Data, Frey and Osborne (2017), National databases

20. See chart on page 6

High-Risk Developed Asia Pacific: Singapore, Japan, and South Korea, despite being developed economies, also have older worker populations that are at high risk of automation and are concurrently experiencing rapid aging. Notably, South Korea and Singapore were found to have older workers that face far higher risks of displacement than younger workers – more so than in many other nations sampled. (See Exhibit 12.) Indeed, in both countries older workers are disproportionately found doing low-skilled work, such as cleaning and food serving. These trends are particularly pronounced in South Korea, which is projected to be the most rapidly aging country in the world between 2015 and 2050, and which also had the highest rate of robot adoption in the OECD between 1990 and 2015.[21] Australia is a notable exception in the region with a much lower risk score to older workers, and a shrinking older worker population.

High-Risk Europe: Of the countries sampled in Europe, the nations that face the highest risks are Italy and Germany. Italy is both rapidly aging and has large older worker populations doing automatable work overall. Younger workers are actually at higher levels of risk compared with older workers – however, this simply indicates that the country is at high levels of risk across key age groups. (See Exhibit 12.) Additionally, Italy is projected to have a working age population that is 38 percent made up of workers aged 50–64 by 2030 – meaning that the risks of displacement to older workers, even if low in comparison with younger workers, will have far-reaching effects. In Germany, older workers have one of the highest Average Risk of Automation scores in Europe at 57 percent. Manufacturing and low-skill services industries in Germany are already facing widespread disruption at the hands of technology, and these industries are common employers for older people as well. Although these older worker populations aren't projected to rapidly grow, they will still make up more than a third of the working age population by 2030. The displacement of older workers in Germany and Italy due to advanced technologies therefore poses a potent risk. [22]

At-Risk Europe: With older workers doing work that is more than 45 percent automatable, and with older worker populations projected to increase going into 2030, the UK, Sweden, and Switzerland will soon also find themselves facing these twin trends head on. Older workers are commonly found in low-skill work in these nations, in comparison with younger workers – considerably more so than in other developed nations such as Australia or Canada. The onset of aging and automation trends are likely to be particularly pronounced in the UK, where controls on immigration following Brexit will speed up the aging of the working population.

At-Risk Americas: Older workers are on average employed in work that is also more than 45 percent automatable in the nations sampled from the Americas. Like many Asian nations, Chile's older worker jobs are at particularly high rates of risk of automation – at 63 percent – and the nation is projected to age rapidly going into 2030. By contrast, the USA's and Canada's older worker population is projected to shrink as a proportion of the working age population going into 2030, and these nations have comparatively much lower risks of automation to older workers. However, these trends may be significantly impacted by changes in immigration policies. As politicians in the United States move toward restricting foreign labor, the aging of the American workforce could increase and the skill composition of workers may shift as a result.

21. Acemoglu and Restrepo, UN WPP
22. It is worth noting here that not all manufacturing work should be seen as equal. The level of sophistication of manufacturing in some nations such as Germany and Japan is certainly more advanced than that of other less-developed nations such as China or Vietnam. This has been captured in our analysis to some extent, which differentiates between 'Plant and machine operators' and the more skilled 'Technicians and associate professionals'. Within these occupational groups might lie even more sophisticated occupations whose level of automatibility and employment amongst older workers we have not been able to capture. Therefore, our estimates may slightly overstate the risk of automation to older workers in some developed countries.

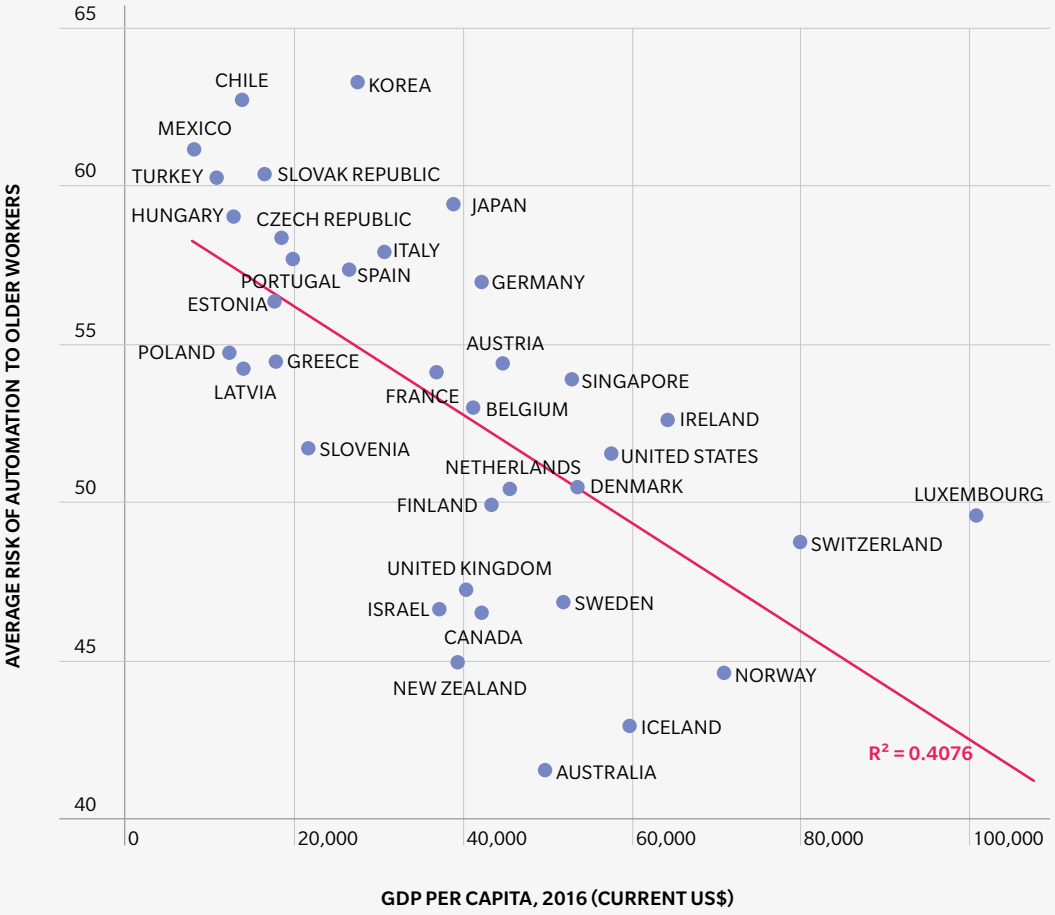
THE AVERAGE RISK OF AUTOMATION TO OLDER WORKERS

KEY DRIVERS

Generally, less developed countries tend to have higher Average Risk of Automation to Older Worker scores compared with developed nations. We see this rather glaringly in our chart, where the top-right quadrant is clustered with low-income Asian nations such as China and Vietnam, while richer nations like the US and Australia occupy the bottom left hand quadrant. Low-income countries are naturally likely to be concentrated in low-skill work overall, and therefore have many low-skill older workers as well.

However, when analyzing just OECD countries and Singapore, we find this relationship breaks down. For example: despite Japan being wealthier than Spain and Italy, its older worker jobs are more susceptible to automation. Similarly, while the USA is wealthier than New Zealand and Canada, its older workers are more at risk. Despite its status as the richest country in the OECD, Luxembourg has a surprisingly high Average Risk to Older Workers score. This raises an interesting question: What might explain the variation in the risk of automation to older workers in developed countries other than GDP per capita? **Put differently – why are older workers in some countries more vulnerable to automation than others, when controlling for GDP per capita?**

Exhibit 13: Relationship Between GDP Per Capita and the Average Automation Risk to Older Workers



Source: APRC analysis

Looking at the 35 countries that make up the OECD plus Singapore,[23] we searched for correlations between our risk scores for older workers and 35 different potentially explanatory variables.[24] (See Appendix for full list of tested variables.) Our Average Risk of Automation to Older Workers scores were adjusted by GDP per Capita and regressed across these 35 variables to search for meaningful relationships. (See Appendix for more on the adjustment method.) This single variable analysis identified the following seven variables to have significant correlations[25] with our Average Risk of Automation to Older Worker scores. (See Table 1.)

Table 1: Explanatory Indicators Relating to the Risk of Automation to Older Workers in OECD Nations (ordered by strength of relationship)

Indicator	**R Squared** (percent of Average Risk of Automation to Older Workers score explained by indicator)	**Relationship**
Adjusted savings: education expenditure (percent of GNI)	24%	**negative**
Manufacturing, value added (percent of GDP)	23%	**positive**
General government final consumption expenditure (percent of GDP)	21%	**negative**
Percent of 55–64yos with tertiary education	18%	**negative**
Percent change in GDP per capita, 1985–2016[26] constant prices, 2010 US$	16%	**positive**
Average pension replacement rate for low-income men and women, gross (percent)	12%	**negative**
Strength of legal rights index (0=weak to 12=strong)	11%	**negative**

23. The choice to evaluate exclusively OECD countries was made for two main reasons: data availability, and to reduce the variation in GDP per capita between nations
24. Most recent data was used where available (data was largely from 2015)
25. R2 > 10 percent at the p<0.05 level
26. Latest GDP levels were used where 1985 data was unavailable: Estonia (1999), Hungary (1991), Poland (1990), Slovak Republic (1990)

These findings tell us that even when two countries have the same GDP per capita, there exists a variety of other factors that could explain variations in older worker occupations. These factors can be grouped into four key themes[27]:

Education: A nation with higher **education expenditure as a percentage of gross national income** may face lower risks of automation amongst older workers. Similarly, a nation with **more highly educated older people** is, unsurprisingly, likely to have lower level of automation risk. Education and re-education are evidently important tools in ensuring older workers stay job-relevant and skilled. Countries with high levels of spending in education by firms, households, and governments are likely to enhance their older workers' skills and reduce their risk of automation. Firms in particular will benefit from re-investing the productivity gains made from automation into ensuring an upskilled workforce.

Industrial Structures: The structure of an economy is also a relevant indicator, even when we strip away absolute GDP per capita. In countries with **large manufacturing sectors**, older workers tend to be in low-skill work, as these countries are likely to be engaged in relatively basic work overall. Also, nations where **GDP per capita has grown faster** over the last three decades tend to be countries with more at-risk older workers in low-skill work. These results tell us that as economies grow, it is easy for older workers to find their skills becoming obsolete. Manufacturing-heavy economies in particular will need to be mindful of these dynamics as new technologies force labor forces to evolve.

Public Spending and Welfare: Another relevant factor from these results seems to be government welfare. In countries with more **government consumption spending** and higher **pension replacement rates**, older workers tend to be doing higher-skilled work. While this may have been because richer countries tend to have better public spending systems on welfare and pensions, this relationship holds even after removing the effect of GDP per capita. This shows that public sector spending and pensions clearly have a part to play in the skill composition of older workers.

This is because countries with strong systems of social protection are more likely to encourage older workers doing low-paid, elementary jobs to exit the workforce promptly. This will leave behind high-skilled workers, who continue to work because their employment income exceeds what they would receive from the state if they retired. Therefore, countries with more generous public spending and safety nets are likely to retain older workers mostly doing less-automatable jobs. Conversely, labor forces in countries with weaker social protection systems will retain their older low-skilled and low-paid workers, thereby resulting in a high-risk of automation score for older workers overall in those countries.

Legal Rights in Financial Systems: In countries with better **legal protections for borrowers and lenders**, older workers are less likely to be at risk of automation and more likely to be in higher-skilled work on average. This could be because older workers are more likely to be able to start their own businesses. Research from the Kauffman Index of Startup Activity shows that in 2015, the rate of new entrepreneurs in the 55–64 age group in the US was over 0.35,[28] and for most of the years in the period 1996–2015, this age group had the highest rate of new entrepreneurs out of all age groups. In countries with better access to new company financing, older workers are more likely to start small businesses in their old age, and therefore maintain "manager" or "professional" status as an older worker in a high-skill, less automatable profession.

27. Note that these four themes reflect thematic groupings seven variables presented on the previous page.
28. That is, 350 out of every 100,000 people in that age group became new entrepreneurs that year

These results show us that risk levels among older workers vary particularly strongly based on how education levels, manufacturing industries, pension systems, and financial systems might be structured. As many developed economies de-industrialize and shift productivity from goods to services sectors, the size of the manufacturing sector in many OECD countries is likely to decline in the coming decade and the number of older workers in automatable jobs could fall as well. However, it is crucial that private and public sector systems facilitate the transition of older workers into either retirement or renewed work. Targeted government spending measures can facilitate this by supporting older worker pensions, as well as by investing in health, retraining, and education. The strength of legal rights in financial systems can also aid in supporting older worker retirement and transitions to renewed self-employment and small business creation.

These variables are likely to be related and could still influence each other, however. The underlying economic and policy forces behind variables such as manufacturing levels and the rate of GDP growth, as well as government expenditure and pension replacement rates, are likely to be similar. These variables also only explain a small extent of the variation in risks to older workers when considered alone. A multivariate regression analysis eliminates confounding variables and produces a combined model with three particularly significant variables: the percentage of an economy engaged in manufacturing, the strength of legal rights around financial systems, and the total amount of government consumption expenditure as a percentage of GDP. ($Y = 0.58 + 0.24Manuf - 0.44GovExp - 0.08Leg$; $R2 = 49.4$ percent. See Appendix 6 for more information.)[29] This tells us that countries with particularly large manufacturing sectors, low government consumption expenditure and weak legal rights in financial systems are likely to have older workers at higher risk of automation.

There may have been additional variables relevant to this analysis that were not considered here, as well as alternative methodologies of analysis. Our variable analysis here was not exhaustive, and there may be additional confounding factors here that aren't reflected. However, it can be said with some certainty that as societies age in the coming decade, older workers in low-skilled occupations stand to suffer some significant displacement at the hands of technology. In countries with growing populations of older workers that tend to be in unskilled work, these risks could result in destabilizing levels of displacement. The industrial structure of a nation, the level of government spending, and the legal rights around financing can serve as significant predictors for the risk levels amongst older workers – and may also serve as useful levers for policymakers and firms as they prepare for the changes ahead.

29. This model was constructed by taking our seven variables from Table 1, removing variables with multicollinearity and finding the combination of variables that produced the strongest model

RETAINING AND REDEPLOYING THE OLDER WORKER

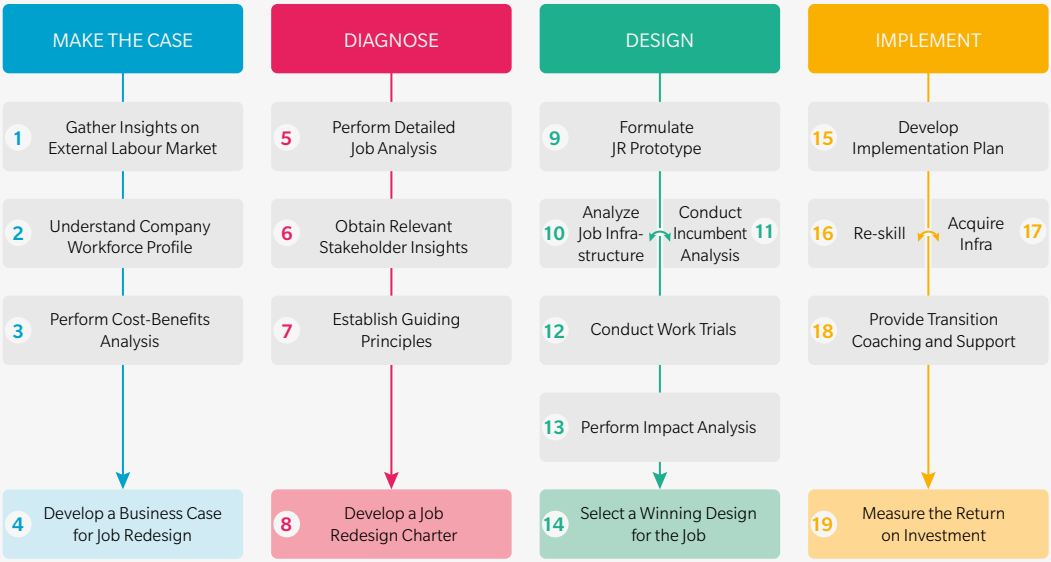
OLDER WORKERS WILL BE VALUABLE AS FIRMS DIGITIZE

As Mercer and Oliver Wyman's recent joint publication, Delivering the Workforce for the Future, has highlighted, the spread of automation will ultimately require human beings and human skills to play an even bigger role in organizations that are going digital. The report points out that what in the past was considered "premium" will now be considered "standard": a phenomenon that will necessarily push human workers out from lower-value work into more value-added services. For example, humans that previously worked as order-takers and payment processers could be transitioned into customer-service and dining-event management roles. Plant and machine operators could become specialty technicians and robotics monitors.

Companies therefore have much to benefit from investing the productivity gains from automation into their human workers – particularly older ones, who are more and more willing and able to remain in or re-enter workplaces around the world. Investing in older workers through firm retraining programs and older worker accommodation strategies would help older workers reskill and be redeployed in the workplace, and provide firms with a fresh source of vitality in a world of shrinking young labor forces. Technological developments and the automation of work offer companies a unique opportunity to evolve and upgrade their suite of offerings. With labor markets around the world aging so rapidly, it will be incumbent upon firms to utilize the unique abilities of older workers as part and parcel of this evolution.

It is also important to note that, contrary to conventional opinion, older workers can actually be a reliable treasure trove of experience, adaptability, and productivity given the right environment and opportunities. Researchers have found, for example, that older workers tend to outperform younger workers in semantic memory and language and speech skills.[30] Older workers also provide crucial abilities for firm building, knowledge consolidation, and continuity in times of flux.[31] An age-diverse workforce can even reduce costs by increasing organizational commitment and reducing turnover.[32] Having worked with a variety of clients and academics on optimizing workforce composition, Mercer has already developed successful workplace strategies for harnessing the unique capabilities of older workers. (See Exhibit 14 as an example.) With more and more older persons re-entering and remaining in the workforce around the world, businesses would do well to devise strategies like these for harnessing the many benefits they have to offer.

Exhibit 14: Mercer Job Redesign for Older Workers



Source: Mercer

30. Becker, Volk & Ward (2015). Cognitive Predictor and Age-Based Adverse Impact Among Business Executives; Klein et al. (2015). Older Workers Bring Valuable Knowledge to the Job
31. Stamov-Rosnagel et al. (2010). Older Workers' Motivation: Against the Myth of General Decline
32. Lord & Farrington (2006). Age-related differences in the motivation of knowledge workers

CONCLUSION

The twin threats of aging and automation present both risks and opportunities for societies globally. This report has discussed the complex interplay of these trends, noting in particular that although automation has the potential to offset the productivity fallouts of societal aging, it can also suppress labor opportunities for older workers. In many major markets, older workers are at mid-to-high risk of automation, and countries highly dependent on low-skill work are at particularly high levels of risk. In China, for example, the average risk of automation to older workers is 76 percent. We have also found that even in countries with high concentrations of advanced-skill work, older workers can still be surprisingly susceptible to automation. In Germany, older worker jobs are on average 57 percent automatable.

A deeper investigation into these results shows that a country's labor market dynamics for older workers can be attributed in large part to education levels, the size of the manufacturing sector, the level of government spending, and the strength of financial laws. These provisions have a significant impact on the susceptibility of older workers to automation – an insight that throws up some important policy implications for both governments and firms. Welfare spending, industrial shifts, financial support, and training and education will be key to preventing the widespread displacement of older workers. Without the proper interventions, societies stand to face serious fallouts as a result of these trends. Un- and underemployment, widening inequality, and severe talent shortages will worsen in countries where older workers are not properly incorporated into firms' digitization and automation strategies.

In a follow-up report to "The Workforce of the Future" series, we will discuss the implications of older person work and automation for firms. As we have briefly noted here, older workers are often unduly dismissed in the workplace. It is often forgotten that they can provide continuity, guidance, and stability in the workplace, and employers aren't generally aware that older workers can have cost-saving effects on a firm. Our subsequent report will explore these benefits in greater detail and outline strategies for how to best optimize older workers in a digital workplace. As the confluence of aging and automation ripples around the globe, these solutions will be crucial to ensuring stable retirement for older workers, and to establishing systems of enduring productivity.

APPENDICES

Appendix 1: Average Risk of Automation to Older Workers Calculation

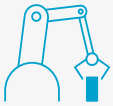
EXAMPLE RESULT: GERMANY

NO. OF WORKERS EMPLOYED

ISCO 08 Major Groups (UN Format)	Germany 50–64 YO	Germany 25–49 YO	Risk of Automation
Managers	524	770	14%
Professionals	1,689	3,924	17%
Technicians and associate professionals	2,754	4,735	50%
Clerical support workers	1,795	2,882	81%
Service and sales workers	1,604	2,733	54%
Skilled agricultural, forestry and fishery workers	93	161	82%
Craft and related trades workers	1,446	2,504	73%
Plant and machine operators and assemblers	965	1,262	83%
Elementary occupations	1,189	1,530	73%
TOTAL	**12,058**	**20,500**	

Sample numbers obtained using the EU's database

Obtained by mapping F&O's occupational groups against the UN's ISCO groups



Average risk of automation to older workers	**0.57**	**0.54**

Calculated for each age group by weighting the Risk of Automation scores by the proportion of workers employed in each occupation. That is, for each age group, the proportion of workers in each occupation was multiplied by the Risk of Automation for that occupation to produce a weightage. These weightages were summed up to produce the Average Risk score for each age group.

Appendix 2: Average Risk of Automation to Older Workers Results

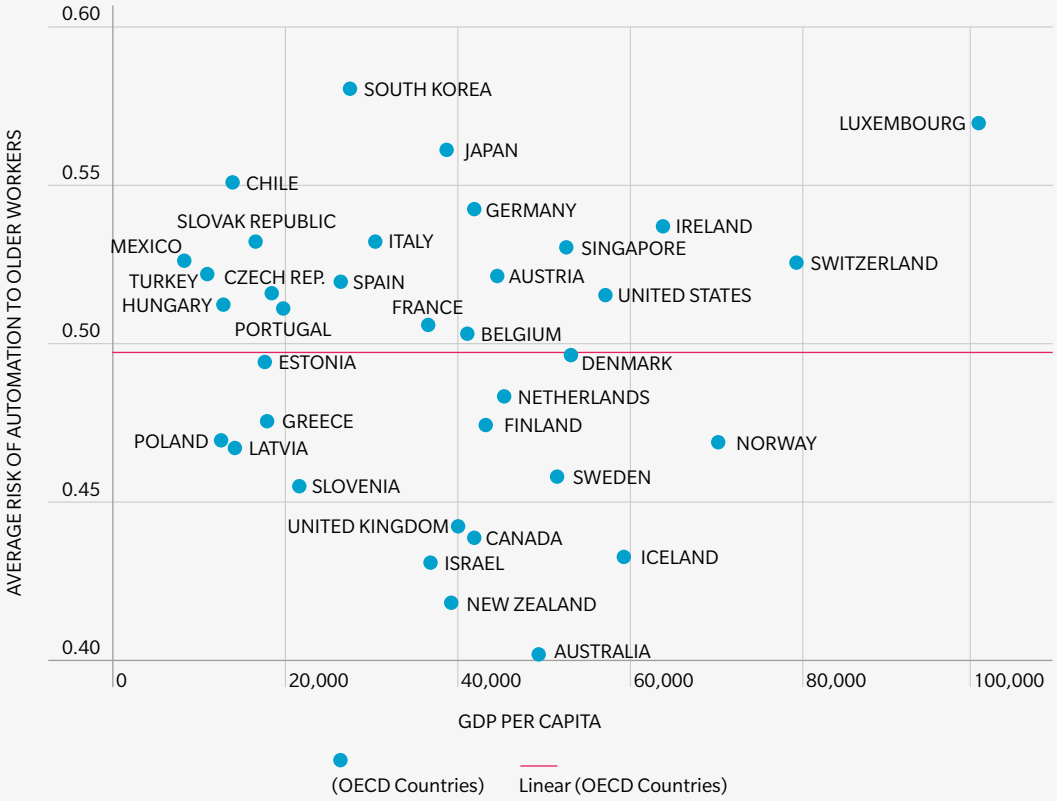
	Average Risk of Automation	
Country	**Older Workers**	**Difference: Older and Younger Workers[33]**
China	0.76	0.06
Thailand	0.69	0.04
Viet Nam	0.69	0.01
South Korea	0.63	0.06
Singapore	0.54	0.13
Poland	0.55	0.03
Germany	0.57	0.03
United Kingdom	0.47	0.02
Ireland	0.53	0.04
Norway	0.45	0.01
Canada	0.47	0.01
Finland	0.50	0.02
USA	0.52	–0.01
Italy	0.58	–0.02
Greece	0.54	0.00
Austria	0.54	0.01
Israel	0.47	0.04
France	0.54	0.03
New Zealand	0.45	0.02
Australia	0.42	0.02
Switzerland	0.49	0.04
Sweden	0.47	0.02
Czech Republic	0.58	0.02
Estonia	0.56	0.04
Latvia	0.54	0.03
Luxembourg	0.5	0.06
Slovakia	0.6	0.01
Slovenia	0.52	0.00
Spain	0.57	0.01
Belgium	0.53	0.03
Denmark	0.50	0.03
Netherlands	0.50	0.04
Hungary	0.59	0.01
Portugal	0.58	0.04
Iceland	0.43	0.01
Chile	0.63	0.06
Mexico	0.61	0.01
Japan	0.59	0.01

33. It's worth noting that although these numbers may be small in their absolute measure, they're interesting because of their relative differences (eg Singapore's contrast with the rest, the US/Italy's contrast with the rest). These numbers also of course do not capture the fact that older workers tend to face more difficulties in the labour market post-displacement than younger workers (see 'A Broader Look: The Risks of Aging and Automation' page).

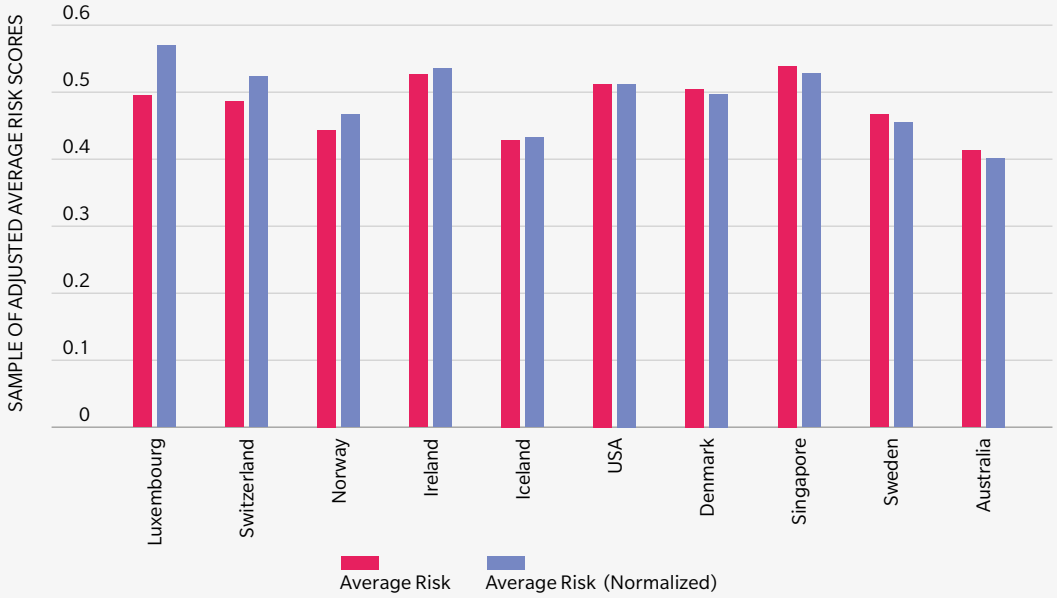
Appendix 3: Older Worker Occupation Data Sources

Country	Source	Source Year	Number of Occupational Categories	Age bracket A	Age bracket B
China	ISCO-88	2010	9	50–64	20–49
Thailand	ISCO-08	2010	9	50–64	20–49
Viet Nam	ISCO-88	2009	9	50–64	20–49
South Korea	National	2016	9	50–64	20–49
Singapore	National	2016	9	50–64	20–49
Poland	EU	2016	9	50–64	20–49
Germany	EU	2016	9	50–64	20–49
United Kingdom	EU	2016	9	50–64	20–49
Ireland	EU	2016	9	50–64	20–49
Norway	EU	2016	9	50–64	20–49
Canada	National	2016	9 (adapted from original 40)	45–64	25–44
Finland	EU	2016	9	50–64	25–49
USA	National	2016	22	55–64	25–54
Italy	EU	2016	9	50–64	25–49
Greece	EU	2016	9	50–64	25–49
Austria	EU	2016	9	50–64	25–49
Israel	National	2015	9	55–64	25–54
France	EU	2016	9	50–64	25–49
New Zealand	National	2013	7 (adapted from 8)	55–64	25–54
Australia	National	2016	7 (adapted from 8)	50–64	25–49
Switzerland	EU	2016	9	50–64	25–49
Sweden	EU	2016	9	50–64	25–49
Czech Republic	EU	2016	9	50–64	25–49
Estonia	EU	2016	9	50–64	25–49
Latvia	EU	2016	9	50–64	25–49
Luxembourg	EU	2016	9	50–64	25–49
Slovakia	EU	2016	9	50–64	25–49
Slovenia	EU	2016	9	50–64	25–49
Spain	EU	2016	9	50–64	25–49
Belgium	EU	2016	9	50–64	25–49
Denmark	EU	2016	9	50–64	25–49
Netherlands	EU	2016	9	50–64	25–49
Hungary	EU	2016	9	50–64	25–49
Portugal	EU	2016	9	50–64	25–49
Iceland	EU	2016	9	50–64	25–49
Chile	National	2016	9	50–64	25–49
Mexico	National	2016	9	50–59	20–49
Japan	National	2016	9 (adapted from original 12)	50–59	25–49

Appendix 4: Average Risk of Automation to Older Workers Scores After Normalization



After normalization, the relationship with GDP per Capita reduced dramatically (as compared with that seen in Exhibit 13)



Average Risk of Automation to Older Worker scores were normalized according to the United States' GDP per Capita

Appendix 5: Variables Tested in Regression Analysis[34]

Indicator
Adjusted savings: education expenditure (percent of GNI), 2015
Manufacturing, value added (percent of GDP), 2016
Ratio of female to male labor force participation rate (percent) (national estimate), 2015
General government final consumption expenditure (percent of GDP), 2015
Percent of 55-64 year olds with tertiary education,2016
Percent change in GDP per capita, 1985/1990s-2016 (constant prices, 2010 US$)
Medium and high-tech exports (percent manufactured exports), 2015
Gross domestic savings (percent of GDP), 2015
Pension replacement rate, 2016, low earners (women, gross)
Average pension replacement rate, 2016, low earners (men + women, gross)
Pension replacement rate, 2016, low earners (women, net)
Average pension replacement rate, 2016, low earners (men + women, gross)
Pension replacement rate, 2016, low earners (men, gross)
Strength of legal rights index (0=weak to 12=strong), 2015
Pension replacement rate, 2016, low earners (men, net)
Cause of death, by non-communicable diseases (percent of total), 2015
Average LF participation rate 50–64, 2016
Percent change 1990–2016 (constant prices, US$ 2010)
Gender wage gap, 2014
Foreign-born population (percent total population), 2015
Public expenditure on old age + survivor welfare, 2013
Gross pension wealth, low earning men, 2016
Collective bargaining coverage (percent all workers), average available data 2012–2016
Gross pension wealth, low earning women 2016
Gini coefficient, 2015
LE at age 60, 2015
Net pension wealth, low earning men, 2016
Public expenditure on old age welfare, 2013
Share of unemployment aged 50–64, 2016, OECD
Net pension wealth, low earning women 2016
Life expectancy, 2015
Net migration rate, 2010–2015 (per 1000)
Old-age dependency ratio, 2016
Public expenditure on old age + health welfare, 2013
GDP per capita (current US$), 2016

34. Variables were selected based on expert recommendations from OW and Mercer, as well as a review of literature that pointed to these variables as potentially explanatory

Appendix 6: Multivariate Regression Results

Regression Statistics	
R Square	0.494

	Coefficients	t Stat	P-value
Intercept	0.583	14.490	1.31E-15
Manufacturing, value added (percent of GDP)	0.241	2.607	0.014
General government final consumption expenditure (percent of GDP)	-0.443	-3.000	0.005
Strength of legal rights index (0=weak financial institutions to 12=strong)	-0.080	-3.235	0.003

$$Y = 0.58 + 0.24Man - 0.44GovEx - 0.08Leg$$

Y = Average Risk of Automation to Older Workers

Man = Manufacturing, value added (percent of GDP)

GovEx = General government final consumption expenditure (percent of GDP)[35]

Leg = Strength of legal rights index (0 = weak financial systems to 12 = strong)[36]

35. "General government final consumption expenditure (formerly general government consumption) includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditures on national defence and security, but excludes government military expenditures that are part of government capital formation." World Bank online database
36. "The strength of legal rights index measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders

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