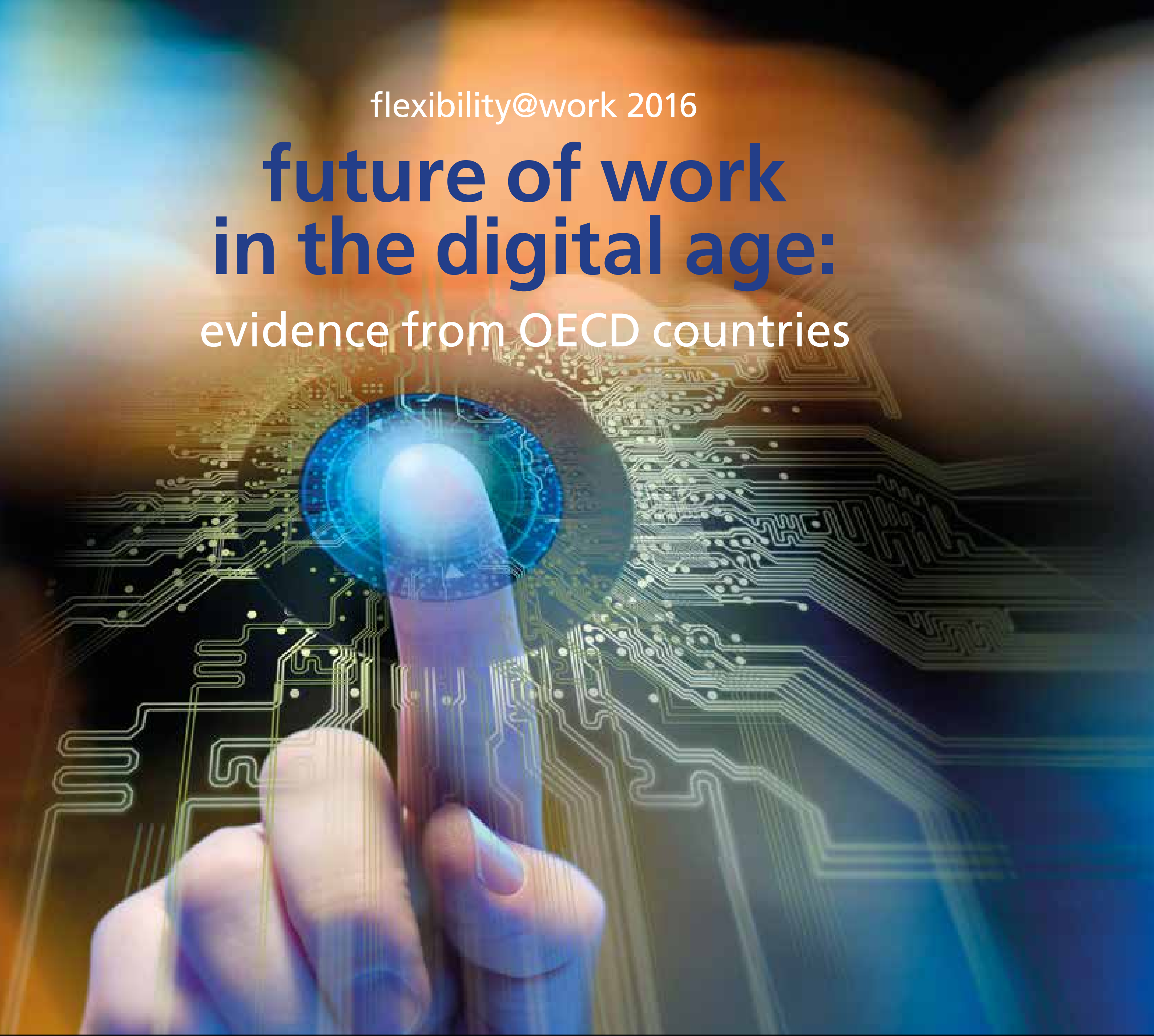
flexibility@work 2016

future of work in the digital age:

evidence from OECD countries



yearly report on flexible labor and employment

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Acknowlegdement

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Preface

Randstad is pleased to present the 2016 edition of Flexibility@work: an annual study on flexible labor and employment. The Flexibility@work report provides a comprehensive overview of international employment trends in the flexible labor market. Additionally, we zoom in on a specific development in the world of work. The 2016 edition focuses on the changes and transitions in the digital era.

The research, 'Future of Work in the Digital Age' by KU Leuven and Utrecht University reveals the labor market is in the midst of drastic changes. To understand the transition currently taking place in the labor market, the researchers assessed two related phenomena: deindustrialization and job polarization in OECD countries. These phenomena capture the shifting composition of the labor market, a clear sign of a labor market in transition. Next to the decrease in manufacturing in the developed countries, the growth in services can be decomposed into low-tech, low-paying and high-tech, high-paying employment, which reveals the current trend of the job polarization.

Job polarization captures the increasing importance of the least and most paid occupations in the economy at the expense of mid-level jobs. In response to the digital economy many new markets and jobs are created, but many existing jobs are and will be eliminated, or will have to be significantly re-tooled in the process. Medium-paid jobs such as machine operators and assemblers; office clerks and customer service clerks are disappearing as a result of robotization, automatization and outsourcing. The research shows this phenomenon is taking place in all developed countries and across all sectors, with a an emphasis on manufacturing.

There is a second kind of job polarization occurring; both the least and most innovative tech-intense sectors are increasing their employment share. The tech intensive sectors create high-tech STEM (science, technology, engineering and mathematics) jobs which are typically more productive and therefore generate additional demand. These companies tend to concentrate in high-tech hubs where high-paid workers employed in STEM occupations are likely to spend their income on local non-routine services. This research shows that with the creation of one high-tech job, between 2.5 and 4.4 additional jobs are created outside tech intensive sectors in these high-tech regions. An important fact because, and contrary to what is sometimes considered, the boosting of high-tech employment helps rather than hurts growth of employment at the lower end of the labor market.

To understand the impact of job polarization in the digital era, we need to move away from the traditional classification of the economy into manufacturing and non-manufacturing sectors. The main differentiator in the digital era is routine tasks versus non-routine tasks. Routine tasks which are easily robotized and outsourced versus the growing share of non-routine tasks which need to be innovative by nature, either on the high end by new products and processes or, at the low end, by new forms and ways of in-person services to provide for an increasing demand for these services.

As the researchers state: 'the technology change is clearly skill- -or better said- routine biased'. The paradox lies in the fact that there still remain many tasks of which we have little understanding of how we perform them or require the human touch and soft skills. These are often tasks which require little human effort to accomplish but still pose great difficulty for computer programmers to put into computer language.

The changes in the digital era raise profound issues how to adapt labor market policy and institutions, as well as decent flexible work arrangements and social security, in order to provide adequate security for workers while exploiting the potential of the new ways of working to enhance opportunities. We need to become as innovative in creating good jobs as we are in developing innovative products and services. What skills are needed for these non-routine tasks? What would it take for business, policy, and education leaders to work together to make it happen? If our approach does not change, people are denied the opportunities they need to develop the skills they require in the digital era.

Jacques van den Broek
CEO Randstad

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Summary

The future of work is changing rapidly as a result of developments in digital technology, globalization, demographic changes and other fundamental changes in the organization of work. These forces are reshaping labor markets drastically and raise challenges to public policy in new, unknown ways. To understand the change currently taking place in the labor market we review two related stylized facts: deindustrialization and job polarization. Job polarization refers to the growing importance of the least and most paid occupations in the economy at the expense of middle-paid ones. These phenomena capture the shifting composition of the labor market, which is a typical feature of a labor market in transition. Just as the introduction of the combustion engine, general plumbing and electricity forced society to review not only (labor) economic policy but also how we think of labor markets more generally, the current wave of technological change challenges us to reconsider the traditional structures and institutions in place.

THE MAIN FINDINGS IN THIS PAPER CAN BE SUMMARIZED AS FOLLOWS:

- Deindustrialization and Job Polarization are two related phenomena that capture rapid changes that are currently taking place in the labor market. Specifically, job polarization captures how changes in the employment share of high-paid, low-paid and middle-paid jobs can be linked to technological change which are masked by the traditional distinction between manufacturing and non-manufacturing employment.
- The role of technology can be understood by looking at the ICT capital intensity of a sector and the share of STEM employment. Both of these provide evidence that technological change drives between-sector job polarization. Moreover, we find that job polarization also takes place within narrowly defined sectors, which is consistent with technology being the underlying driving factor.
- STEM employment is more resilient to economic shocks. During recessions they tend to be associated with higher levels of productivity, productivity growth and employment growth. This confirms the Schumpeterian view of creative destruction: Recessions are times that new technology and innovation is being implemented which impacts on the type of jobs and amplifies polarization.
- The evidence demonstrates that in order to understand the current changes in the labor market, both researchers and policy makers should move away from the traditional distinction between manufacturing and non-manufacturing employment. Rather the focus should be on key enabling technologies, how they interact with employment and which type of occupations play a key facilitating role. Moreover, evidence is given that there are positive spillover effects from high-tech employment to low-tech employment, especially in the form of in-person services. This provides evidence that policy boosting STEM employment may generate a positive impact reverberating across many occupations, including non-STEM.
- Suggestive evidence is given for the positive relationship between more and better investment in (higher) education and the share in STEM employment. This provides potential avenues for policy makers to focus on.

Future of Work in the Digital Age

To understand the change currently taking place in the labor market we review two following, related stylized facts: deindustrialization and job polarization. These phenomena capture the shifting composition of the labor market, which is a typical feature of a labor market in transition.

I. Introduction

The future of work is changing rapidly as a result of developments in digital technology, globalization, demographic changes and other fundamental changes in the organization of work. These forces are reshaping labor markets drastically and raise challenges to public policy in new, unknown ways. The impact of labor-saving technology is a long-standing debate in economics and is fueled by new waves of technological progress. Just as the introduction of the combustion engine, general plumbing and electricity forced society to review not only (labor) economic policy but also how we think of labor markets more generally, the current wave of technological change challenges us to reconsider the traditional structures and institutions in place.

To understand the change currently taking place in the labor market we review two following, related stylized facts: deindustrialization and job polarization. These phenomena capture the shifting composition of the labor market, which is a typical feature of a labor market in transition. First we discuss the features of each of these phenomena before turning to the role of technology as a driving force in the next sections.
Figure 1 illustrates the long run decline in manufacturing employment that took place in all developed economies since 1980, known as deindustrialization, while at the same time, jobs in service sectors have been growing steadily, absorbing jobs lost in industry, resulting in an increased 'servatization' of the economy. (1)

This taste shift towards demand for services worry policy makers as the decline of manufacturing may result in permanently lower productivity growth. The underlying reasoning is that it would be harder to innovate in services than in manufacturing. This hypothesis has brought forth a large literature which investigates its validity, both with production and consumer side data, including recent additions (Nordhaus, 2008 & 2015). Still, with this flood of evidence it remains difficult to assess differences in productivity growth and their net effect.

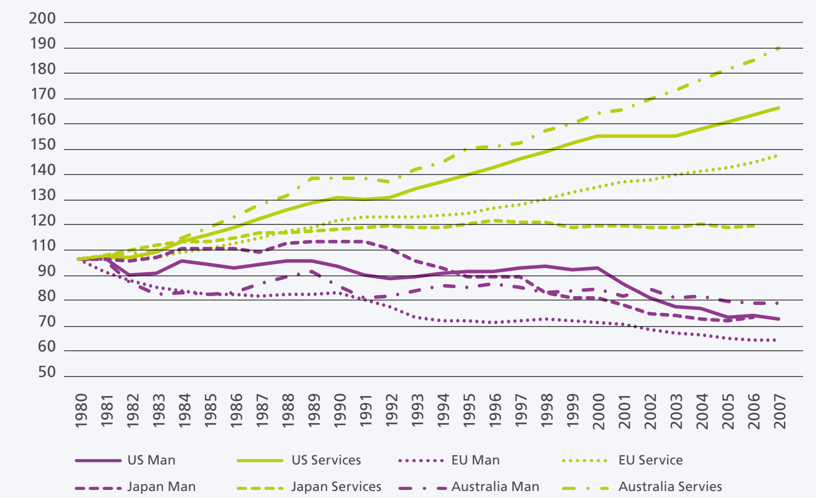
Interestingly, the growth in services can be decomposed into low-tech, low-paying and high-tech, high-paying employment, which reveals the second stylized fact: job polarization. Job polarization captures the growing importance of the least and most paid occupations in the economy at the expense of middling jobs. This connects with deindustrialization given that manufacturing contains many of these middling jobs in decline. However, it creates a more complex picture and suggests that the simple distinction between services and manufacturing has become obsolete.

Figure 2 shows the evolution of employment shares by their average pay-scale for 16 EU countries between 1993-2010. Occupations are ranked in 'high-paying', 'middle-paying' and 'low-paying'. Typically high-paying occupations are corporate managers, physical, mathematical, and engineering professionals, life science and health professionals, in other words, typical jobs related to Science, Technology, Engineering and Mathematics (STEM in short) which can be found in parts of both manufacturing and services. In contrast, low-paying occupations are service workers, sales persons in retail, services in elementary occupations, etc.. And middle-paying work consist of occupations such as machine operators and assemblers; metal workers; drivers and mobile plant operators; office clerks; precision, handicraft, craft printing, and related trade workers; extraction and building trades workers and customer service clerks. These can be found in a variety of sectors but a large share are situated in manufacturing. (2)

From Figure 2, it is clear that the employment share of both high-paying and low-paying occupations have been increasing, while the middle-paying

Job polarization captures the growing importance of the least and most paid occupations in the economy at the expense of middling jobs. It is clear that the employment share of both high-paying and low-paying occupations have been increasing, while the middle-paying occupations have decreased.

1. Evolution of Employment in Manufacturing & Services in the U.S., Europa, Australia and Japan, 1980-2007



Notes: Employment is the sum of manufacturing and service sectors employment and expressed in millions of hours worked. Employment is indexed in 1980 for clarity. Manufacturing and services are defined as suggested by the OECD, respectively ISIC classification section D for manufacturing and G to P for services. Employment index for European countries (Austria, Belgium, Denmark, Spain, Finland, France, Germany, Ireland, Italy, Netherlands, Sweden, United Kingdom) is a cross-country average. Employment data for Japan is missing in 2007.

occupations have decreased. Especially the high-paying occupations have gained in relative importance. This is what typically is referred to as polarization of occupations. Figure 3 shows a similar trend for the United States, where typical operational and blue collar routine occupations have lost ground over the same period. So, this seems to have been a pervasive trend in most advanced countries, which suggests there must be some systematic mechanism underlying this evolution, albeit the extent of polarization seems to differ from country to country. For instance, in Figure 2 we see that the increase in the share of high-paying occupations varies from around 4% in Portugal and Austria to over 12% in Luxembourg and Finland. (3)

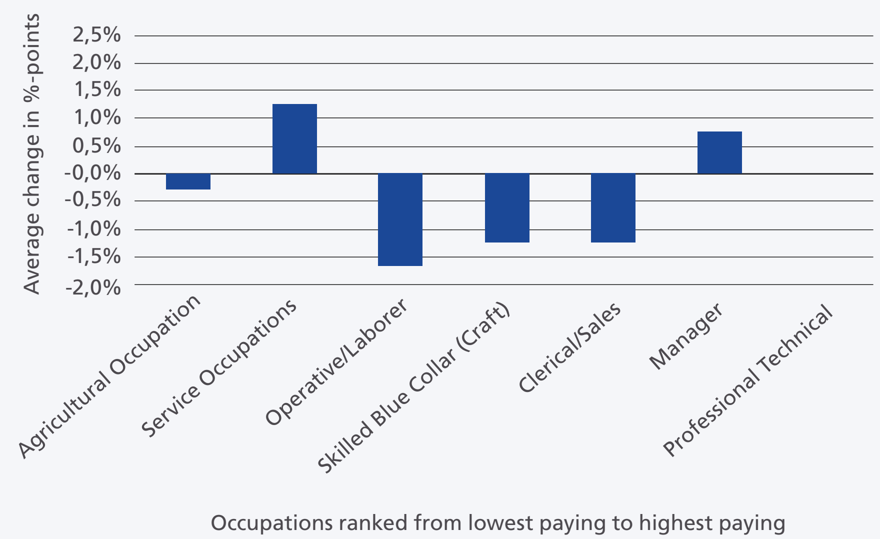
2. Change in Occupational Employment Shares in Low, Middle, and High-Wage Occupations in 16 EU countries, 1993-2010

Source: Goos, Manning and Salamons [2014, Table 2]

Notes: Starting from 2 digit ISCO classified occupations, 'Low' is defined as the employment in the four lowest paying occupations, 'Middle' as the nine middling occupations and 'High' and the eight highest-paying occupations.

This paper wants to take a closer look at the long-run process of deindustrialization and job polarization. To this end, we use various data sets to document and analyze how deindustrialization and job polarization are affecting various types of occupations, which type of jobs tend to grow and which do not, and how these trends affect productivity growth. Typically, productivity growth is related to the introduction of new technology and innovation. In this context, we will focus in particular on the role of key enabling technologies. While the first industrial revolution was triggered by the introduction of the combustion engine and electricity as a key enabling technology, arguably, the economy today is increasingly shaped by the introduction of computers, robots and more in general the adaption and use of Information and Communication Technology (ICT) as a key enabling technology. ICT has triggered a process of job polarization due to an increased automation of encodable tasks in search of cost cutting (e.g. Goos, Manning and Salamons, 2014). In addition, there is evidence that the presence of STEM occupations marks the strong impact of technology as many of these occupations play a key facilitating role in the adoption of digital technology. As we will illustrate extensively in this work, this polarization and automation process forces us to move away from the traditional classification of the economy into manufacturing and non-manufacturing sectors. Rather we should think in terms non-routine tasks embedded in jobs versus routine tasks. With automation the latter are easily replaced or offshored to low-wage countries, while

3. Polarization of Occupations in the United States 1990-2010



Source: Based on Katz and Margo [2014], Table 1.6, panel A and own calculations.

non-routine tasks are harder to substitute with robots (e.g. Autor, 2015)[4]. These questions and observations concerning the role of technology will be the main subject of Section II.

In the subsequent sections two more observations are discussed arising from the macroeconomic literature that looks broader than the labor market, considering the economy as a whole. The first observation relates to the timing of job polarization. While the evidence on job polarization and deindustrialization shows the long term trends in employment, it is also important to understand how these changes take place within a shorter time span. For example, are these changes gradual over time or do they take place in short bursts over the short to medium run? There is some evidence that the cyclical nature of the economy also has a role to play. It is namely observed that the largest decline in middling jobs takes place during recessions. In other words, job polarization seems to be amplified during downturns in the economy. This relationship and timing of events is discussed in Section III. Secondly, deindustrialization relates to the growing literature on differences in productivity growth, captured by differences in total factor productivity (TFP). Here, it becomes increasingly important to allow for heterogeneity between sectors and even between firms. These differences in productivity and the potential looming of a secular stagnation in the economy are discussed in Section IV.

These long term trends in employment have inspired many countries to develop policies to support manufacturing and especially in the aftermath of the great recession many initiatives have been launched under the realm of New Industrial Policy. For instance, the European Union set out its policy

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4 Routine tasks are structured and can therefore be increasingly codified in software and embodied in capital, whereas non-routine tasks are harder to automate. As a result, capital accumulation leads to an accumulation of routine tasks in the economy -- hence the term Routine-Biased Technological Change -- while decreasing the demand for routine relative to non-routine labor tasks. Because routine labor tasks are concentrated in middling jobs, RBTC leads to a hollowing out of labor demand or job polarization.

Job polarization and automation process forces us to move away from the traditional classification of the economy into manufacturing and non-manufacturing sectors. Rather we should think in terms non-routine tasks embedded in jobs versus routine tasks. With automation the latter are easily replaced or offshored to low-wage countries, while non-routine tasks are harder to substitute with robots.

in the context of the Innovation Union initiative. In particular, it aims to create an innovation-friendly environment to bring economic growth and jobs to its regions. For example, it strives for a 50% (or 150 billion Euro) increase in R&D investments by 2020, claiming this could increase annual European GDP by 5% (or by 715 billion Euro) and increase employment by 1.7% (or by 3.7 million jobs) by 2025. Moreover, the Innovation Union plan contains over thirty action points to guarantee that this growth is inclusive with more and better jobs for all, and to remove obstacles to innovation. Most of these initiatives are targeted towards industry. However, in recent years the growth of jobs seem to have been concentrated in STEM jobs (e.g. Goos et al, 2015). In Section V, we discuss the importance of such policies and touch on potential avenues for the future. We conclude in Section VI.

II. The Role of Technology

In this section we show that deindustrialization and job polarization are (mainly) driven by technology by reviewing these stylized facts in three different ways.

First we illustrate a different way of looking at the polarization from the labor market based on sector employment. As mentioned, ICT is considered as a key enabling technology in the current wave of digitization. Therefore we distinguish sectors based on their ICT capital intensity as a proxy for this difference in susceptibility to technological employment. Second, we rank sectors by their share in STEM occupations as an alternative and perhaps even more accurate way of capturing the essential difference in susceptibility to technological change between sectors. However, the growth of digital capital performing certain tasks is a phenomenon that changes not only the size but also the composition of sectors. That is, if technology really is an importance driver, we expect there to be evidence both between and within sectors. This aspect will be the focus of the final subsection.

2.1. ICT INTENSITY AND BETWEEN-SECTOR JOB POLARIZATION SINCE 1980

The literature has explored two key hypotheses that potentially account for labor market polarization, one is offshoring of 'routine' occupations to low-wage countries, the other is skill-biased, or rather routine-biased technological change (Acemoglu and Autor, 2011).

It is the latter that has received more attention as technological progress is changing the relative demand for skills and hence the relative wages, 'offshoring' of routine jobs then becomes a natural consequence of routine biased technological change. Arguably, a major technological shock that overlaps the same period as the emergence of labor market polarization is the increased adaption of computers in the production process and more generally the spread of ICT[5].

The intuition is that high-tech occupations are capable of attracting a larger share of (high skilled) employment through the complementarity with the accumulation of ICT capital. They will do so more than occupations at the middle of the distribution given the larger importance of ICT capital intensity and resulting larger decrease in relative prices as predicted by Baumol's cost disease[6]. At the same time, middling sectors are discarding more (less-skilled) workers previously employed in routine labor tasks which are now increasingly performed by digital capital. These are drawn in by the least capital intensive sectors at the bottom of the distribution which are growing due to the complementarity in consumption and the growing taste for services in the economy. These sectors, containing most of the in-person services, are, as of yet, still little affected by changes in ICT technology. The lack of automation can be summarized by a constraint referred to by Autor [2015] as Polayni's Paradox[7].

The scope for automation of certain tasks is bounded since it requires an explicit knowledge of the rules that govern them. The paradox lies in the fact that, for now, there still remain many tasks of which we have only a tacit understanding of how we perform them. This implies that they require little effort for humans to accomplish but still pose great difficulty for computer programmers to put into computer language. Still, in-person services are inherently connected due to the increased demand for these services over time; a relation we will explore further in Section V. Taken together, routine-biased technical change predicts that both the least and most innovative or ICT intense sectors will increase their employment share over time. Figure 4 shows the change in the employment share of sectors between 1980 and 2007 that are ranked by their ICT capital intensity for the US, EU, Australia and Japan based on data from the EU KLEMS database [8,9]. While there are cross-country differences, a clear pattern of job polarization emerges, this time not in terms of occupations, but in terms of total employment in the sectors. While in the previous section and in most other papers, this phenomenon is discussed in terms of employment change in occupations ranked by the wage, this shows that there are other dimensions through which job polarization can be understood. (see text box next page)

Figure 4 also shows the direct connection between job polarization across sectors and the decline in manufacturing sectors. Given that sectors with a large share of routine labor tasks are often part of the manufacturing industry, we can expect these to lose employment share over time. On the other hand, sectors with a large share of non-routine labor tasks are more often services with varying levels of technology present in production. E.g. both child day care as well as financial consulting. That is, we find services with rising shares of employment at both ends of the distribution of sectors according ICT capital intensity. This is also suggestive of how these sectors differ and how they are gaining employment share for different reasons. The ICT intensive sectors typically create high-tech STEM jobs, while the low ICT intensive sectors would tend to create non-routine service type of jobs, presumably triggered by increased demand for these services initiated by the rising income of workers in the high-tech STEM jobs. It is striking to note that this polarization trend has been taking place

The growth of digital capital performing certain tasks is a phenomenon that changes not only the size but also the composition of sectors.

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5 Unfortunately, empirical measures on the 'routiness' and 'offshorability' of jobs most often overlap, even though they are distinct concept. Given the necessary measurement error inherent to each of these measures, one must be careful in how much one can claim to disentangle these two forces. 6 Baumol's [1967] original thesis stated that, if productivity growth is unbalanced across sectors, sectors with lower productivity growth will see their relative output price as well as their share in total employment increase. Moreover, he argued that unbalanced productivity growth would lead to an increasing share in GDP for less innovative sectors, and thus to a slowdown in sector-weighted aggregate growth. 7 Polanyi was an economist, philosopher and chemist who in 1966 observed that, "We know more that we can tell". [Polanyi 1966; Autor 2015] .

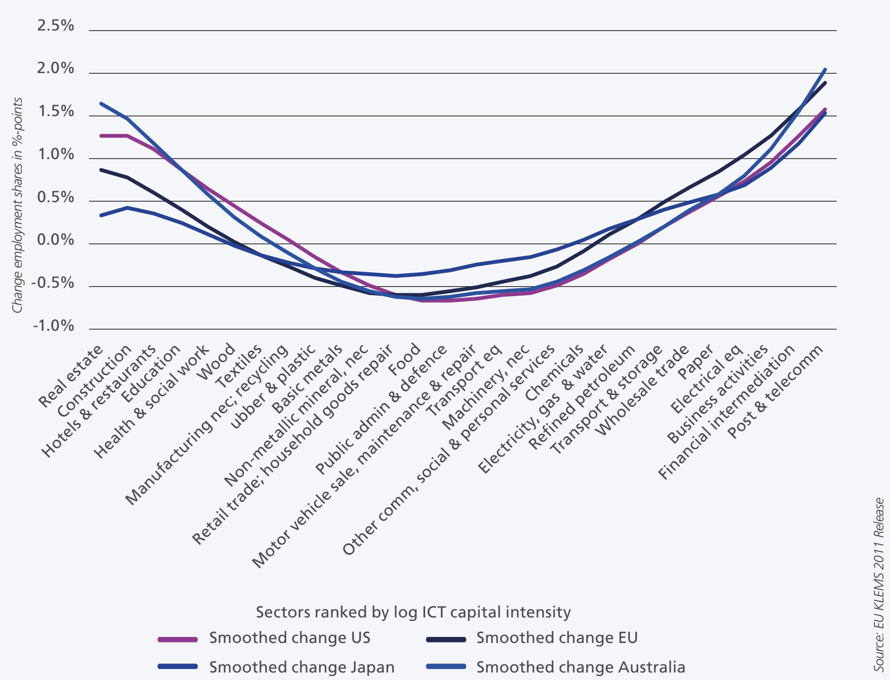
8 The latest update of the EU KLEMS data project covers data until 2007. While we do miss information on the last ten years, including the great recession, this data allows us to spot long run trends in job growth and polarization. To analyze more recent trends, we will therefore be using alternative data sources, including the European Labor Force Survey amongst others. 9 ICT capital intensity is defined as ICT capital compensation relative to the total income from production measured in value added and is taken from the EU KLEMS data (see data appendix for more details). ICT capital compensation is the product of the ICT capital stock (consisting of office and computing equipment, communication equipment and software) and its user cost [Timmer et al., 2007]. We define this in the year 2005, but if we take a different year, the ranking remains the same. In the appendix, table A1, we provide an overview of sectors ranked by their ICT intensity. We can note that sectors like 'financial intermediation', 'post & telecom' are typically among the highest users of ICT, as expected.

Routine-biased technical change predicts that both the least and most innovative or ICT intense sectors will increase their employment share over time. The ICT intensive sectors typically create high-tech STEM jobs, while the low ICT intensive sectors would tend to create non-routine service type of jobs, presumably triggered by increased demand for these services initiated by the rising income of workers in the high-tech STEM jobs

in all major advanced economies, although there are some differences in magnitude. This is also the case for European countries, where there is some heterogeneity in terms of job polarization across countries, as can be seen from Figure 5 (see also appendix). This is not surprising as the absorption capacity and the rate technological change embedded in ICT may vary depending on initial conditions, labor and product market institutions. Nonetheless, the polarization pattern is clear in all regions and it affirms the importance of moving away from the traditional distinction between innovative manufacturing and low-tech services. Rather, we should distinguish employment based on the way it interacts with technology. (4 en 5)

The evidence we have provided so far shows that the long term decline in manufacturing employment and rise in service employment masks important shifts in occupations. In particular, this long-term trend of deindustrialization seems to take place in parallel with labor market polarization into high-paying and low-paying non-routine tasks. Moreover, this polarization of tasks is pervasive for a large group of

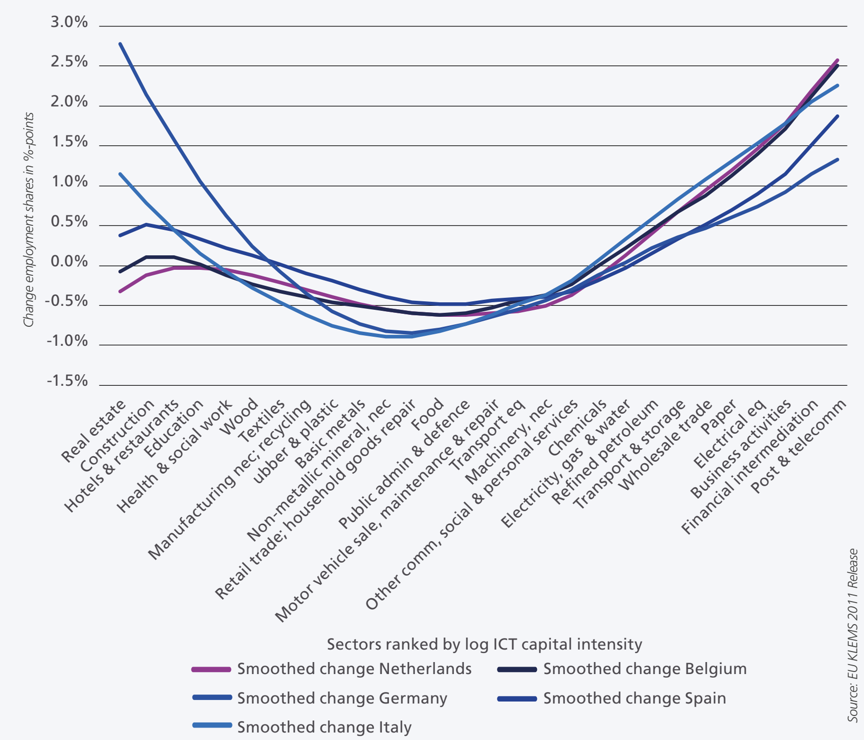
4. Between-Sector Job Polarization in the U.S., EU, Australia and Japan



Notes: Employment is expressed as share in total employment. We plot the percentage point change in the employment share between 1980 and 2007. The primary sector (Agriculture and Mining) and Private household employment are left out. Employment shares for European countries is a cross-country average. Employment data for Japan is missing in 2007, therefore, changes represented for Japan are for 1980-2005. Smoothing is done on 28 observations with bandwidth 0.8.

advanced countries, which experience that the middle-paying occupations, typically capturing 'routine' tasks, tend to disappear. Second, we have demonstrated that this polarization trend is highly correlated with the use and adoption of computers, and more generally, ICT capital. When we rank sectors by their ICT intensity we not only note that polarization in the typical task/occupation dimension is correlated, but also into the dimension of overall jobs in these sectors. Third, it seems that polarization is not only taking place in manufacturing, but it seems to cut across sectors. This suggests that the deindustrialization process and the implied 'Baumol's disease' of servitization, leading to secular stagnation, seems to be more complex than initially thought. In other words, the adaption of ICT did not only lead to automation and a reduction in manufacturing employment, it also triggered new job creation at the high-end of the job ladder and at the low-end. In other words, despite the overall decline in manufacturing employment, there is also job creation going on within manufacturing. Likewise, despite the growth in services, there is also job destruction taking place within services. In

5. Between-Sector Job Polarization in the Netherlands, Belgium, Germany, Spain and Italy



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It is striking to note the relatively fast growth of STEM jobs compared to non-STEM jobs in all countries.

particular, these growing, high-paying jobs are typically related to sciences, technicians, health and managing occupations, in short occupations highly correlated with STEM content. Typically, such jobs are believed to generate high value added and innovation. Given the strong increase in these high-wage occupations, we will focus next on the importance of STEM jobs in order to understand the broad picture of deindustrialization and servitization of the economy.

2.2. STEM (HIGH-TECH) EMPLOYMENT GROWTH SINCE 1980

We use the European Labor Force Survey (ELFS) to compute for each sector the fraction of STEM occupations (see data appendix). By deploying the variation in occupations of respondents in the ELFS across sectors, it is possible to characterize sectors by their intensity in STEM occupations. These occupations are important for the adoption and implementation of new (digital) technologies at the workplace and therefore provide a good proxy for the importance of technology in the economic activity. Table 1 lists the occupations at the 2 digit level which are classified by Eurostat as STEM occupations and which are commonly used in studies analyzing STEM occupations (e.g. Goos et al, 2013).

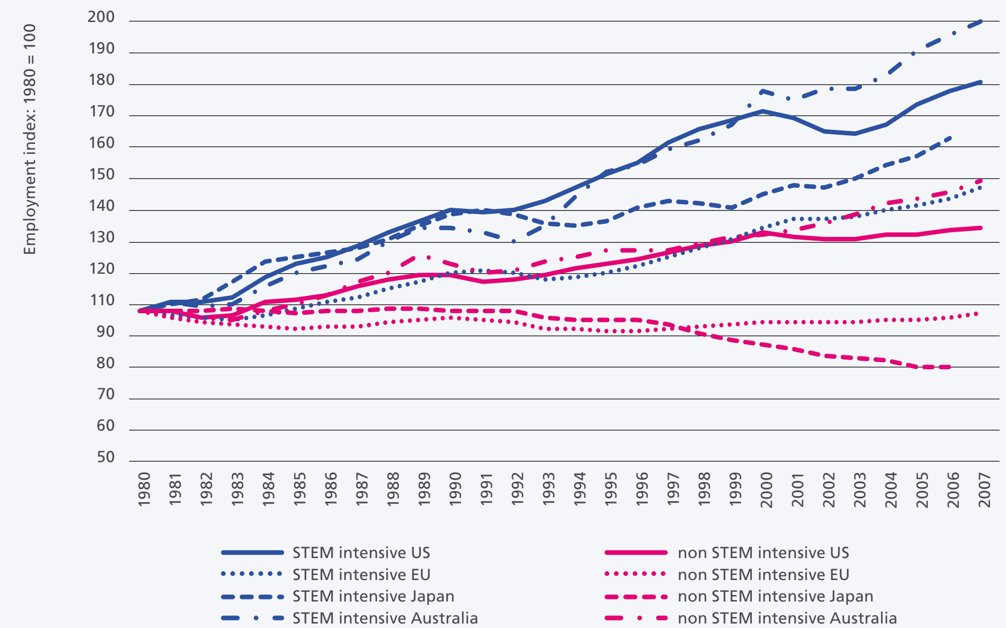
The share of STEM employment in sectors is then calculated by the number of workers with a STEM occupation divided by the total number of workers for that sector. This share is calculated at the country-sector-year level. Given the representative nature of the ELFS sample and the number of observations per sector, the variation in the number of observations should be representative. Alternatively, one could calculate the share with the use of populations weight. Making use of such weights does not qualitatively alter these shares, at least not the ranking of sectors by these shares which is the measure used in the analysis.

We classify sectors as STEM intensive when the employment share of STEM occupations is at least 13.5%[10]. Figures 6 and 7 show the evolution of STEM versus non-STEM employment in various countries since 1980, using the EU KLEMS data series. It is striking to note the relatively fast growth of STEM jobs compared to non-STEM jobs in all countries. There is one exception for the year 2001 where there seems to have been a small dip in the evolution of STEM jobs, which can be explained by the dotcom crisis. Still, the trend remains clear. Interestingly, the non-STEM jobs in most countries are mostly stable or slightly increasing. Clearly, these non-STEM jobs capture two groups, on the one hand they refer to non-routine low-paying occupations, on the other hand they also capture routine middle-paying occupations described in previous section. However, the dynamic evolution of routine jobs clearly differs from non-routine jobs, the latter growing in relative importance, the former declining.

Table 1: STEM occupations for 2 digit ISCO 88 classification

Professionals
21. Physical, mathematical and engineering science professionals
22. Life science and health professionals
Technicians and associate professionals
31. Physical and engineering science associate professionals
32. Life science and health associate professionals

6. STEM vs. non-STEM Employment in the U.S., Europe, Australia and Japan



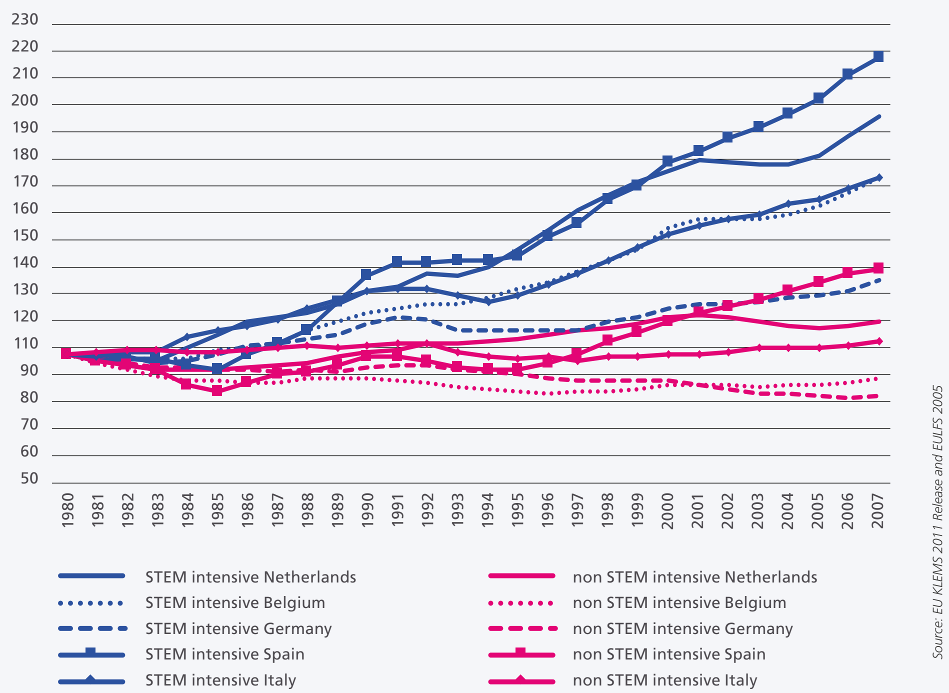
Source: EU KLEMS 2011 Release and EULFS 2005

Notes: Employment is expressed in millions of hours worked. We plot the growth in employment between 1980 and 2007 where employment is indexed in 1980 for clarity. Employment shares for European countries is a cross-country average. Employment data for Japan is missing in 2007. Stem intensity is defined at the sector level where sectors are characterized as STEM intensive if the share if STEM employment is more than 13,5%. This accounts for 22% of all employment in 1980, increasing to 30% of employment in 2007.

Growth in the employment share of sectors that are STEM intensive is not just restricted to high-tech manu-facturing, such as 'Chemicals', but also sectors such as 'Post & Telecom', 'Business Activities, 'Health and Social Work' tend to have experienced high changes in employment and are highly STEM intensive.

10 We have also experimented with a cut-off level of 10%. The results of this alternative specification can be found in Appendix A. 1 and are very similar.

7. STEM vs. non-STEM Employment in the Netherlands, Belgium, Germany, Spain and Italy

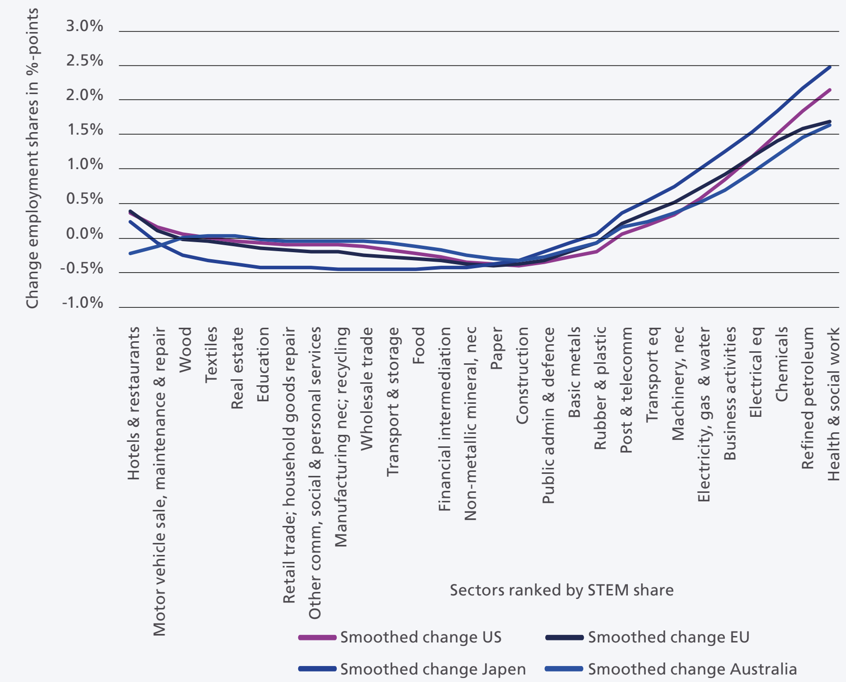


Notes: Employment is expressed in millions of hours worked. We plot the growth in employment between 1980 and 2007 where employment is indexed in 1980 for clarity. Stem intensity is defined at the sector level where sectors are characterized as STEM intensive if the share if STEM employment is more than 13,5%. This accounts for 22% of all employment in 1980, increasing to 30% of employment in 2007. For a definition of STEM employment, see A 1 in the Data Appendix.

The traditional view that innovation and high-tech employment is mostly related to manufacturing activities does no longer seem to hold up.

In Figure 8 we show that the aggregate evolution of STEM jobs shown in Figures 6 and 7 still masks some heterogeneity between sectors. We rank sectors by their STEM intensity in Figure 8 and Figure 9 and plot the change in employment shares since 1980 for these sectors. Note that the growth in the employment share of sectors that are STEM intensive is not just restricted to high-tech manufacturing, such as 'Chemicals', but also sectors such as 'Post & Telecom', 'Business Activities, 'Health and Social Work' tend to have experienced high changes in employment and are highly STEM intensive. Sectors with low STEM intensity tend to have stable or declining employment shares, including for example manufacturing sectors, like 'textiles' and 'wood', but also stable and slightly increasing service sector employment. Thus the traditional view that innovation and high-tech employment is mostly related to manufacturing activities does no longer seem to hold up. Hence,

8. Employment shares across STEM intensity in the U.S., Europa, Australia and Japan



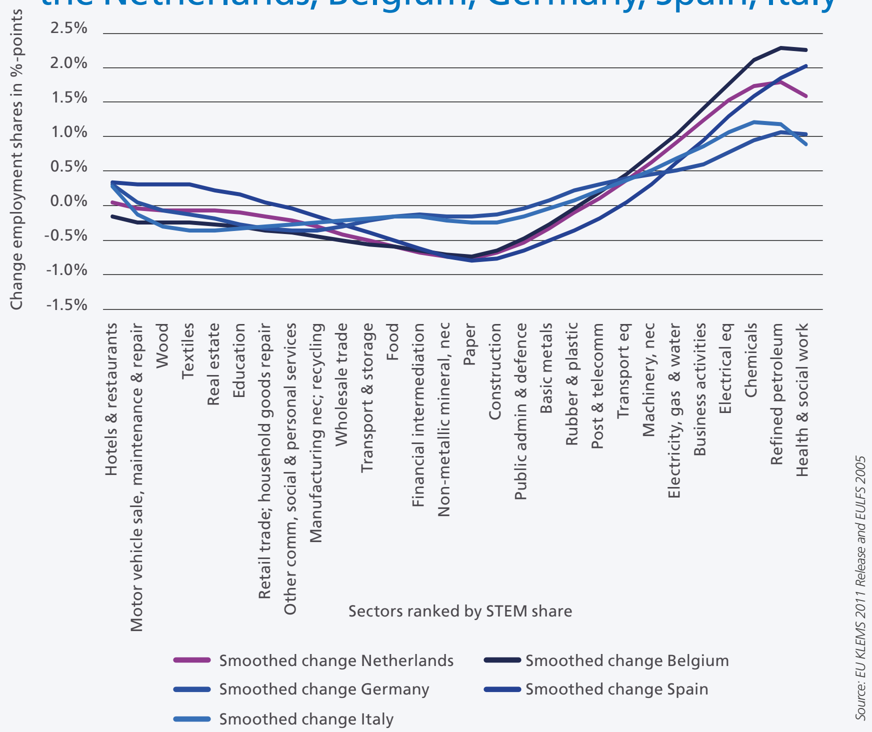
Notes: Employment is expressed as share in total employment. We plot the percentage point change in the employment share between 1980 and 2007. The primary sector (Agriculture and Mining) and Private household employment are left out. Employment shares for European countries is a cross-country average. Employment data for Japan is missing in 2007, therefore, changes represented for Japan are for 1980-2005. The ranking of sectors is based on the average share of STEM employment in EU countries. For a definition of STEM employment, see AI. Data Appendix. Smoothing is done on 28 observations with bandwidth 0.8.

The fact that we can note that non-STEM jobs are also growing suggests that there exist complementarities between STEM jobs and non-STEM jobs.

when we want to understand the growth of high-tech employment we need to go beyond the traditional split of manufacturing and non-manufacturing. STEM intensity, related to the non-routine content of high-tech jobs provides a more meaningful distinction.

The fact that we can note that non-STEM jobs are also growing suggests that there exist complementarities between STEM jobs and non-STEM jobs. We will explore these in section V in more detail, but for the time being it suffices to point out that this is likely due to demand spillovers from STEM jobs to non-STEM jobs, through the consumption of complementary services. The crucial issue is hence to assess whether these STEM jobs, which are pushing the long term trends in polarization and employment growth across various sectors, are typically also jobs that provide high value added. We take this up in the Section III and IV.

9. Employment shares across STEM intensity in the Netherlands, Belgium, Germany, Spain, Italy



Notes: Employment is expressed as share in total employment. We plot the percentage point change in the employment share between 1980 and 2007. The primary sector (Agriculture and Mining) and Private household employment are left out. Employment shares for European countries is a cross-country average. The ranking of sectors is based on the average share of STEM employment in EU countries. For a definition of STEM employment, see AI. Data Appendix. Smoothing is done on 28 observations with bandwidth 0.8.

2.3. WITHIN-SECTOR ANALYSIS

So far, the evidence shows that the surge in digital technology enabled by the implementation of key technologies and the presence of STEM workers had an important role in explaining the recent changes in the composition of the labor market. In the previous subsection, this has been shown for changes in the sector level employment shares. Arguably, the influence of technology should also be visible in similar changes in employment away from routine tasks taking place within sectors. Therefore, we explore how polarization takes place within sectors and how this relates to the ICT intensity of a sector, returning to employment at the level of occupations. To this end, we use data from EUROSTAT on employment in 10 broad occupational categories in various sectors for the years 2008-2014[11]. This data covers not only the EU 28, but also countries like Norway, Switzerland and Turkey, 34 countries in total. Following Goos et al (2014) we group these 10 occupational categories in three, 'low-paying', 'middle-paying' and 'high-paying' occupations[12].

In Table 2 and Table 3 we show, by sector, the average change in employment shares for each of these three broad occupational groups, averaged over all countries in our sample. The appendix provides a break-down by country.
While we cover only 7 years of data and include the 'great recession', we find that even in this relatively short time period polarization continues to increase. In Table 2, we can note that for the major sectors, Construction, Manufacturing and Services, the share of middle-paying jobs, associated with routine tasks, has been declining between 2008-2014, with 4%, 3.1% and 3.1% respectively. The share of the high-paying jobs has been increasing with 5% in construction, 3% in Manufacturing and 1.5% in Services. Only in Agriculture we can note a different pattern, but Agriculture represents only a tiny fraction of total employment. The share of low-paying occupations has also gone up, except in Construction. It is also important to note that the pattern of job polarization cannot be pinned down to particular sectors. Job polarization takes place within most sectors (see Table 3). Routine jobs (middle-paying) are on average declining in all sectors, while most sectors see especially a strong relative increase in high-paying occupations. For low-paying occupations we see a mixed picture, with most of them being either stable or slightly increasing.
The fact that job polarization is taking place within sectors indicates that substantial heterogeneity exists between firms and type of occupations within sectors. The fact that we see such a strong effect with high-paying occupations and middle-paying occupations suggests that it is technological change that is the main trigger, affecting all sectors in a similar way. We explore the role of technology for within-sector employment changes more directly in Figure 10.

The fact that we see such a strong effect with high-paying occupations and middle-paying occupations suggests that it is technological change that is the main trigger, affecting all sectors in a similar way.

Table 2: Job Polarization within Broad Sectoral Classifications: 2008-2014

Sector	High	Middle	Low
Agriculture	-1.6%	0.8%	0.7%
Construction	5.3%	-4.0%	-1.2%
Manufacturing	3.0%	-3.1%	0.0%
Services	1.4%	-3.1%	1.7%

Source: Eurostat ELFS, authors' calculations

Notes : Occupation employment is grouped within a sector by the wage levels according to the distinction made in Table 1, p4 of Goos, Manning and Salomons [2014]. The changes across the period 2008-2014 are averaged across EU 28 plus Norway, Switzerland and Turkey.

11 Eurostat does not publish data at the level of sector-occupations before 2008. 12 In particular, low-paying: 'Elementary Occupations', 'Service and Sales Workers', 'Agricultural, forestry and fishery workers'; middle-paying: 'Armed Forced Occupations', 'Clerical Support Workers', 'Craft and Related Trades.

Workers', 'Plant and Machine operators'; high-paying: 'Technicians and Associate Professionals', 'Professionals', 'Managers'

Table 3: Job Polarization within Narrowly Defined Sectors: 2008-2014

Sector	High	Middle	Low
Administrative support	-1.3%	-1.0%	2.3%
Agriculture	-2.5%	1.4%	1.1%
Arts	2.9%	-2.9%	0.0%
Construction	4.1%	-2.6%	-1.4%
Education	-0.9%	-0.3%	1.3%
Electricity, Gas	12.3%	-11.9%	-0.4%
Financial	5.6%	-6.1%	0.5%
Health	3.2%	-1.3%	-1.9%
Hotels & Restaurants	-0.5%	-0.4%	-0.9%
Household services	1.2%	-1.7%	0.5%
Manufacturing	3.0%	-3.1%	0.1%
Mining	2.9%	-1.9%	-1.0%
Other services	3.4%	-2.1%	-1.3%
Public services	3.2%	-3.7%	0.5%
Publishing, Telecom, IT	3.5%	-4.6%	1.1%
R&D, business services	2.6%	-2.2%	-0.3%
Real Estate	2.2%	-2.8%	0.6%
Transport	1.0%	-1.2%	0.1%
Water supply	9.2%	-2.7%	-6.5%
Wholesale & Retail	-4.3%	-4.1%	8.4%
Extra-territorial organizations	1.0%	-7.7%	6.6%

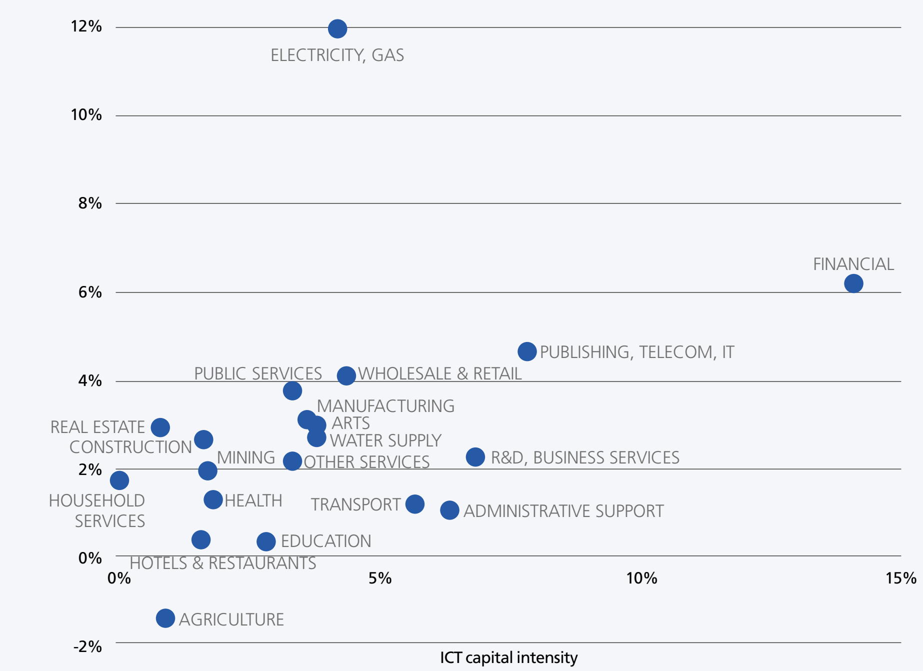
Source: Eurostat ELFS, authors' calculations

Notes : Occupation employment is grouped within a sectpr by the wage levels according to the distinction made in Table 1, p4 of Goos, Manning and Salomons [2014]. The changes across the period 2008-2014 are averaged across EU 28 plus Norway, Switzerland and Turkey.

In Figure 10, we document for the years 2008-2014 the extent of job polarization in various sectors, averaged over all countries in our sample. On the vertical axis we measure an index of job polarization, which we construct by taking the sum of the change in the employment share of the high-paid and low-paid occupational groups. Recall that we observe polarization within each sector. Therefore, within each sector we would expect to see a relative increase in the high-paid as well as in the low-paid occupations and hence the middle-paid ones would decline relatively. We therefore construct a job polarization index by simply adding the shares of the low and high-paid occupations and computing their growth rate over time. Next, we want to explore whether this relative increase in high-paid and low-paid occupations within each sector is correlated with the use of ICT. We therefore measure on the horizontal axis ICT intensity by sector. Hence, we rank sectors by their ICT capital intensity, from low to high.

Each dot in Figure 10 represents the average change between 2008 and 2014 in the employment share of high- paid and low-paid occupations in a particular sector. Since both types should become relatively important, we would expect positive growth rates of their employment shares. In Figure 10, all points, except for the sector Agricultural are located above zero, which indicates that in all sectors polarization, as measured by our index, has increased. We obtain three additional important insights from the pattern shown in Figure 10: First, there is heterogeneity in polarization across sectors. For instance, we can note that polarization is higher in 'Finance' then in 'Retail and Wholesale Trade'. Second this polarization tends to be correlated with ICT intensity. We can note a positive correlation between ICT intensity and our polarization index. Third, this is not just restricted to manufacturing sectors, but equally so in

10. Employment Share changes, Within-Sectors ranked by ICT intensity: 2008-2014



Source: Eurostat, EU KLEMS and Authors' calculations

Notes: This figure plots the data in Table 3 after ranking sectors based on their ICT capital intensity taken from the EU KLEMS database.

services. In particular, in Figure 10, 'Financial Services' and 'Telecom, publishing and IT services' are among the most intensive ICT adopters, clearly they seem to also be experiencing substantial polarization. (10)

So far, we have looked at job polarization reflected in differential growth rates of various occupations, where the employment in the high-tech, typically, high-skilled and abstract occupations as well as low paid service jobs tends to have grown disproportionately at the expense of middle type, routine occupations. The growth of both low- and high-tech employment can be explained by complementarities between high-skilled and low-skilled non-routine occupations. This affirms the role of technology as a main driver for the changes that are found both within and between sectors. Taken together, the three types of measurements reviewed in this section, all point in the direction of digital technology driving the aggregate evolution captured by deindustrialization and job polarization. This can be explained by the hypothesis of routine biased technical change where digital technology substitutes for the routine task content of employment. Given that this innovation and presence of routine tasks cannot be restricted to the traditional distinction between manufacturing and services, this evidence calls for a new view of the labor market where we cut through the data by looking at task content and susceptibility to technological change.

From the hypothesis of routine-biased technical change, we know that the negative and positive effects of labor-saving technology does not affect all workers equally.

III. High-Tech Employment and Recessions

In order to understand the timing of the events discussed in the previous section, it is important to think about what the impact of technology is in the short to medium run. Firstly, if digital technology is implemented with the aim of reducing (labor) costs, it is important to understand whether if affects firms by increasing output because firms are capable of producing at a lower cost; or by reducing employment because it has become more productive; or by a combination of these two.

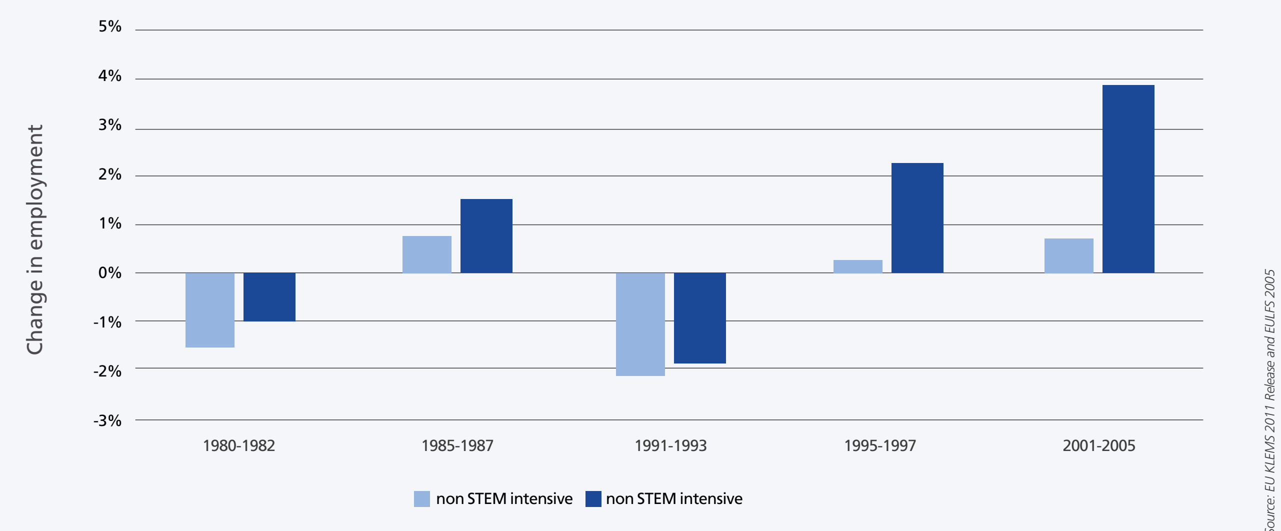
This depends highly on whether firms pass on cost-saving technology into lower prices and on whether product markets respond rapidly to these prices. On the one hand, economists such as Keynes (1933) have argued that innovation improves labor productivity faster than product demand and as such, is bound to reduce employment at least in the short to medium run. This effect has a direct negative impact on employment known as "Technological Unemployment". Others have claimed that firms do pass on the cost reducing impact of innovation into lower prices and that product markets respond rapidly to such changes. The increased product demand would imply an increase in production and overall demand for inputs, including employment. Even if economists cannot agree on the timing in the short run, it is plausible that both of these effects become important after some time. Still, from the hypothesis of routine-biased technical change, we know that the negative and positive effects of labor-saving technology does not affect all workers equally. In addition, it is important to understand when firms find it optimal to invest in labor-saving technology, i.e. when opportunity costs are low. There is evidence that firms use recessions to implement innovation because opportunity costs of restructuring are low. The "cleansing effect" of recessions is often associated with both job destruction and job creation since it usually involves the introduction of new production processes, replacing the least productive by more productive (e.g. Foster, Grim and Haltiwanger, 2014; De Loecker and Konings, 2006).

This is particularly relevant in the context of automation and digitalization, where routine type jobs may suffer more from such a creative destruction process. In contrast, high-tech STEM jobs are less likely to be displaced as they typically are complementary to ICT technology that is being implemented faster in recessions. Therefore, the performance of STEM intensity employment is the focus of this section. To analyze whether high-tech employment is doing better in recessions, we take not only the recent great recession of 2008-2009 into account, but we consider all recessions that took place since 1980 in the various countries that we have in our data set. We use two main sources to define the existence of recession and expansion periods, the NBER for the US and the OECD for the EU[13], Japan and Australia. The OECD labels recession periods through its Composite Leading Indicator (CLI).[14]

3.1. STEM EMPLOYMENT AND RECESSIONS IN EUROPE, THE US AND JAPAN: A GENERAL DISCUSSION

Figures 11 to 13 show for Europe, the U.S. and Japan the evolution of STEM versus non-STEM jobs during recessions. Overall, these graphs show that STEM intensive sectors tend to do better during recessions than sectors that are less intensive in STEM jobs. Since the EU KLEMS data stop reporting in 2007, we could not tune in on the impact of the great recession, but we will do so using another more disaggregated data set of firms in the next section. Figure 12 shows for the U.S., however, that during the dotcom crisis of 2001 STEM jobs did worse. This may be explained by the fact that the dotcom crisis hit the U.S. especially severe, given the high concentration of ICT activities in places like Silicon Valley. Figure 14 confirms this, in particular, it plots the evolution of ICT investment as a percent of GDP in the U.S.. While clearly on a strong upward trend, during the dotcom crisis it collapsed in a major way and hence it is not surprising that especially STEM jobs were hurt. But, this collapse in ICT investment seems rather the exception.

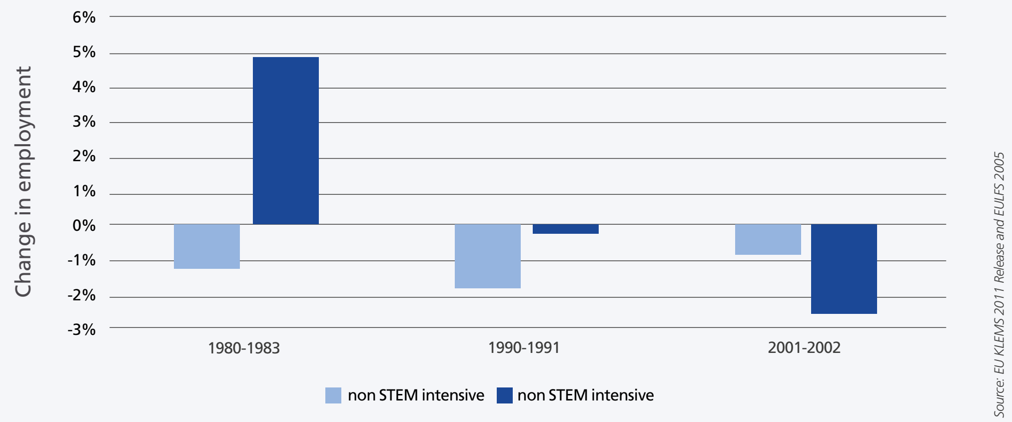
11. Evolution of Employment in Europe during recessions



Notes: Employment is expressed in millions of hours worked as a cross-country average. We plot the growth in employment within different episodes of recession. Periods of recessions has been determined by the OECD through a leading indicator for countries. http://www.oecd.org/std/leadingindicators/CLI-components-and-turning-points.pdf. Episodes for Europe are based on Germany. Stem intensity is defined at the sector level where sectors are characterized as STEM intensive if the share if STEM employment is more than 13,5%. This accounts for 22% of all employment in 1980, increasing to 30% of employment in 2007. For a definition of STEM employment, see AI. Data Appendix.

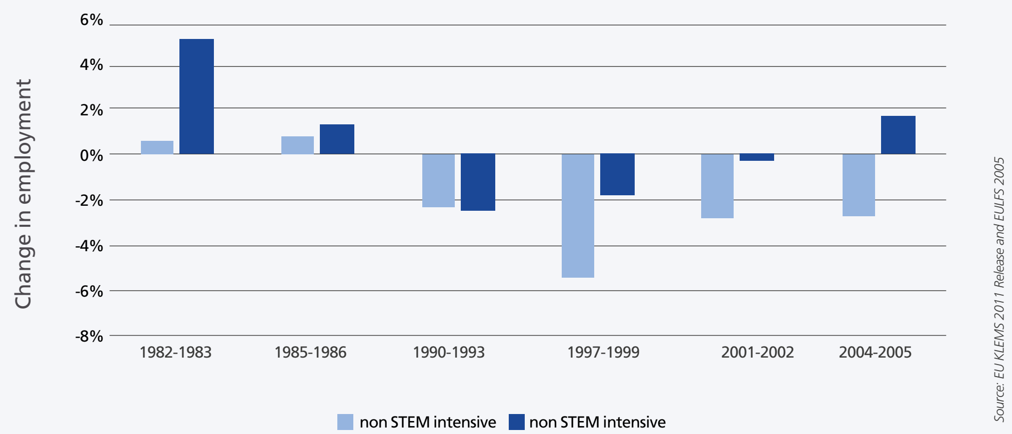
13 The recession periods for the EU are approximated by the recession periods in Germany. 14 The OECD CLI system is based on the growth cycle and identifies business cycles as deviations from the trend. The main reference series to calculate these deviations is industrial production (IIP) covering all industry sectors with the exclusion of construction, given its cyclical nature and monthly availability. GDP for the total economy is used to complement the more specific information of IIP. The NBER explores the behavior of several indicators, placing more emphasis on indicators that encompass the entire economy rather than specific sectors. It uses three independently developed indicators of monthly GDP and GDI, real personal income excluding transfers, the payroll and household measures of total employment, and aggregate hours of work in the total economy. Monthly data on industrial production and manufacturing-trade sales are used only as complementary information when there is any ambiguity.

12. Evolution of Employment in the United States during recessions



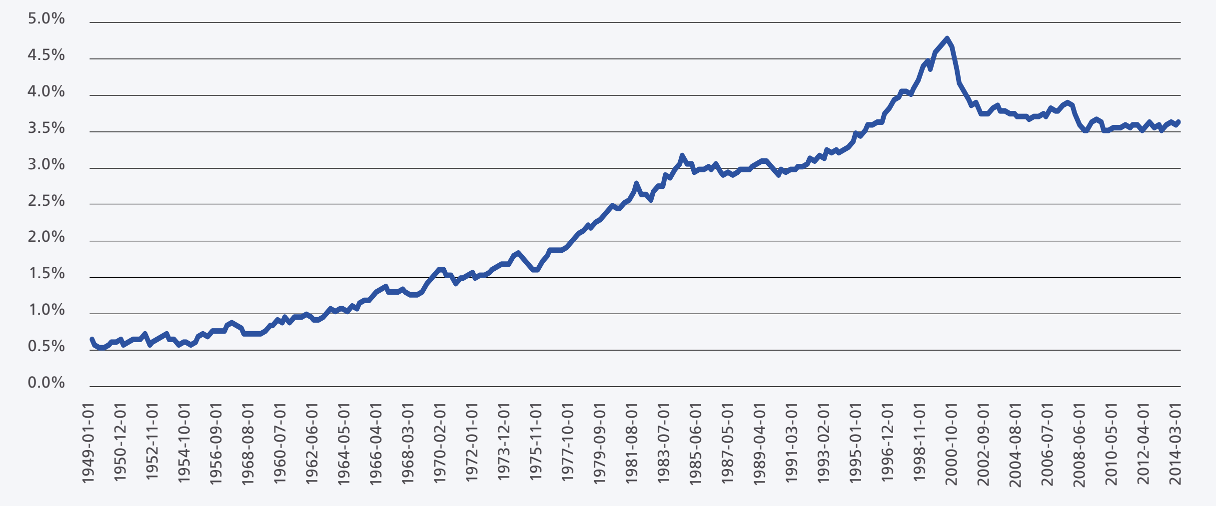
Notes: Employment is expressed in millions of hours worked. We plot the growth in employment within different episodes of recession. Periods of recessions has been determined by the NBER on the basis of business cycles. http://www.nber.org/cycles.html Stem intensity is defined at the sector level where sectors are characterized as STEM intensive if the share if STEM employment is more than 13,5%. This accounts for 22% of all employment in 1980, increasing to 30% of employment in 2007. For a definition of STEM employment, see AI. Data Appendix.

13. Evolution of Employment in Japan during recessions



Notes: Employment is expressed in millions of hours worked. We plot the growth in employment within different episodes of recession. Periods of recessions has been determined by the OECD composite leasing indicator for countries. http://www.oecd.org/std/leading-indicators/CLI-componentsand-turning-points.pdf Stem intensity is defined at the sector level where sectors are characterized as STEM intensive if the share if STEM employment is more than 13,5%. This accounts for 22% of all employment in 1980, increasing to 30% of employment in 2007. For a definition of STEM employment, see AI. Data Appendix.

14. Private fixed investment in information processing equipment and software as a percentage of GDP



Notes: Quarterly data, seasonally adjusted. Downloaded from https://research.stlouisfed.org/fred2.

3.2. REGRESSION ANALYSIS

In order to assess the impact of recessions in a more rigorous manner, we engage in a statistical analysis using all countries and sectors available in the EU KLEMS data between 1980 and 2007. In particular we look at how annual employment growth in each sector is affected by recessions and whether sectors that have a higher share of STEM jobs behave differently during recessions[15]. Table 4 confirms the aggregate data and the graphs of previous section and shows that in recessions employment growth is reduced by 2.3%, but sectors that are more STEM intensive (the multiplication between Recession and STEM in the table) tend to have higher growth rates on average.

Table 4: Evolution of employment growth rates during recessions

	Growth
Recession	-0.023***
	(0.005)
Recession X STEM	0.012***
	(0.003)
N	214

*Notes: Country-specific dummies for the years of recession displayed in Figures 8 to 11 are interacted with stem intensity. Error terms are clustered at the country-sector intensity level. For the estimated coefficients: ***, significant at 1 percent level. **, significant at the 5 percent level and *, significant at the 10 percent level. Standard errors are in parentheses.*

15 We run the following model, with g representing employment growth, subscript s is sector, c is country and t is year. R is a dummy equal to 1 when a country is in a recession and 0 else, STEM is the share of STEM jobs in a particular sector and ε is a white noise error term.: $g_{sct}=\alpha_0+\alpha_1 R_{ct}+\alpha_2 R_{ct}\times STEM_{sc}+\alpha_3 STEM_{sc}+\varepsilon_{sct}$. We expect that α_1 is negative as in recessions job growth is lower, but α_2 would be expected to be positive if sector that are more STEM intensive to better in recessions. We estimate this equation using fixed country and sector effects.

Average labor productivity growth is higher in STEM intensive sectors.

IV. Productivity and High-Tech Employment

It is important to take into account the impact on productivity as despite STEM jobs do better in recessions, this may be at the expense of productivity. In particular, if there would be some kind of labor hoarding going on for STEM jobs: when output collapses, output per worker or labor productivity would also collapse. We therefore look at how STEM jobs perform in terms of productivity. This is important to understand given that lower growth is one of the main concerns about increased servitization. Since there are also many STEM jobs located in services we explore in this section whether they are capable of realizing productivity gains.

To this end, we use two different data sources. The first is the one we have been using so far and is the EU KLEMS data. These data provide information on value added per worker, but also on total factor productivity growth. The latter measure also takes into account other factor of production, besides labor. Our second data source is the Amadeus firm level data base. First, it provides us data up to the year 2012, which allows us to extent the analysis beyond 2007, which is the final year that the EU KLEMS data provides useable information. Second, the firm level data allow us to explore heterogeneity between firms within sectors, taking into account size and age differences, which are often related to employment demand in firms and hence the sectors they operate in. Third, we will be able to look at spillovers between firms.

4.1. PRODUCTIVITY AND STEM JOBS: A GENERAL DISCUSSION

In Table 5 and 6 we show for Europe, the U.S. and Japan the average labor productivity growth (i.e. value added per worker) and total factor productivity growth respectively. We do this for two sub-periods, 1980-2007, the entire sample period we have and 1995-2007 (the appendix provides data by country). Arguably, the spread of ICT and the emergence of STEM jobs has been more important in the latter period than in the 1980s. We classify sectors in STEM intensive when they have a share of more than 13.5% of their employment in STEM occupations (when we use different cut-offs, such as 10%, the results remain similar, see appendix).

The results confirm our intuition and earlier work by Goos et al. (2015) and Bay Area Council (2012). In particular, on average labor productivity growth is higher in STEM intensive sectors. In Europe, the average growth in labor productivity is 1.88%, similar to the U.S., where it was 1.91% between 1980-2007. Labor productivity in non-STEM intensive sectors is clearly lower. This pattern is even more pronounced in Japan. When we look at the later period, 1995-2007, we can note that the average annual labor productivity growth in STEM intensive sectors is much higher in the U.S. than in Europe. This may explain why overall productivity growth in the U.S. has been much higher than in Europe in the last decade. When we look at growth in total factor productivity, which is a more complex, but complete measure of productivity, we find similar results.

4.2 PRODUCTIVITY AND STEM JOBS: FIRM LEVEL ANALYSIS

4.2.1. EMPLOYMENT, PRODUCTIVITY AND THE GREAT RECESSION

We use firm level data from the Amadeus data base to compute labor productivity (value added per worker). This data base covers firms that are active both in manufacturing and nonmanufacturing sectors and a wide range of European countries for the period 2002 – 2012. We use data of more than 1.1 million firms covering the following countries, Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Portugal, Spain, Sweden and the United Kingdom. Table 7 shows some basic firm level patterns in relation to the STEM intensity of the sectors these firms are operating in, summarized over all countries and years that we observe the firms (see appendix for similar data by country). The pattern described in Tables 5 and 6 based on more aggregate sector level data also emerges when firm level data are used. Average labor productivity is lower in firms operating in non-STEM sectors compared to sectors in STEM sectors, 50 361 euro versus 57 831 euro. Also employment is lower, 18 versus 42 workers on average. Moreover, we find that the annual growth rate in labor productivity as well as in employment is higher in firms active in STEM sectors, despite that on average these firms are larger.

Table 5: Yearly growth in labor productivity (STEM 13.5%)

	Europe	USA	Japan
1980 – 2007			
STEM	1.88%	1.91%	3.80%
NO STEM	1.62%	1.48%	1.87%
1995 – 2007			
STEM	1.84	2.81%	**3.19%**
NO STEM	1.15%	1.55%	1.17%

Source: EU KLEMS 2011 Release and Authors' calculations

Notes: Labor productivity is defined as a volume index (with 1995 = 100) of gross value added per hour worked. Growth rates in the table are compound annual growth rates. Aggregations are weighted by sector employment. For Japan, labor productivity data is available until 2006 and missing for NACE 95t97.

Table 6: Yearly growth in TFP (STEM 13.5%)

	Europe	USA	Japan
1980 – 2007			
STEM	0.72%	0.42%	1.17%
NO STEM	0.60%	0.44%	0.30%
1995 – 2007			
STEM	0.62	0.88%	**1.46%**
NO STEM	0.25%	0.51%	-0.22%

Source: EU KLEMS 2011 Release and Authors' calculations

Notes: TFP is based on value added. Growth rates in the table are compound annual growth rates. Aggregations are weighted by sector employment. For Australia, Japan and the USA, TFP measures are missing for NACE 95t97. For Japan, TFP measures are only available until 2006.

Table 7: European Firms in STEM versus Non-STEM sectors

	Labor productivity	Employment	Growth labor productivity	Growth employment
NON-STEM	€ 50 361	18	1.0%	1.0%
STEM	€ 57 831	42	2.4%	2.7%

Source: Amadeus and Authors' calculations

Table 8: Can STEM jobs weather the Crisis?

	Job growth	Job growth	Productivity	Productivity
STEM	0.055* (0.038	0.035 (0.037)	0.661*** (0.003)	0.636*** (0.004)
CRISIS X STEM		0.068** (0.022)		0.098*** (0.008)
CAPITAL/LABOR			0.004*** (0.000)	0.004*** (0.000)
#OBSERVATIONS	12472171	12472171	7444205	7444205

Source: Amadeus and Authors' calculations

*Notes: For the estimated coefficients: ***, significant at 1 percent level. **, significant at the 5 percent level and *, significant at the 10 percent level. Standard errors are in parentheses.*

In Table 8 we show on the basis of a standard firm level regression analysis that these differences are statistically significant and persist even when we control for the size and age of the firm and the capital intensity of the firm. Furthermore, Table 8 also shows that the great recession has triggered a process in which firms active in high intensive STEM sectors increase their productivity as well as their employment. The idea here is that during the recession typically STEM occupations benefit from restructuring, implementing new and more modern ICT production techniques. This is confirmed in column (2) and (4) of Table 8. In column (2) the coefficient that belongs to Crisis X STEM is 0.068 which indicates that on average job growth has been 6.8% higher during the crisis in firms that operate in STEM intensive sectors, compared to firms that operate in non-intensive STEM sectors. Similarly, the last column, column (4) indicates that the average measured labor productivity in firms active in STEM intensive sectors is 63% higher than in firms that operate in non-intensive STEM sectors. Moreover, during the crisis the labor productivity in firms in STEM intensive sectors increases even more. This suggests that firms in STEM-intensive sectors use recessions as periods to restructure and engage in more technology adoption, consistent with the idea of Schumpeterian creative destruction described earlier.

4.2.2. LOCAL FIRM SPILLOVERS

While we have demonstrated that STEM jobs seem to be more cushioned against shocks, like the financial crisis, there is another important dimension related to STEM jobs. In particular, as shown above, STEM jobs are typically more productive, and this cuts across sectors. In other words, we can note that STEM jobs within manufacturing are more productive, but also STEM jobs within Service sectors are. The fact that they are more productive suggests that they may generate additional demand. In particular, workers employed in STEM occupations would typically have higher pay (as these jobs are also more productive) and hence they are likely to spend part of this locally, which may increase local demand for services often related to non-STEM occupations (e.g. restaurants, coffee bars, hairdressers, child care, etc.). This channel, which emphasizes the complementarity between STEM and non-STEM jobs, has been documented before in the context of what is known as local multipliers (e.g. Moretti, 2012).

In Table 9 we therefore analyze to what extent STEM jobs are complementary for non-STEM jobs. We therefore analyze employment growth in European firms, taking into account that typically small firms and young firms tend to grow faster than large firms and old firms. We look for an additional effect on employment growth of non-STEM-jobs. In particular, if the fraction of STEM jobs in total in a particular region is high, we would expect that this generates additional demand for non-STEM jobs. We therefore look at the correlation between the fraction of regional STEM jobs and average firm level growth of non-STEM jobs[16] of firms in the same region. In Table 9 we report a positive and statistically significant coefficient of 0.05. This means that as the fraction of STEM jobs in total in a particular region increases, this has positive effects on non-STEM employment, indicating spillovers between STEM jobs and non-STEM ones in the same region. We explore this further in the next section.

The great recession has triggered a process in which firms active in high intensive STEM sectors increase their productivity as well as their employment. The idea here is that during the recession typically STEM occupations benefit from restructuring, implementing new and more modern ICT production techniques.

Table 9: Complementarities between STEM and non-STEM jobs

	Employment growth non STEM	Employment growth non STEM
LOG (EMPLOYMENT LAST YEAR)		-0.036*** (0.001)
LOG (AGE OF THE FIRM)		-0.0267*** (0.001)
REGIONAL FRACTION OF STEM JOBS IN TOTAL	0.03*** (0.006)	0.05*** (0.009)
# OBSERVATIONS	9,670,799	9,588,719

Source: Amadeus and Authors' calculations

As the fraction of STEM jobs in total in a particular region increases, this has positive effects on non-STEM employment, indicating spillovers between STEM jobs and non-STEM ones in the same region.

16 Recall that we classify firms in sectors which are typically low intensive in terms of STEM versus sectors which are typically high-intensive in terms of STEM jobs.

Some complementarity exists between STEM and non-STEM intensive employment which is necessary to explore in order to understand the full impact of innovation and targeted policies on the economy-wide employment.

V. Policy Implications

This section discusses some of the avenues that policy makers can explore in order to mitigate the negative transition effects of technological progress while trying to maximize the positive effects. Firstly, we consider an important positive spillover effect that exists between STEM and non-STEM employment. The evidence above shows that both low-paid, low-tech and high-paid, high-tech employment is growing in importance in the economy. This implies that our policy should not only be geared towards training more STEM workers, but also to support this low-tech service employment to respond to the increased demand. Still, the evidence of complementarity between the two suggests that it could be enough for policy makers to create policies that stimulates STEM employment in order to boost both target groups. This is contrary to the consideration in public debates that investing in STEM only creates employment at the top while destroying employment at the bottom. Second, we consider how such policy boosting STEM employment might be developed and what it should focus on. Specifically, we look at the potential impact of investment in (higher)

5.1. COMPLEMENTARITY BETWEEN STEM AND NON-STEM EMPLOYMENT

The evidence above shows that both employment and productivity growth can be associated in particular with STEM employment. Moreover, STEM employment provides a better buffer against employment loss during recessions than non-STEM employment. However, as mentioned in section II.1 and II.2., employment growth is not restricted to STEM employment, which can be found both in manufacturing and service sectors. The drop of employment in low-tech manufacturing sectors is also absorbed by an increased employment share in low-paying, low-ICT intensive service employment which tends to be the least STEM intensive sectors in the economy. This suggests that some complementarity exists between STEM and non-STEM intensive employment which is necessary to explore in order to understand the full impact of innovation and targeted policies on the economy-wide employment.

There are several interacting factors which may contribute to this complementarity. We have already given evidence on one aspect of this by showing that there is a positive association between STEM and non-STEM employment at the firm level. In this section we have a closer look at how this plays out at the local level and also provide empirical evidence present in the current literature.

First, we provide a theoretical framework which links innovation to the growth of both high-tech employment as well as employment in local services through a combination of interacting demand and supply effects. The mechanism described is in line with the arguments presented by Autor and Dorn (2013) for the US and Goos, Manning and Salomons (2014) for countries in the European Union underlying the phenomenon of job polarization.

Innovation increases demand for high-tech jobs because of existing complementarity of these jobs in the production of high-tech goods. In additional, the decrease in the relative price of these high-tech goods (in accordance with the idea of Baumol's cost disease) may increase the demand for employment in high-tech production. Secondly, innovation leads to an increase in demand for local services following an increase in the average income in the region. This demand-side effect may be sizeable given the evidence that demand for services is relatively income elastic but also price demand inelastic. Consider, for example, the increase in demand for household services, childcare, restaurant, schools, etc., as the average income in developed countries increased. In addition, we can expect this increased demand to remain even in the case of increasing relative prices. For example, the demand for education is likely to increase even if consumers are facing increasing prices. We can expect this increased demand for services to be translated in increased employment demand given that these services cannot be readily automated due to their non-routine content or outsourced. The non-tradable aspect of services can be related to the fact that these local services also tend to be in-person, such as waiting on someone in a restaurant or cutting someone's hair in a barbershop.

This mechanism may explain why there is growth in both high- and low-tech employment and more specifically, why a local high-tech job multiplier may exist given that the increased demand for non-tradable, in-person services can be expected to have local effect. A local high-tech job multiplier

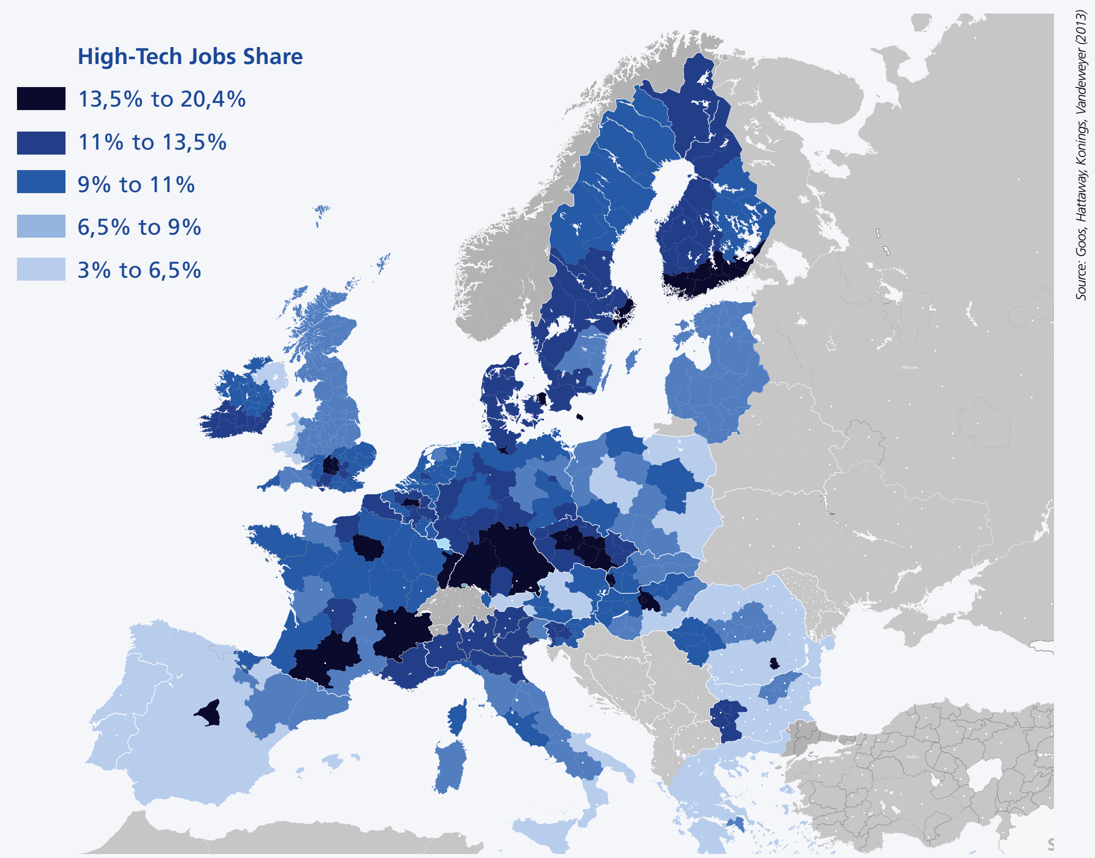
Innovation leads to an increase in demand for local services following an increase in the average income in the region. We can expect this increased demand for services to be translated in increased employment demand given that these services cannot be readily automated due to their non-routine content or outsourced. The non-tradable aspect of services can be related to the fact that these local services also tend to be in-person, such as waiting on someone in a restaurant or cutting someone's hair in a barbershop.

would capture that for every additional job in high-tech employment, more than one additional job is created within the region.

Evidence for such a local high-tech job multiplier has been presented by Moretti (2010) for US cities. Moretti estimates that for every created tradable job, 1.5 non-tradable jobs are created within the same city. This estimate increases to 2.5 in non-tradable local goods and services when considering only the creation in skilled jobs. The estimated local multiplier increases further to 5 when considering urban high-tech employment in two specific sectors: "machinery and computing equipment"; and "electrical machinery and professional equipment". Moretti and Wilson (2014) provide further specificity by exploring the impact of local R&D subsidies in multiple states. They present even larger local job multipliers which have particular impact on the growth of employment in construction, for job creation in bio-tech companies. This evidence has been extended to Sweden using information on 72 local labor markets in Sweden. The multiplier following an additional job in skilled tradable employment is 2.8 for non-tradable employment in that region. This number decreases to 1.1 when considering and additional job in high-tech manufacturing.

The fact that local spillovers between high-tech jobs and low-tech jobs, or alternatively, 'abstract STEM type of jobs'

15. Regional distribution high-tech jobs



and ‘service non-routine jobs’ becomes clear from Figure 15, which shows that high-tech employment is often regionally concentrated. Typically these tech hubs are in major urban areas throughout the continent and in regions with highly skilled workforces.

Goos et al. (2015) consider therefore the existence of a local high-tech job multiplier with regional data at the NUTS 2 level of 27 countries of the European Union. Moreover, the authors expand the definition of high-tech employment. Starting with the high-tech employment at the sector level, it includes all workers employed in manufacturing sectors defined by a high ratio of R&D expenditure over value-added and in knowledge-intensive services characterized by a high share of tertiary educated workforce. In addition, high-tech employment is determined by employment in STEM occupations which are located across both high-tech and other sectors. This implies that high-tech employment is captured both through the specificity of the occupation itself or the innovation character of sector activity. For example, we consider an engineer to be high-tech employment regardless of the sector he or she is working in because it is a STEM occupation. On the other hand, a manager, which may not be regarded as high-tech per se, is considered as such if he or she is working in a high-tech sector. This generates four components of high-tech employment: STEM occupations in high-tech sectors, STEM occupations outside high-tech sectors, and non-STEM employment in high-tech sectors.

To take into account that the interpretation of the empirical results may not be causal if, for example, there are shocks at the regional level which affect both high-tech and other employment, the authors suggest a correction in constructing Instrumental Variables. The instruments are based on taking the average growth in high-tech employment in the country, excluding the growth of the region for which the instrument is calculated. In addition, this instrument is expanded to the four different components of high-tech employment based on their definition. See Goos et al. (2015, p6-7) for further details.

The authors report the results for the OLS and IV specification using either or both of the instruments described for 5-year growth periods. The OLS estimates suggest that the creation of one high-tech job leads to the creation of 2.57 jobs in other employment within that region. The IV specification provides substantially larger estimates. Regardless of the specified instruments, the estimated local multipliers suggest that for every high-tech job, 4.75 other jobs are created in the region. This is robust to restricting the growth in high-tech employment to STEM occupations. That is, if we consider growth in high-tech employment only as the growth in STEM occupations and exclude non-STEM employment in high-tech sectors, the estimated local multiplier still equals 2.8 when applying OLS and 4.45 when making use of the introduced instruments[17]. The definition of high-tech employment, which is more specified towards the presence of innovation may explain the difference in magnitude of the estimated job multiplier with respect to the previous evidence.

In sum, regional growth in high-tech employment can be connected to an even stronger growth in other employment, which may be explained by the presence of complementarity in consumption and spillover effects in demand. This can explain why there is growth also beyond STEM occupations as a second order effect of innovation taking place. The estimates suggest that, on average, with the introduction of one high-tech workers between 2.5 and 4.4 jobs are created outside high-tech employment. This also implies that policies geared towards high-tech employment can boost both employment groups which we know are under increased demand due to technological progress and their non-routine nature. Contrary to what is sometimes considered, the boosting of high-tech employment helps rather than hurts growth of employment at the bottom.

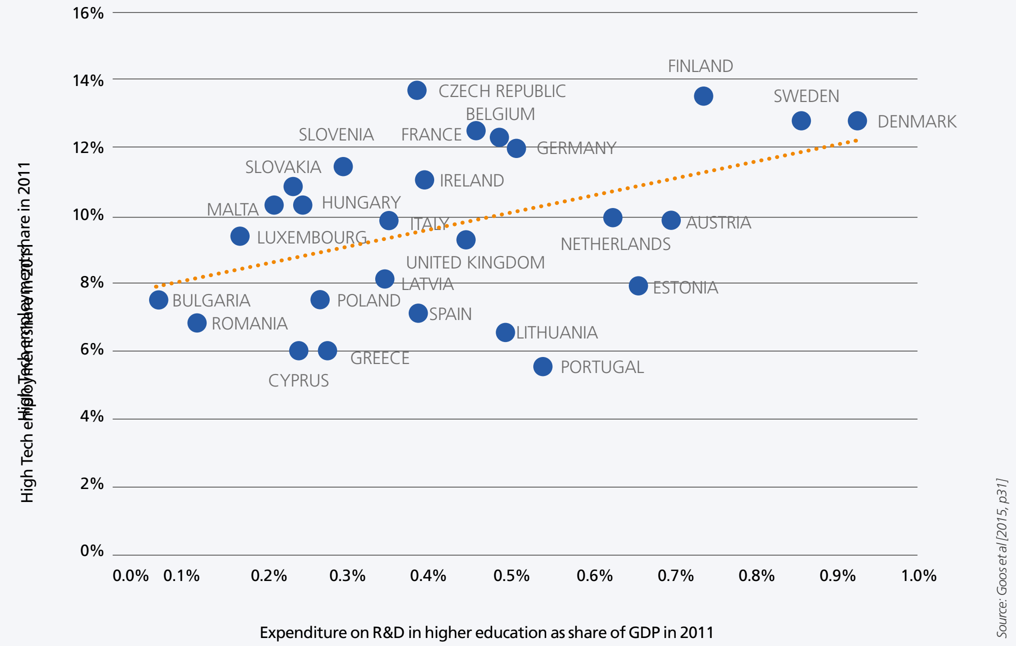
5.2. STEM EMPLOYMENT AND HUMAN CAPITAL

Given the evidence of positive spillover effects of STEM employment and its robustness to economic shocks, it becomes increasingly important to understand how we can gear policy towards supporting the growth in these occupations. This section tries to shed some light on the potential policy implications of the importance of STEM employment at the country level in creating higher levels of economy-wide employment growth which may also prove to be more resilient to negative shocks in the economy.

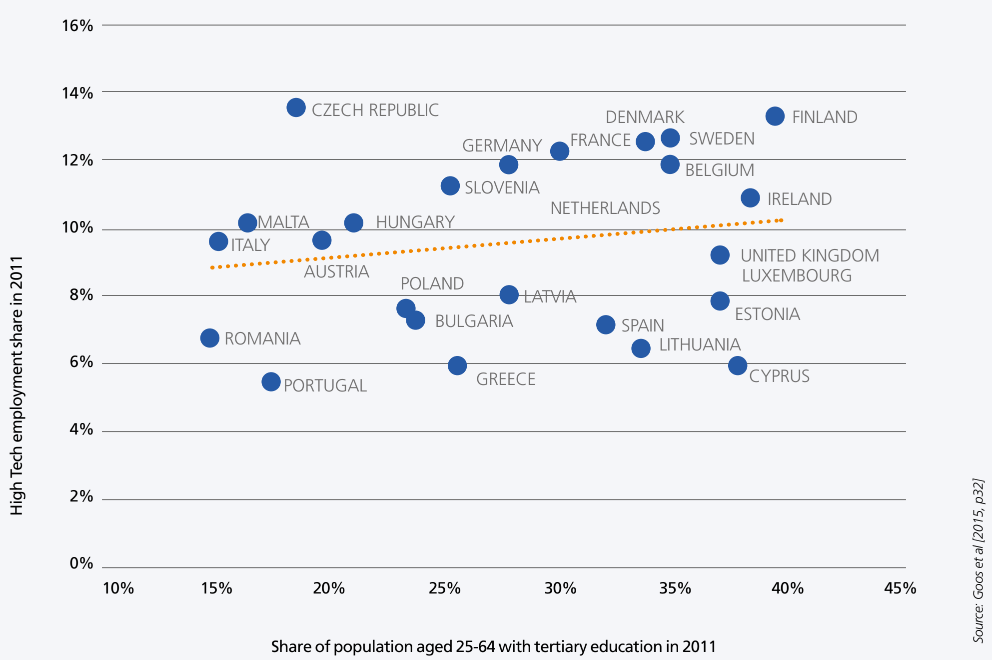
The estimates suggest that, on average, with the introduction of one high-tech workers between 2.5 and 4.4 jobs are created outside high-tech employment. This also implies that policies geared towards high-tech employment can boost both employment groups which we know are under increased demand due to technological progress and their non-routine nature. Contrary to what is sometimes considered, the boosting of high-tech employment helps rather than hurts growth of employment at the bottom.

17 These results can be found in greater detail in Table 3 of Goos et al. (2015).

16. High-tech employment share in 2011



17. High-tech employment share in 2011



Policies on how to boost STEM employment may remain important as Figure 6 and 7 show that country level differences in the share of STEM employment are not decreasing. Goos et al. (2015) also present the existence and persistence of regional dispersion both at the country and regional NUTS-2 level. While they also argue that convergence between regions is taking place, it is very slow. At the rate that the authors estimate it would take Europe's lagging regions at least 60 years to close half of the gap with Europe's more high-tech intensive regions.

There exist many possible explanations for such regional differences, which are very difficult to detangle and to causally relate. This section provides some suggestive evidence taken on the importance of Human Capital growth for the share of high-tech employment. Figure 15 plots on the horizontal axis, a country's expenditure on R&D in higher education as a share of GDP in 2011.

A clear positive relationship can be discerned between the expenditure in R&D in higher education and the share of high-tech employment across countries. However, the figure also suggests that some countries make better use of their investments than others. While countries like Lithuania and Portugal spend more or less equal amounts of investment in R&D as a share of their GDP as countries such as Belgium and Germany, their high-tech employment share is only half, which suggests a potential doubling of their high-tech employment share by spending their investments in R&D in higher education more effectively.

The authors provide a second indicator at the country level for the importance of high education to boost STEM employment: the share of tertiary educated aged 24-64 in a country. These results are reproduced in Figure 17.

Again, the relationship is positive, suggesting that a higher share of tertiary educated can be associated with a high share in high-tech employment. The correlation is relatively weak though indicating that increasing the share of tertiary educated is less effective in fostering the growth of STEM occupations in a country. One reason for this may be that the quality of the education rather than the quantity matters for the growth of high-tech employment. In other words, the 33% share of tertiary educated in Spain may have a different content that the 33% share in the Netherlands or in Denmark[18].

In sum, low public investment in (higher) education both in terms of quantity and quality may be holding back growth in high-tech employment and is one of the reasons why there is such persistence in the differential growth of high-tech employment between regions. This suggests that regions should consider increasing their investment in tertiary education and in R&D in higher education in particular as means to boost their high-tech employment growth. Still, the presence of wide cross-country variation suggests that some caution is necessary. Not all expenditure in (higher) education is equal and countries should consider policy measures careful, also when adopting them from other, seemingly successful contexts.

In sum, low public investment in (higher) education both in terms of quantity and quality may be holding back growth in high-tech employment and is one of the reasons why there is such persistence in the differential growth of high-tech employment between regions. This suggests that regions should consider increasing their investment in tertiary education and in R&D in higher education in particular as means to boost their high-tech employment growth.

18 The authors show that the correlation increases when restricting the share of tertiary educated to those with high literacy proficiency levels or when examining the regional differences in tertiary attainment within countries.

Conclusions and Recommendations

In order to understand the rapid changes that the labor market is currently experiencing, this paper takes a closer look at the long-run process of deindustrialization and job polarization. We use various data sets to document that these two are related phenomena. In particular, job polarization provides a more accurate decomposition of the growth in services in the economy associated with the phenomenon of deindustrialization. Job polarization also connects to the task approach of the labor market which provides the meaningful distinction in employment between routine and non-routine tasks. This allows us to bridge the observed changes with the driving force of technological change and reveals that the servitization of the economy and the associated stagnation is much more complex. By focusing on key enabling technologies, we have shown that the implementation of ICT has triggered a process of job polarization due to an increased automation of encodable tasks in search of cost cutting. Moreover, we have also shown that the presence of STEM workers provides an even more accurate approximation of the exposure to new technologies. That is, high intensity of STEM workers is associated with higher growth in employment share. In favor of technology underlying the changes in employment shares resulting in job polarization, the evidence also shows that job polarization can be found within narrowly defined sectors in addition to between sectors. Moreover, this within-sector job polarization increases with the ICT intensity of that sector.

This exercise has demonstrated that the current wave of technological change forces us to move away from the traditional classification of the economy into manufacturing and nonmanufacturing sectors. Rather we should think in terms non-routine tasks embedded in jobs versus routine tasks. With automation the latter are easily replaced or offshored to low-wage countries, while non-routine tasks are harder to substitute with robots.
By focusing on employment with high STEM intensity, the evidence reveals that these employment shares are not only associated with higher growth, but also with better performance during recessions than other employment and with higher levels of productivity, measured as labor productivity or TFP more broadly.

While there are interesting cross-country differences, these results are strikingly similar between the different OECD countries that we study in this paper. This reinforces the idea of a global force such as technological change or globalization being behind these changes.

This evidence also reinforces the possibilities for policy makers to target and tailor future policies. While the cross-country variation in labor market institutions provide interaction effects which should be taken into careful consideration by policy makers, it is possible to make some general recommendation for policy makers. First of all, policy should not be blindsided by the traditional structures of manufacturing versus non-manufacturing as engines for growth. This paper has shown that innovation occurs in both camps. Therefore, the servitization of the economy need not be associated with long term declines in economic growth. It is more meaningful to distinguish between employment in the way it interacts with technology. Two dimensions have been introduced: ICT capital intensity and STEM share in employment. By focusing on employment which is STEM intensive, you can boost employment which benefits highly from the current technological change, it is more resilient during recessions and can generate higher levels of productivity. Moreover, we have provided evidence of a structural link between STEM and non-STEM employment, especially in in-person services. This takes place because of positive spillover effects from STEM employment through demand in consumption for local services. Therefore, by supporting STEM employment, the other, expanding share of the market may also be supported. We have given one suggestion of possible avenue for economic policy by providing evidence of a positive association between better and higher investment in (higher) education and STEM employment.

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APPENDIX

LIST OF FIGURES AND TABLES

A 1. Data Appendix

A. EU KLEMS

Based on harmonized data from the National Statistics of several OECD countries the authors Timmer et al. [2007] have compiled a country-sector level dataset over a long period of time, 1970-2007. This dataset contains information on sectors (ISIC rev 3. which overlaps with NACE rev. 1) concerning: Value added, output volume, labor and capital input and output prices (a.o.). Interesting is that the employed capital can be split into ICT and non-ICT. This allows us to compute an indicator on a sector's susceptibility to advances in digital technology.

In order to have consistent information between 1980 and 2005/2007, we confine the analysis to the following 15 countries: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Ireland, the Netherlands, Spain, Sweden, UK, United States, Japan and Australia. Information on the United States starts in 1980 which is why we take this as a starting point.

For the majority of summary statistics, a cross-country average of European countries will be used. This leaves us with 4 country indicators, EU= average of European countries, US= United States, JPN= Japan, AUS=Australia.

In order to deploy the largest variation possible at the sectors level, we chose the most disaggregated sector level at which we could still find consistent information on ICT capital compensation. This leaves with a total of observations for 31 sectors, as presented in Table 1. These 31 sectors are ranked according to their ICT capital intensity, which is the ICT capital compensation relative to the total income from production measured in Value Added. EU KLEMS defines ICT capital compensation as the product of the ICT capital stock (consisting of office and computing equipment, communication equipment and software) and its user cost. See Timmer et al. [2007] for details. This measure is an indication of the importance of ICT in the production process and therefore also of the potential for implementation of digital technology. ICT capital intensity is therefore a number between zero and one where zero would indicate that ICT capital does not have any role to play in production in which case there is also no susceptibility for advances in digital technology, see Table A1.

Given that the ranking of sectors according to this measure is consistent over time, we make us of ICT capital intensity as measures in 2005. Note that to investigate employment polarization along this dimension we leave out the primary sector. Also, we leave out the sector 'P: Private households with employed persons', due to data limitations. Alternatively we group sectors under.

Manufacturing and Services. Manufacturing contains the sum of employment that falls under the sector section 'D' while Services encompasses everything from 'G' to 'P' as suggested by the OECD.[19]

This leaves out the primary sectors Agriculture, Forestry and Fishing; Mining and Quarrying; Gas, Water and Electricity Supply; and Construction. Note that Gas, Water and Electricity Supply and Construction are included in the statistics on job polarization where we only make use of the ICT capital intensity to rank sectors.

19 https://stats.oecd.org/glossary/detail.asp?ID=2432

Table A 1: Average Ranking of Sectors according to ICT Capital Intensity

		ICT capital intensity 2005 in %
P	**Private households with employed persons**	0.03
AtB	**Agriculture, hunting, forestry, fish**	0.72
70	**Real estate activities**	0.83
F	**Construction**	1.57
H	**Hotels and restaurants**	1.61
M	**Education**	1.81
N	**Health and social work**	1.70
C	**Mining and quarrying**	1.75
20	**Wood and wood products**	1.86
17t19	**Textiles, textile, leather and footwear**	2.15
36t37	**Manufacturing nec; recycling**	2.35
25	**Rubber and plastics**	2.32
27t28	**Basic metals and fabricated metals**	2.48
26	**Other non-metallic minerals**	2.91
52	**Retail trade, except of motor vehicles; repair of household goods**	2.98
15t16	**Food, beverages and tobacco**	3.15
L	**Public admin and defense; compulsary soc sec**	3.35
50	**Sale, maintenance and repair of motor vehicles**	3.45
34t35	**Transport equipment**	3.63
29	**Machinery nec**	3.65
O	**Other community, social and personal services**	3.83
24	**Chemicals and chemical products**	3.92
E	**Electricity, gas and water supply**	4.18
23	**Coke, refined petroleum and nuclear fuel**	6.65
60t63	**Transport and storage**	5.07
51	**Wholesale trade and commission trade, except of motor vehicles**	5.50
21t22	**Pulp, paper, printing and publishing**	5.74
30t33	**Electrical and optical equipment**	5.94
71t74	**Renting of m&eq and other business activities**	7.28
J	**Financial intermediation**	14.41
64	**Post and telecommunications**	19.33

Notes: Sectors are ranked by their log ICT capital intensity in 2005. The table presents the cross-country average ICT capital intensity in 2005 for the following countries: Austria, Belgium, Denmark, Spain, Finland, France, Germany, Ireland, Italy, Netherlands, Sweden, United Kingdom, United States, Japan and Australia. The ICT capital intensity is defined at the income share accruing to ICT capital. That is, ICT capital compensation over Value added at the sector level. Sectors that are underlined are defined by EUROSTAT as high-tech or knowledge intensive.

B. EU LABOUR FORCE SURVEY

The European Union Labor Force Survey is a large sample survey among private households in European countries providing EUROSTAT with data from national labor force surveys. It covers both the active and inactive population over 15 years of age. The used sample for this paper covers the same countries as explored by the EU KLEMS: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Ireland, the Netherlands, Spain, Sweden, UK, for the time period 1995-2007.

Active participants in the labor market were asked both for their principal activity and for their profession. The first is captured by the NACE Rev1.1 (Statistical classification of economic activities in the European Community) code for the establishment where the work is performed. These code have been aggregated to reflect the code level used in the EU KLEMS dataset. The respondent profession is captured by a 2 digit ISCO (International Standard Classification of Occupations) code. This allows us to explore the distribution of certain occupations across industries. Table A2 and A3 list the number of observations in the EULFS sample across countries and sectors for the year 2005. And table A4 shows the share of STEM jobs by sector, computed on the basis of the observed STEM occupations in the LFS in each sector as a fraction of the total number of jobs.[20]

Table A 2: Number of observations in EULFS dataset per country in 2005

Countrey	Frequ ency	Percent
Austria	19,532	5.43
Belgium	10,172	2.83
Denmark	6,551	1.82
Spain	36,063	10.02
Finland	15,665	4.35
France	27,124	7.54
Germany	54,646	15.19
Ireland	29,338	8.15
Italy	46,145	12.82
Netherlands	44,029	12.24
Sweden	22,574	6.27
United Kingdom	48,021	13.34
Total	359,860	100

20 For more information, see http://ec.europa.eu/eurostat/statistics-explained/index.php/EU_labour_force_survey

Table A 3: Number of observations across countries in eulfs dataset per sector in 2005

Sector	Code	Freq.	Percent
Health & social work	N	36062	10.02
Business activities	71t74	35562	9.88
Retail trade; household goods repair	52	31620	8.79
Construction	F	23930	6.65
Education	M	21248	5.9
Other comm, social & personal services	O	21241	5.9
Public admin & defence	L	20654	5.74
Hotels & restaurants	H	16970	4.72
Transport & storage	60t63	16624	4.62
Wholesale trade	51	13874	3.86
Financial intermediation	J	12384	3.44
Agriculture, forestry & fishing	AtB	11825	3.29
Basic metals	27t28	9776	2.72
Food	15t16	8812	2.45
Motor vehicle sale, maintenance & repair	50	8400	2.33
Electrical eq	30t33	7624	2.12
Paper	21t22	6571	1.83
Machinery, nec	29	6412	1.78
Post & telecomm	64	6340	1.76
Transport eq	34t35	5839	1.62
Manufacturing nec; recycling	36t37	5591	1.55
Chemicals	24	4692	1.3
Real estate	70	4269	1.19
Textiles	17t19	4149	1.15
Non-metallic mineral, nec	26	3056	0.85
Electricity, gas & water	E	3000	0.83
Rubber & plastic	25	2992	0.83
Private households	P	2743	0.76
Wood	20	2607	0.72
Mining	C	1233	0.34
Refined petroleum	23	460	0.13
Missing sector			0.92
Total		359,860	100

Table A 4: Average Ranking of Sectors according to STEM share

		average share of STEM occupation employment in 2005
H	Hotels & restaurants	0.70%
P	Private households with employed persons	2.51%
50	Motor vehicle sale, maintenance & repair	2.52%
AtB	Agriculture, fishing forestry	3.90%
20	Wood	3.98%
17t19	Textiles	5.14%
70	Real estate	5.32%
M	Education	5.61%
52	Retail trade; household goods repair	5.89%
O	Other comm, social & personal services	5.96%
36t37	Manufacturing nec; recycling	6.38%
51	Wholesale trade	6.40%
60t63	Transport & storage	6.51%
15t16	Food	6.54%
J	Financial intermediation	6.56%
26	Non-metallic mineral, nec	9.22%
21t22	Paper	9.46%
F	Construction	9.93%
L	Public admin & defence	10.15%
27t28	Basic metals	10.61%
25	Rubber & plastic	11.26%
C	Mining	13.41%
64	Post & telecomm	13.61%
34t35	Transport eq	15.60%
29	Machinery, nec	18.76%
E	Electricity, gas & water	22.22%
71t74	Business activities	24.88%
30t33	Electrical eq	26.59%
24	Chemicals	27.08%
23	Refined petroleum	29.96%
N	Health & social work	31.82%

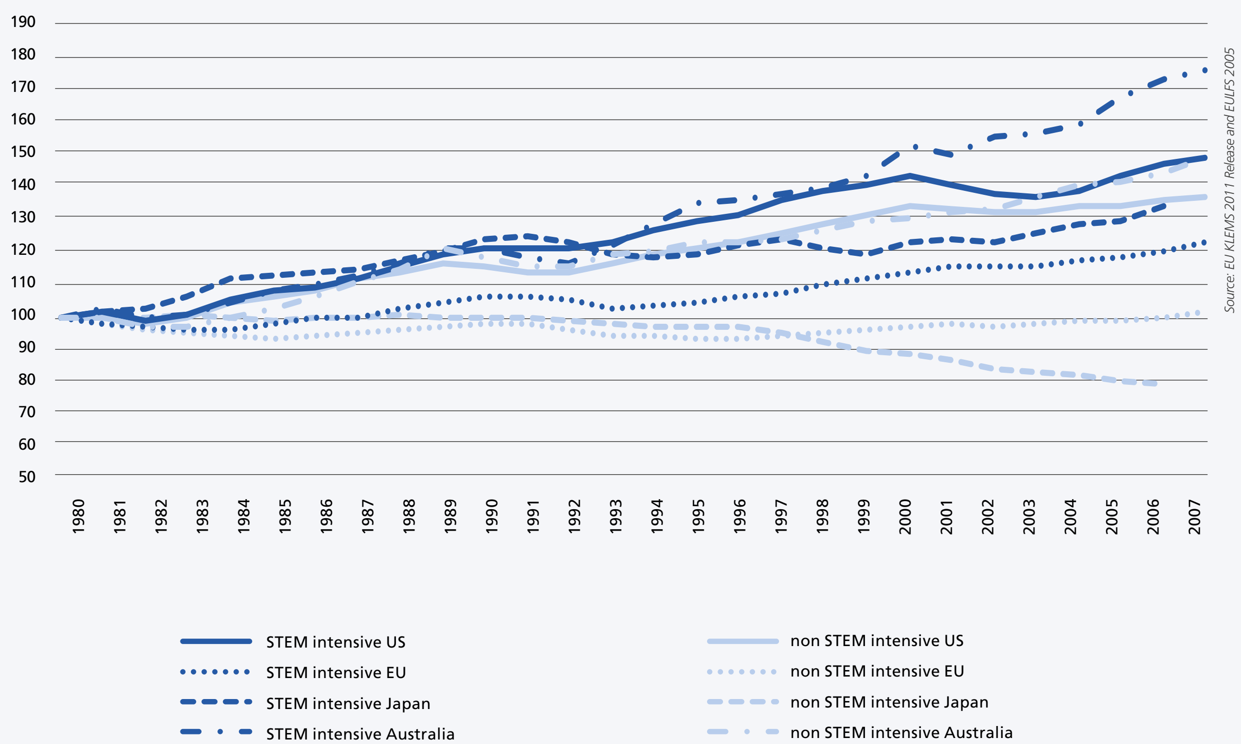
Source: EU Labour Force Survey 2005

Notes: Employment is expressed as share in total employment by sector. These shares are a cross-country average for European countries: Austria, Belgium, Denmark, Spain, Finland, France, Germany, Ireland, Italy, Netherlands, Sweden, United Kingdom. The definition of STEM employment can be found in AI. Data Appendix. See Table A3. About <1% of the data in the EULFS contained no sector code identification.

A.2. ROBUSTNESS

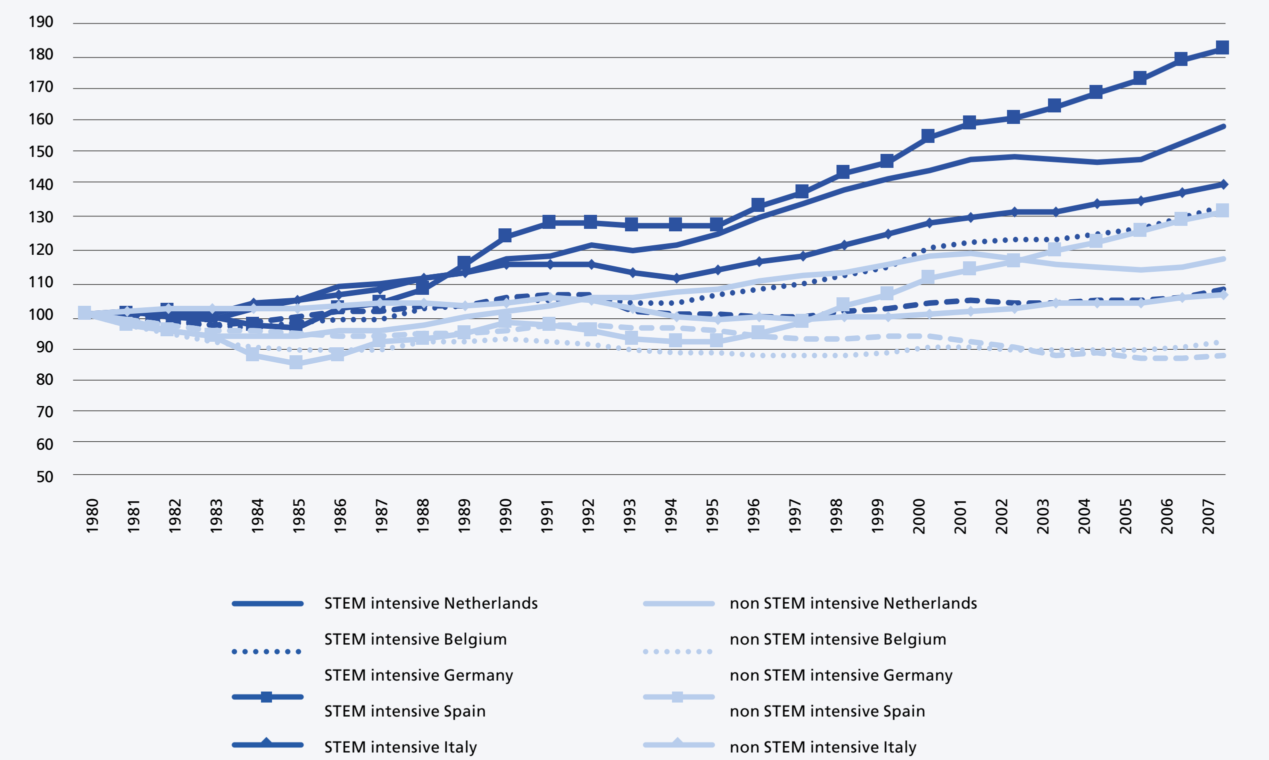
In this data appendix we repeat a number of graphs, but using different cut-offs as a robustness check. In particular, we have used in the main text as a cut off for STEM intensive sectors, 13.5%; we report here the same using a cut-off of 10%. Our results remain by and large the same.

A.1 Evolution of Employment in the U.S., Europa, Australia and Japan (10% stem intensity)



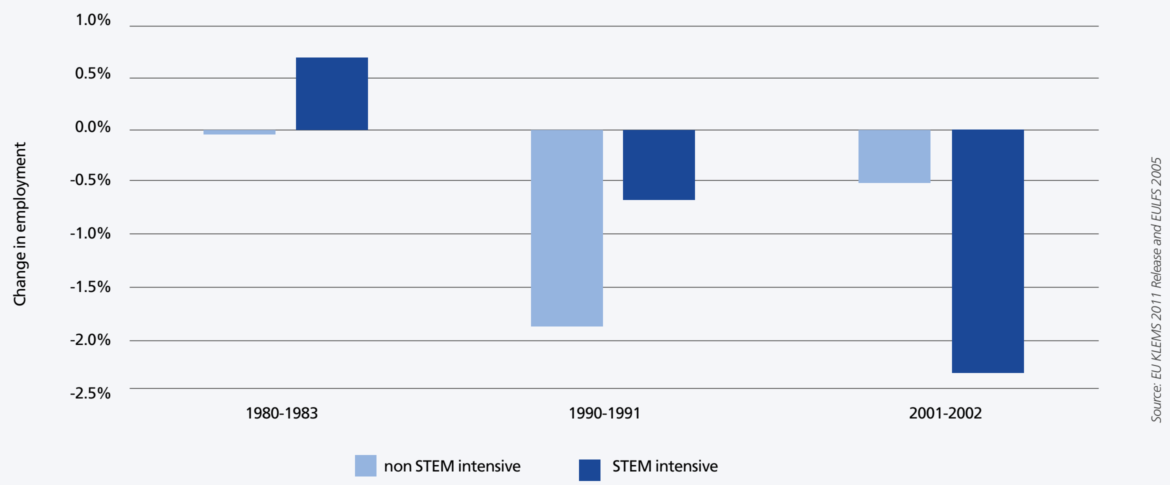
Notes: Employment is expressed in millions of hours worked. We plot the growth in employment between 1980 and 2007 where employment is indexed in 1980 for clarity. Employment shares for European countries is a cross-country average. Employment data for Japan is missing in 2007. Stem intensity is defined at the sector level where sectors are characterized as STEM intensive if the share if STEM employment is more than 10%. This accounts for 34% of all employment in 1980, increasing to 40% of employment in 2007. For a definition of STEM employment, see AI. Data Appendix.

A.2 Evolution of Employment in the Netherlands, Belgium, Germany, Spain and Italy (10% stem intensity)



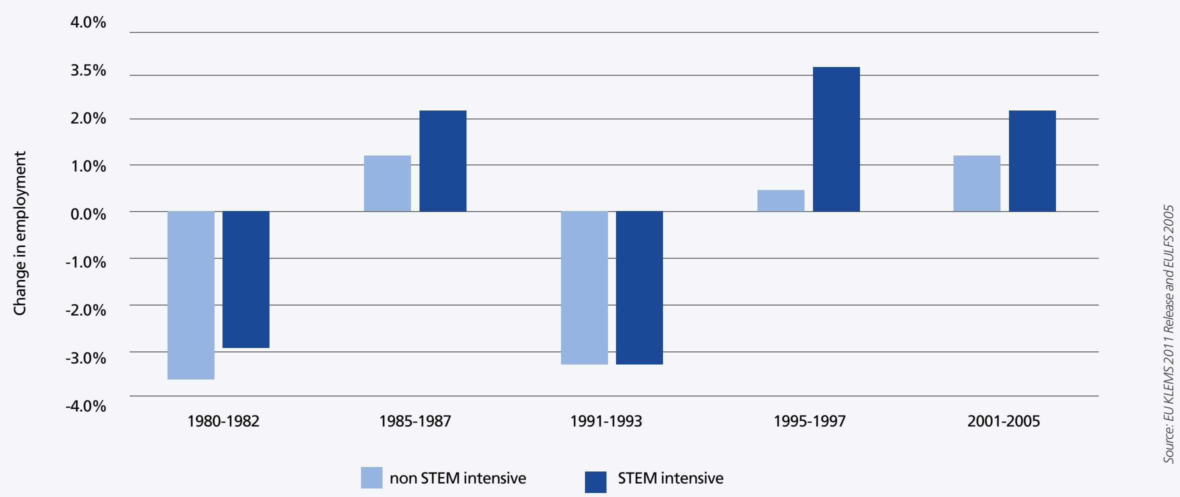
Notes: Employment is expressed in millions of hours worked. We plot the growth in employment between 1980 and 2007 where employment is indexed in 1980 for clarity. Stem intensity is defined at the sector level where sectors are characterized as STEM intensive if the share if STEM employment is more than 10%. This accounts for 34% of all employment in 1980, increasing to 40% of employment in 2007. For a definition of STEM employment, see AI. Data Appendix.

A.3 Evolution of Employment in the United States (10% stem intensity)



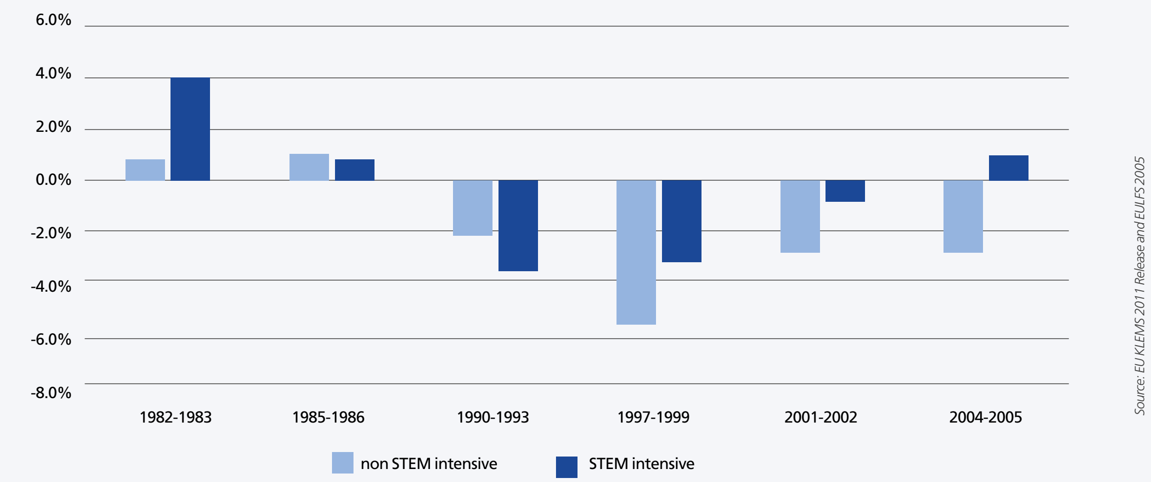
Notes: Employment is expressed in millions of hours worked. We plot the growth in employment within different episodes of recession. Periods of recessions has been determined by the NBER on the basis of business cycles. http://www.nber.org/cycles.html Stem intensity is defined at the sector level where sectors are characterized as STEM intensive if the share if STEM employment is more than 10%. This accounts for 34% of all employment in 1980, increasing to 40% of employment in 2007. For a definition of STEM employment, see AI. Data Appendix.

A.4 Evolution of Employment in Europe (10% stem intensity)



Notes: Periods of recessions has been determined by the OECD through a leading indicator for countries. http://www.oecd.org/std/leadingindicators/CLI-components-and-turning-points.pdf. Episodes for Europe are based on Germany. Stem intensity is defined at the sector level where sectors are characterized as STEM intensive if the share if STEM employment is more than 10%. This accounts for 34% of all employment in 1980, increasing to 40% of employment in 2007. For a definition of STEM employment, see AI. Data Appendix.

A.5 Evolution of Employment in Japan (10% stem intensity)



Notes: Employment is expressed in millions of hours worked. We plot the growth in employment within different episodes of recession. Periods of recessions has been determined by the OECD composite leasing indicator for countries. http://www.oecd.org/std/leading-indicators/CLI-componentsand-turning-points.pdf Stem intensity is defined at the sector level where sectors are characterized as STEM intensive if the share if STEM employment is more than 10%. This accounts for 34% of all employment in 1980, increasing to 40% of employment in 2007. For a definition of STEM employment, see AI. Data Appendix.

Table A 5: Yearly growth in labor productivity (STEM 10%)

	Europe	USA	Japan	Australia
1980 – 2007				
STEM	1.82%	1.64%	3.37%	1.35%
NON STEM	1.60%	1.56%	1.84%	1.46%
1995 – 2007	**Europe**	**USA**	**Japan**	**Australia**
STEM	1.75%	2.26%	**2.93%**	1.46%
NON STEM	1.08%	1.68%	1.07%	1.81%

Notes: Labor productivity is defined as a volume index (with 1995 = 100) of gross value added per hour worked. Growth rates in the table are compound annual growth rates. Aggregations are weighted by sector employment. For Australia and Japan, labor productivity measures are missing for NACE 95t97.

Source: EU KLEMS 2011 Release and Authors' calculations

Table A 6: Yearly growth in TFP (STEM 10%)

	Europe	USA	Japan*	Australia**
1980 – 2007				
STEM	0.64%	0.22%	0.89%	0.06%
NON STEM	0.61%	0.58%	0.31%	0.52%
1995 – 2007	**Europe**	**USA**	**Japan***	**Australia****
STEM	0.63%	0.56%	**1.17%**	0.07%
NON STEM	0.17%	0.65%	-0.27%	0.49%

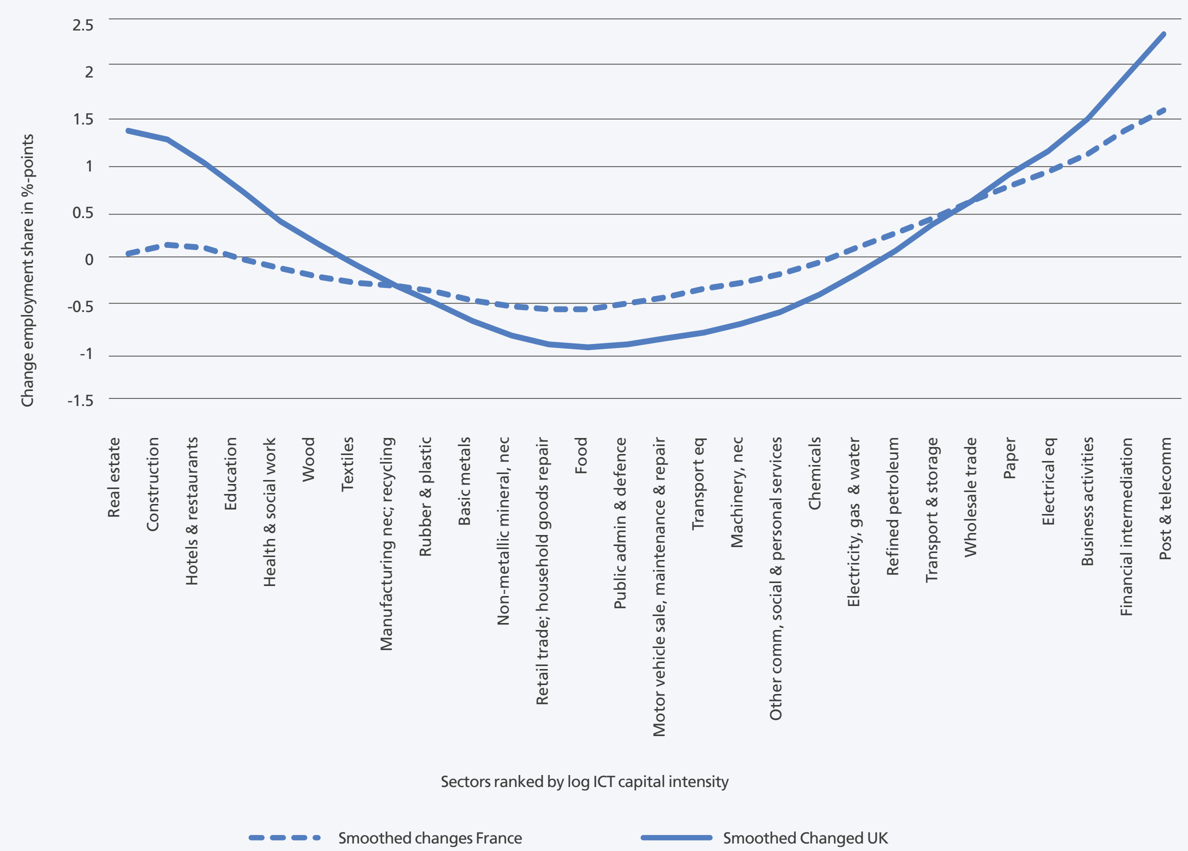
*Notes: TFP is based on value added. Growth rates in the table are compound annual growth rates. Aggregations are weighted by sector employment. For Australia, Japan and the USA, TFP measures are missing for NACE 95t97. * For Japan, no data is available after 2006. Hence for Japan, the calculated growth rates are based on data up to 2006. ** For Australia, no TFP measures are available for the period 1980-1981. So for Australia, TFP growth rates are based on the period 1982-2007 for the upper part of the table.*

Source: EU KLEMS 2011 Release and Authors' calculations

A 3: Country Profiles

A3.1. JOB POLARIZATION: AGGREGATE TRENDS AND WITHIN BROAD SECTOR CLASSIFICATIONS: 2008-2014

A 6: Between-Sector Job polarization in the UK and France: 1980-2007



Notes: Employment is expressed as share in total employment. We plot the percentage point change in the employment share between 1980 and 2007. The primary sector (Agriculture and Mining) and Private household employment are left out. Smoothing is done on 28 observations with bandwidth 0.8.

Source: EU KLEMS 2011 Release and EULFS 2005

Table A 7: Belgium 2008 -2014

Sector	High	Middle	Low
Aggregate	2.8%	-4.6%	1.8%
Agriculture	-7.4%	0.0%	7.4%
Construction	0.2%	2.2%	-2.4%
Manufacturing	3.0%	-0.1%	-2.8%
Services	2.4%	-4.9%	2.5%

Source: EULFS and Authors' calculations

Table A 8: Germany 2008 -2014

Sector	High	Middle	Low
Aggregate	1.4%	-2.5%	1.0%
Agriculture	-0.7%	1.8%	-1.0%
Construction	8.9%	-10.0%	1.1%
Manufacturing	3.4%	-4.7%	1.2%
Services	-0.5%	-0.6%	1.1%

Source: EULFS and Authors' calculations

Table A 9: France 2008 -2014

Sector	High	Middle	Low
Aggregate	3.3%	-7.2%	3.9%
Agriculture	4.5%	1.9%	-6.4%
Construction	18.0%	-18.0%	0.0%
Manufacturing	8.2%	-9.6%	1.3%
Services	0.5%	-4.7%	4.2%

Source: EULFS and Authors' calculations

Table A 10: Italy 2008 -2014

Sector	High	Middle	Low
Aggregate	-4.1%	-3.4%	7.5%
Agriculture	-10.9%	0.0%	10.8%
Construction	0.5%	0.3%	-0.8%
Manufacturing	2.2%	-2.7%	0.4%
Services	-7.1%	-2.4%	9.5%

Source: EULFS and Authors' calculations

Table A 11: Netherlands 2008 -2014

Sector	High	Middle	Low
Aggregate	-0.9%	-4.3%	5.3%
Agriculture	-38.7%	2.6%	36.1%
Construction	-0.3%	-2.1%	2.4%
Manufacturing	5.5%	-5.2%	-0.3%
Services	-1.4%	-3.5%	4.9%

Source: EULFS and Authors' calculations

Table A 12: Poland

Sector	High	Middle	Low
Aggregate	4.3%	-3.1%	-1.2%
Agriculture	2.0%	2.3%	-4.3%
Construction	6.0%	-7.0%	0.9%
Manufacturing	4.3%	-4.1%	-0.1%
Services	2.0%	-2.6%	0.5%

Source: EULFS and Authors' calculations

Table A 13: United Kingdom 2008 -2014

Sector	High	Middle	Low
Aggregate	5.0%	-5.2%	0.2%
Agriculture	-4.2%	-3.3%	7.5%
Construction	6.6%	-5.7%	-0.8%
Manufacturing	2.4%	-3.6%	1.2%
Services	4.9%	-4.1%	-0.7%

Source: EULFS and Authors' calculations

A3.2 STEM VERSUS NON-STEM SECTORS, BY COUNTRY: LABOR PRODUCTIVITY AND TOTAL FACTOR PRODUCTIVITY (EU KLEMSS DATA, STEM SHARE > 13.5%)

Table A 14: Yearly growth in labor productivity (STEM 13.5%)

	1980 – 2007		1995 – 2007	
	STEM	NON STEM	STEM	NON STEM
Australia	1.23%	1.49%	1.54%	1.75%
Belgium	1.37%	1.60%	1.08%	0.89%
France	1.82%	1.99%	1.32%	1.39%
Germany	2.02%	1.63%	1.66%	1.17%
Italy	0.12%	1.15%	0.05%	0.44%
Netherlands	0.95%	1.50%	1.18%	1.71%
Spain	0.98%	1.47%	0.69%	0.38%
United Kingdom	3.10%	1.99%	3.37%	1.58%

Notes: Labor productivity is defined as a volume index (with 1995 = 100) of gross value added per hour worked. Growth rates are compound annual growth rates. Aggregations are weighted by sector employment.

Source: EU KLEMS 2011 Release and Authors' calculations

Table A 15: Yearly growth in Total Factor Productivity (STEM 13.5%)

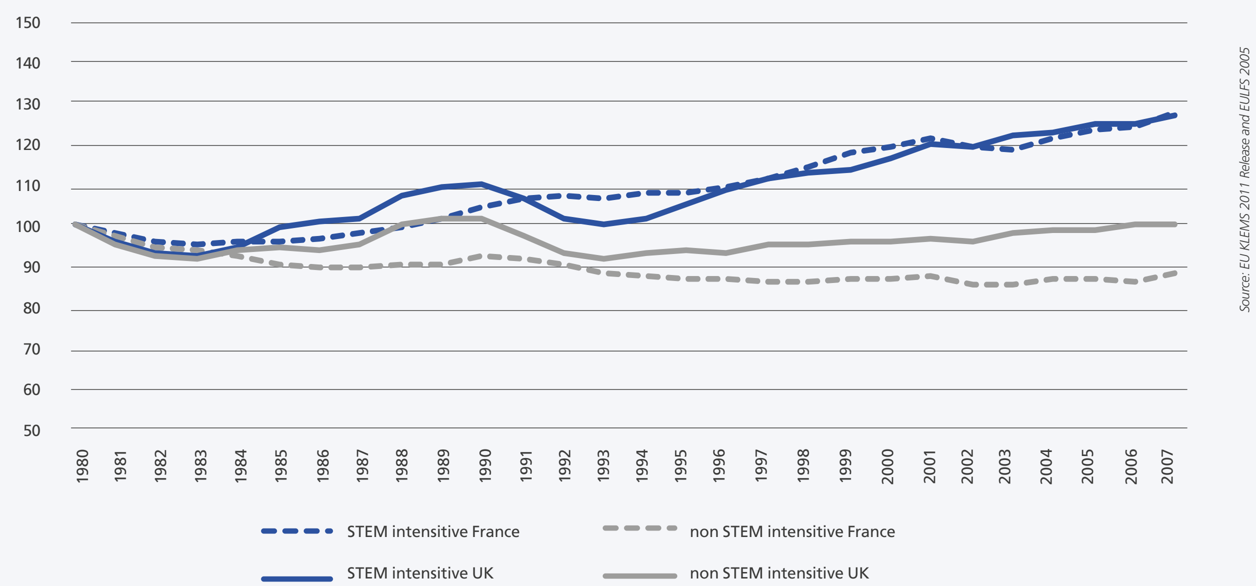
	1980 – 2007		1995 – 2007	
	STEM	NON STEM	STEM	NON STEM
Australia	-0.05%	0.51%	0.12%	0.43%
Belgium	0.06%	0.18%	-0.19%	-0.20%
France	0.75%	0.99%	0.34%	0.46%
Germany	0.95%	0.81%	0.53%	0.73%
Italy	0.07%	0.42%	-0.22%	-0.43%
Netherlands	-0.05%	0.67%	-0.01%	0.74%
Spain	-0.68%	0.09%	-0.81%	-0.73%
United Kingdom	1.22%	0.78%	1.49%	0.27%

Notes: Total Factor Productivity (TFP) is defined as a growth rate (with 1995 = 100). TFP is based on value added. Growth rates are compound annual growth rates. Aggregations are weighted by sector employment. For Australia, TFP measures are reported from 1982 onwards, for Germany from 1991 onwards and for Belgium TFP measures are available until 2006. For Australia, Belgium, The Netherlands, Spain and the United Kingdom TFP there is no data on TFP for NACE 95t97.

Source: EU KLEMS 2011 Release and Authors' calculations

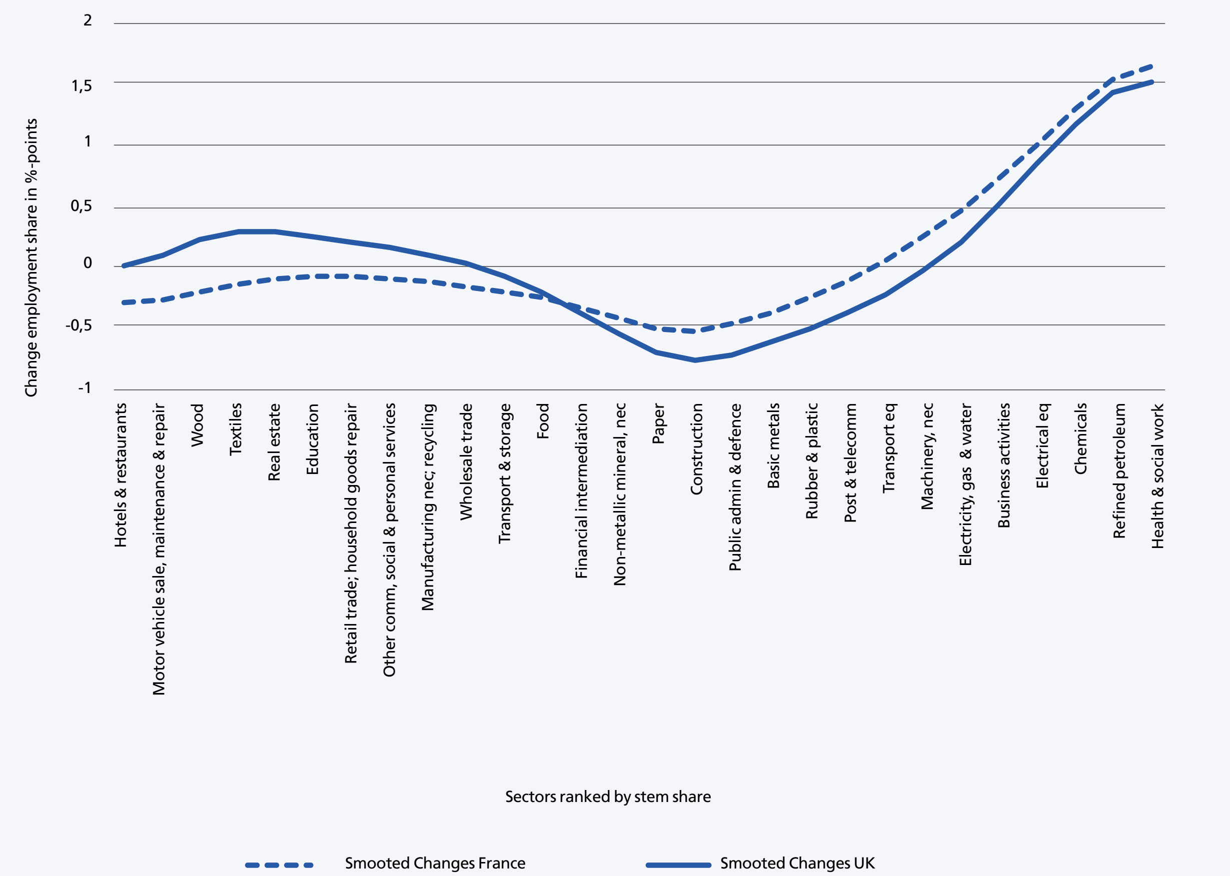
A 3.3 STEM VERSUS NON-STEM SECTORS, BY COUNTRY: LABOR PRODUCTIVITY AND EMPLOYMENT (AMADEUS FIRM LEVEL DATA BASE)

A 7: STEM vs. non-STEM employment in the UK and France: 1980-2007



Notes: Employment is expressed in millions of hours worked. We plot the growth in employment between 1980 and 2007 where employment is indexed in 1980 for clarity. Stem intensity is defined at the sector level where sectors are characterized as STEM intensive if the share if STEM employment is more than 13,5%. This accounts for 22% of all employment in 1980, increasing to 30% of employment in 2007. For a definition of STEM employment, see AI. Data Appendix.

Figure A 8: STEM vs. non-STEM employment in the UK and France: 1980-2007



Notes: Employment is expressed as share in total employment. We plot the percentage point change in the employment share between 1980 and 2007. The primary sector (Agriculture and Mining) and Private household employment are left out. The ranking of sectors is based on the average share of STEM employment in EU countries. For a definition of STEM employment, see AI. Data Appendix. Smoothing is done on 28 observations with bandwidth 0.8. 0

Table A 16: STEM versus Non-STEM sectors – Belgium

	Labor productivity	Employment	Growth labor productivity	Growth employment
Non-STEM	€ 103 411	12	0.1%	3.4%
STEM	€ 106 614	33	0.7%	4.5%

Source: Amadeus and Authors' calculations

Table A 17: STEM versus Non-STEM sectors – Germany

	Labor productivity	Employment	Growth labor productivity	Growth employment
Non-STEM	€ 76 290	39	0.8%	3.8%
STEM	€ 78 316	133	1.3%	5.5%

Source: Amadeus and Authors' calculations

Table A 18: STEM versus Non-STEM sectors – France

	Labor productivity	Employment	Growth labor productivity	Growth employment
Non-STEM	€ 61 488	16	3.3%	1.3%
STEM	€ 72 548	43	4.2%	2.7%

Source: Amadeus and Authors' calculations

Table A 19: STEM versus Non-STEM sectors – Italy

	Labor productivity	Employment	Growth labor productivity	Growth employment
Non-STEM	€ 54 283	21	-1.3%	2.0%
STEM	€ 58 575	48	0.9%	2.9%

Source: Amadeus and Authors' calculations

Table A 20: STEM versus Non-STEM sectors – Netherlands

	Labor productivity	Employment	Growth labor productivity	Growth employment
Non-STEM	€ 108 367	6	4.9%	0.9%
STEM	€ 105 470	12	8.7%	3.6%

Source: Amadeus and Authors' calculations

Table A 21: STEM versus Non-STEM sectors – United Kingdom

	Labor productivity	Employment	Growth labor productivity	Growth employment
Non-STEM	€ 66 640	133	-2.3%	0.5%
STEM	€ 78 052	134	0.0%	1.0%

Source: Amadeus and Authors' calculations

part II

The squeezed middle

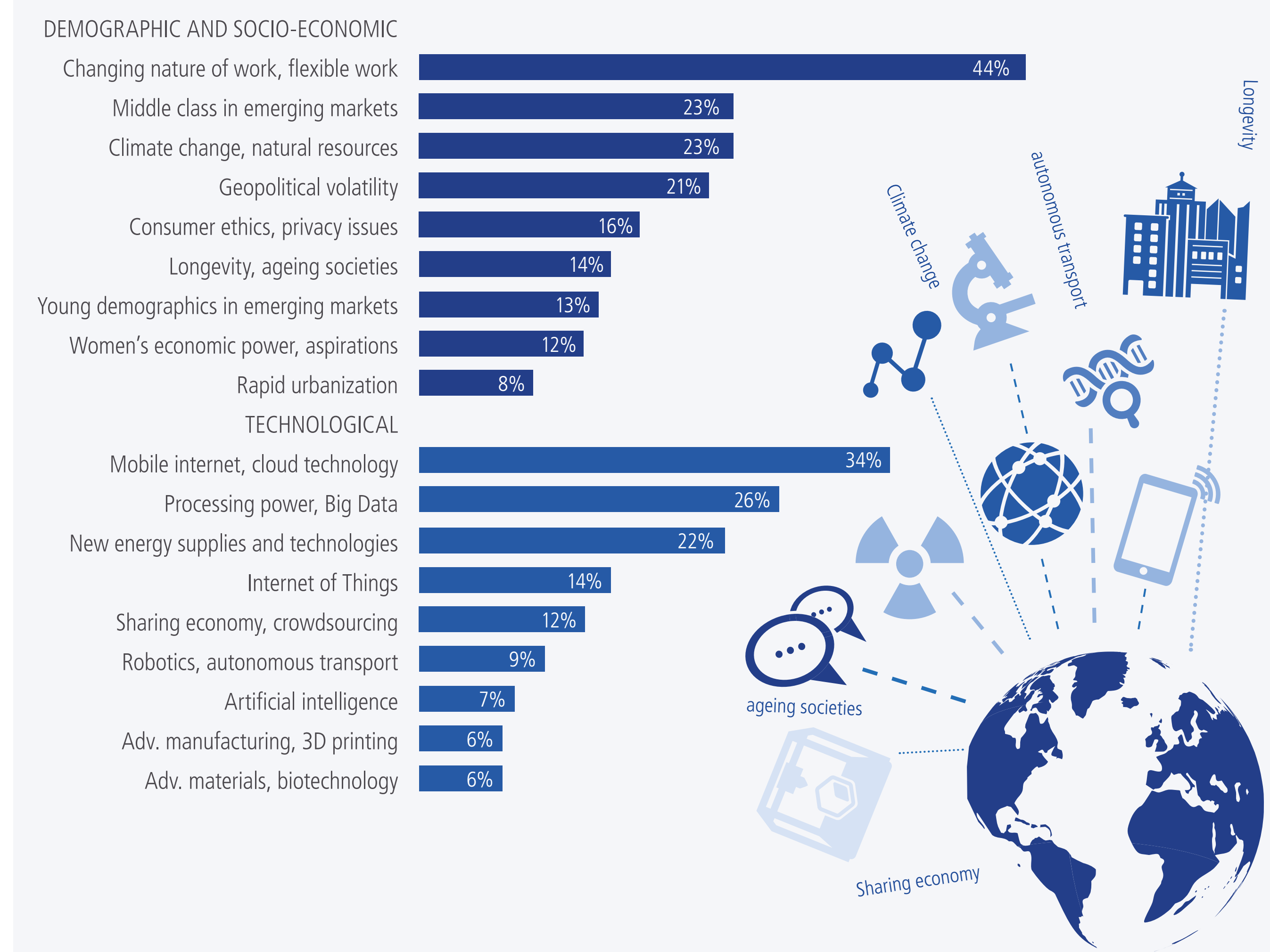
Jobs traditionally associated with the middle class (assembly line workers, data processors, foremen and supervisors) are beginning to disappear, either through relocation or automation. Workers must either move up, joining the group of “mind workers” which will continue to grow in demand (engineers, doctors, attorneys, teachers, scientists, professors, executives, consultants), or settle for low-skill, low-wage service jobs thereby pushing the low-educated out of the labor market.

Labor market 2015

The world of work is being reshaped by tremendous forces. Economic shifts are redistributing power, wealth, competition and opportunity around the globe. Disruptive innovations, radical thinking, new business models and resource scarcity are impacting every sector. Technology is changing industries at a rapid pace and the labor market is therefore entering a period of uncertainty. Managing this transition is an important challenge, as is preparing for the future for the workforce of tomorrow.

The balance among employment sectors – and the kinds of skills required by those sectors – has been shifting for five decades. Occupations, both traditional and new, require more highly skilled workers now than before. The Information Age is affecting the workforce in several ways. Especially the medium-skilled workers are being replaced by computers that can do the job more effectively and faster. This has created a situation in which workers who perform tasks which are easily automated being forced to find work which involves tasks that are not easily automated and workers are being forced to compete in a global job market.

Future of work, drivers of change



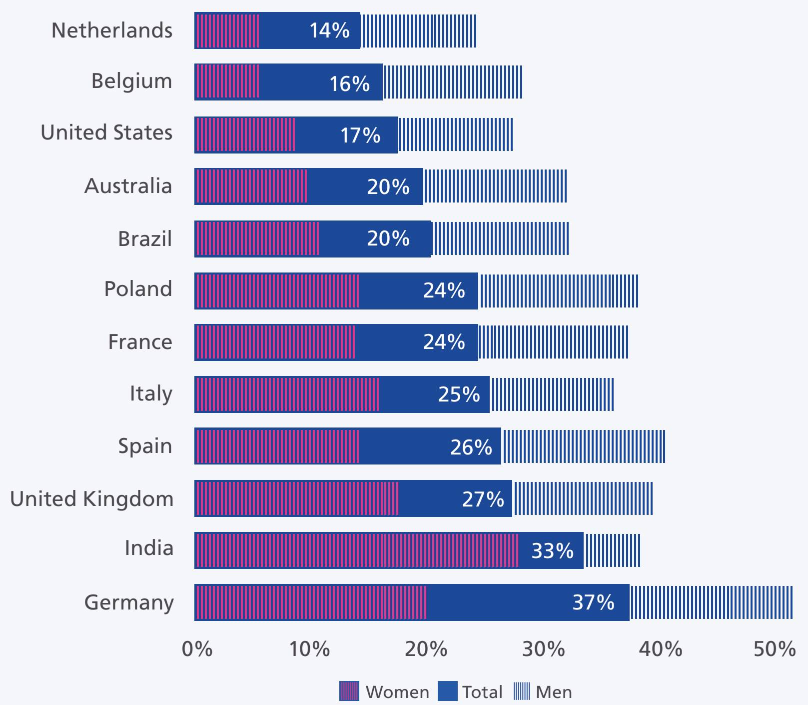
Source: WEF, Future of jobs (2016)

SKILLS ARE NEEDED MORE THAN EVER

Being skilled has always been an advantage – if not a necessity – for individual workers. Today, having a skilled workforce is just as much a necessity for countries competing in an advanced economy. Promoting education and training is an important facet of developing a skilled workforce.

Skilled people generate knowledge that can be used to create and implement innovations and educated workers have a better start for acquisition of further skills. On the other hand, a concern is that in the future of work, only the highly skilled will have access to rewarding professional careers, and that this trend will increase

Percentage of students in tertiary education enrolled in STEM



Source: UNESCO (2014)

Investing in STEM

Investment in STEM disciplines (science, technology, engineering and mathematics) is increasingly seen in the US and Europe as a means to boost innovation and economic growth. The importance of science education is recognized on both sides of the Atlantic but the debate gets particularly heated when it intersects with immigration. Europe is in a similar position to the United States, but has much more rigid immigration policies making that Europe attracts fewer high-skilled workers than not only the United States, but also Canada and Australia. Only 3 percent of scientists in the European Union come from non-EU countries, whereas in the United States 16 percent of scientists come from abroad.

Educate for the 21st century

The future of work requires a systemic change in education and training. The types of skills that employers need are changing all the time. Employees need to continually learn and adapt to changing and new industries. Business needs are reshaped continuously by technology, creating ongoing skill gaps both individuals and countries will have to address.
Education systems are often badly equipped to develop these dynamic skills in students, most schools and universities are teaching a 20th-century education to young people who will need cutting-edge 21st-century skills. Employers need to collaborate with schools and universities on the development of curricula and a shared practical knowledge of the market. The education system also needs to change to allow a focus on lifelong learning.

inequality on the labor market. Countries can, through the education system, develop the skills needed for participation in the labor market. This requires a broad range of skills that raise employability in the short term (and ease their transition to the labor market) as well as in the long term, by giving people the capacity to learn, develop further and adapt their knowledge to labor market needs.

Education and labor policy need to be re-examined to make them more reactive and relevant to the ever-changing market realities. On average, developed countries spend about 6 percent of their GDP on educational institutions. Most countries have worked to increase the proportion of students who complete secondary education and move on to post-secondary and higher education.

The importance of science education is recognized on both sides of the Atlantic but the debate gets particularly heated when it intersects with immigration. Europe is in a similar position to the United States, but has much more rigid immigration policies making that Europe attracts fewer high-skilled workers than not only the United States, but also Canada and Australia. Only 3 percent of scientists in the European Union come from non-EU countries, whereas in the United States 16 percent of scientists come from abroad.

THE FUTURE OF WORK IS GLOBAL

Some 230 million people – are living (and in large part working) in a country other than that of their birth. Sometimes described as the unfinished business of globalization, labor migration issues raise complex and sensitive political, human rights, economic and social concerns, as well as an array of legal and regulatory challenges. Migration accordingly occupies a prominent place on both national and multilateral policy agendas, and in public discourse and debate.

Significant talent challenges are looming in the Northern and Southern hemispheres by 2020 and beyond. In the Northern hemisphere, the expected talent gaps will be caused mainly by demographic shifts – notably, the retirement of baby boomers. For example in the United States, Germany, Canada and the United Kingdom, immigration and expected birth rates will not balance the workforce losses caused by aging populations. Over the next decade, Western Europe's talent

Top 10 soft skills in 2020

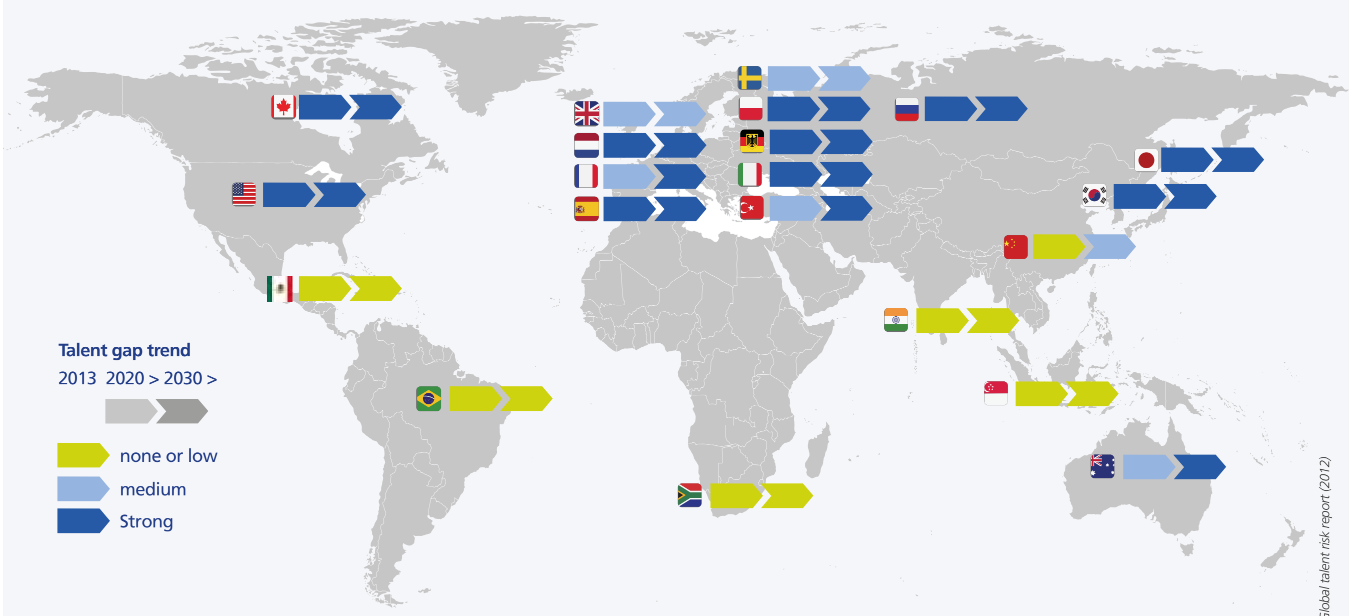
Even at the height of the crisis employers reported having difficulties in finding workers with the appropriate skills. Employers say they cannot fill vacancies because even highly-qualified candidates have the wrong skills. The education systems 'educate graduates of tomorrow in the skills needed in the industry yesterday' as they claim. Many employers are concerned that applicants lack 'soft skills', such as interpersonal, communication and analytical problem-solving abilities. This clearly indicates that jobs in growing sectors such as health, education and other services require a different set of skills than those acquired by unemployed people who worked in declining sectors, such as agriculture and manufacturing. Youth often lack certain social and emotional skills such as those involved in working in teams, which can undermine the use of their cognitive skills.

Source: World Economic Forum, 'Future of jobs report' (2015)

A global labor market is already here

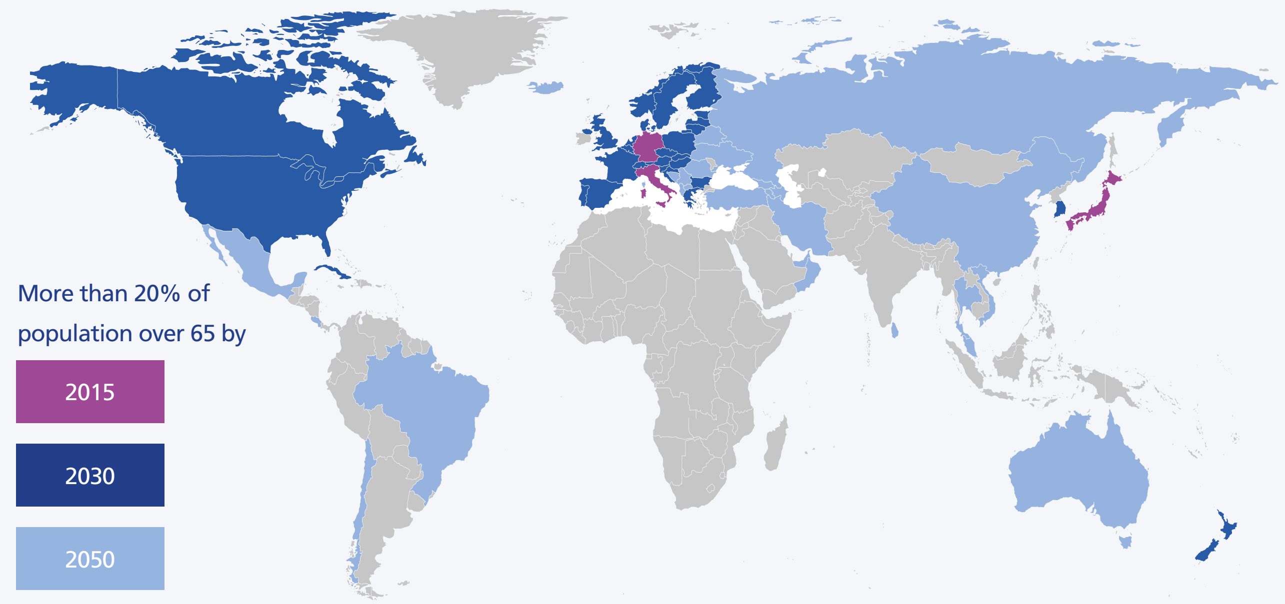
A global labor market is already here, but we lack the institutions to make it work effectively. Global shortage of STEM skills is not the real problem for the world economy, but the location mismatch between employers and employees. Talented people cannot move to where the jobs are. Several US and European firms have moved their R&D operations offshore over the last two decades, which diminishes the number of STEM jobs in both the United States and Europe. Demand has not dropped, but has relocated to countries such as China and India. Commissioned by Randstad, IZA Institute for the Study of Labor in Bonn is currently researching the drivers of the global 'jobs to people, people to jobs' mobility. This report will be published fall 2016.

Global talent gap



Notes: colour codes based on compound annual growth rates of talent supply and demand by 2020 and 2030.
Based on: WEF Global Talent Risk report

Dawn of super-aged societies



supply will continuously decrease, leading to almost empty talent pipelines beyond 2020. Economic growth expectations coinciding with projected waves of retirements will force employers to find, attract and retain scarce talent.

DEMOGRAPHIC SHIFTS ARE UPON US

Demographic shifts are upon us and will significantly lower economic growth. The number of "super-aged" countries – where more than one in five of the population is 65 or older – will reach 27 in 2030.
Only Germany, Italy and Japan meet that definition today. Thanks to the aging of today's middle-aged demographic swell and ongoing improvements in life expectancy, the population of seniors is projected to surge to 1.5 billion in 2050. The result will be a much older world, a future in which roughly one-in-six people is expected to be 65 and older by 2050, double the proportion today.

In the coming decades, aging and slower rates of growth are expected to characterize the populations of all major regions in the world. Ranked by median age, Europe is currently the oldest region in the world and should will remain so in 2050. Even relatively young countries such as Brazil and Turkey are aging. Moreover, the pace of aging in some of these countries is more rapid than in developed economies. Some societies in Eastern Asia are forecast to age particularly fast.

The population of children, meanwhile, will be at a virtual standstill due to long-term declines in birth rates around the world.
The number of children younger than 15 is expected to increase with only 0.2 billion to 2 billion in 2050. Consequently, more countries will find that they have more adults over 65 than they have children younger than 15.

Aging of the population will be challenging for public budgets and pension systems. The falling share of the population at traditionally

Ageing will slow economic growth

Most of the countries set to join the "super-aged" club by 2020 are in Europe and include the Netherlands, France, Sweden, Portugal, Slovenia and Croatia. But by 2030 they will be joined by a more diverse group including Hong Kong, Korea, the US, the UK and New Zealand. According to Moody's the unprecedented pace of population aging will slow annual global economic growth by 0.4 percent over the next five years and by 0.9 percent between 2020 and 2025. The OECD warned about the issue when it predicted population aging would contribute to slow global annual economic growth from an average 3.6 percent in this decade to about 2.4 percent between 2050 and 2060.

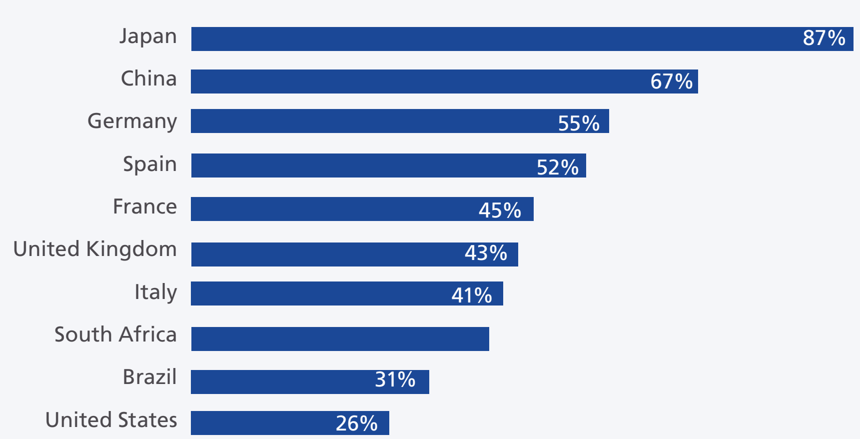
productive ages means relatively fewer people will pay taxes and social contributions at a time when the rising share of older persons implies that more people will receive pensions and costly health services. In response, many countries have implemented reforms, such as a rise in the retirement age, designed to delay the rate of increase. Nonetheless, public pension expenditures are expected to consume about 15 percent of GDP in several European countries by 2050. Pension expenditures in the United States are projected to increase to 8.5 percent in the same period.

Larger concerns revolve around public health care expenditures, which are rising faster than pension expenditures in most countries. Health care expenditures are pushed up not just by aging but by cost inflation as well. In the U.S., public health expenditures are projected to more than double to 15 percent in 2050. Similarly, large increases are expected in Japan and several countries in Europe.

Public concern

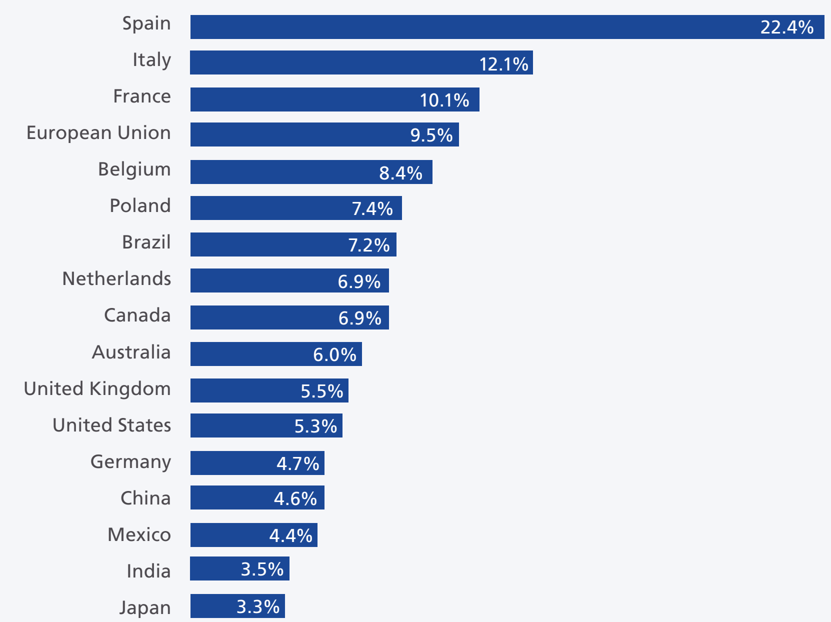
A survey by PEW research in 2013 on attitudes towards aging showed concern peaks in East Asia, wherePro nearly nine-in-ten Japanese, eight-in-ten South Koreans and seven-in-ten Chinese describe aging as a major problem for their country. Europeans also display a relatively high level of concern with aging, with more than half of the public in Germany and Spain saying that it is a major problem. Americans are among the least concerned, with only one-in-four expressing this opinion.

Is aging a problem in your country?



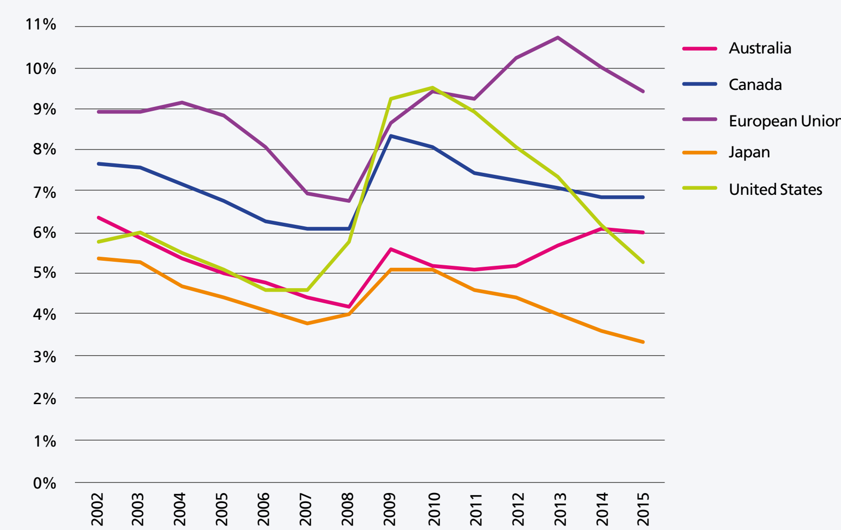
Source: PEW research (2013)

Unemployment rates 2015



Source: Eurostat (2015q2), OECD.stats (2015q2), ILO Estimates (2015)

Development unemployment rates

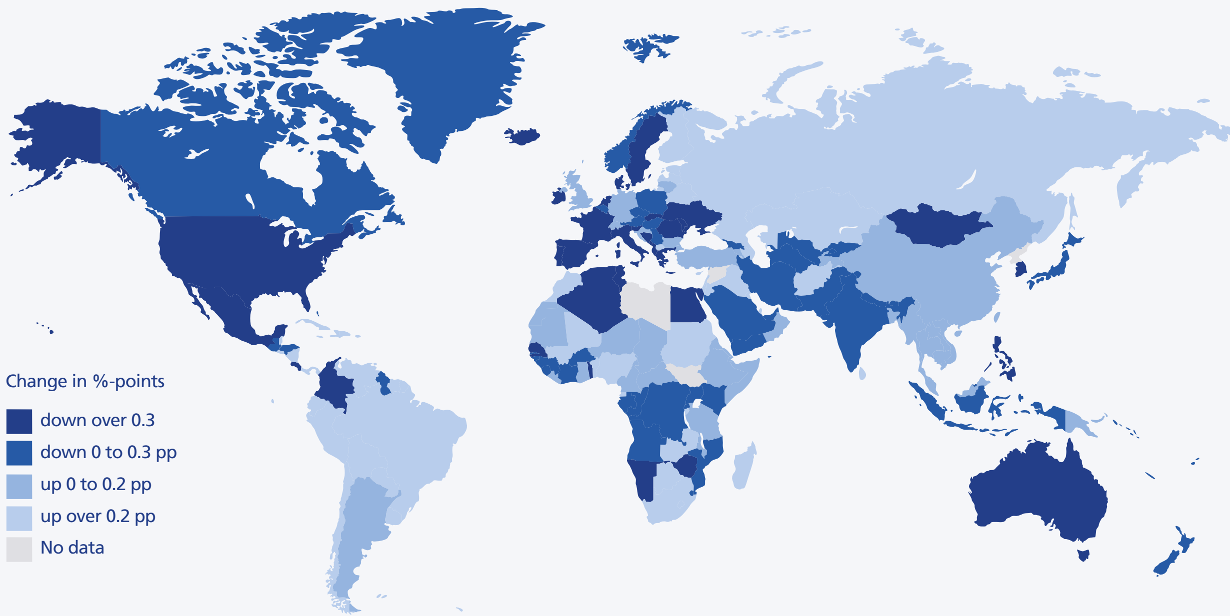


Source: Eurostat (2015q2), OECD.stats (2015q2), ILO Estimates (2015)

Unemployment trend

Based on the most recent economic growth projections by the ILO, the number of unemployed globally is forecast to rise by about 2.3 million in 2016, with an additional 1.1 million unemployed in 2017. Emerging economies predicted to contribute the greatest number to this total are Brazil (0.7 million) and China (0.8 million). Developing economies will see an increase in unemployment levels of 1 million over the two-year period. Globally some of that increase will be offset by continued improvements in developed economies, where unemployment levels are anticipated to fall by 1.4 million over the course of 2016 and 2017, driven by reductions within the EU-28 and the United States.

Change in global unemployment rate, 2015–17



Source: ILO, WESO trends 2016

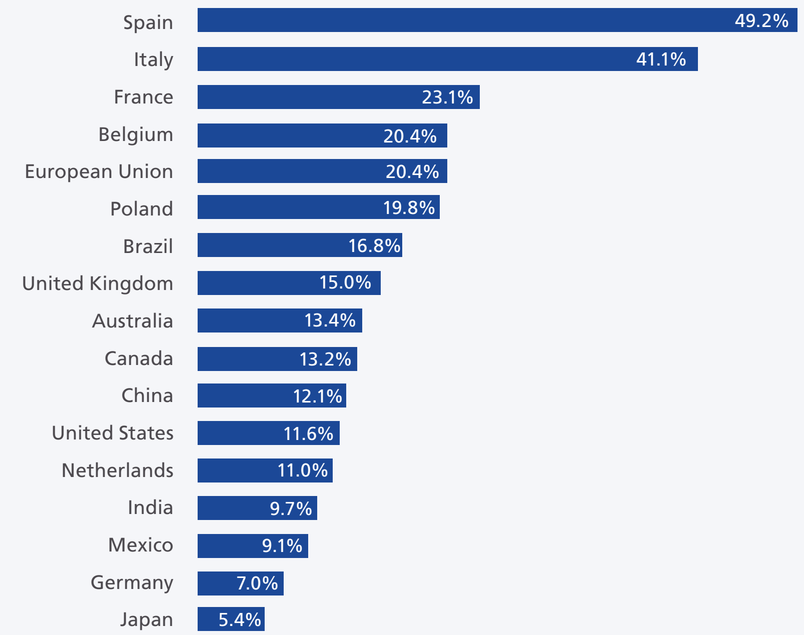
Shift of economic power

The coming changes in world demography could alter the distribution of global economic power over the coming decades. The graying of the world's population in the aggregate conceals some important variations. Japan, China, South Korea and many countries in Europe are expected to have greater numbers of people dependent on shrinking workforces, a potentially significant demographic challenge for economic growth.

For the United States and Australia population trends may lead to greater opportunities in the global economy of the future. Although the United States population is anticipated to turn older and grow at a slower rate in the future, it is projected to increase at a faster pace and age less than the populations of most of the rest of the developed world. Thus, to the extent that demography is destiny, the United States may be in a position to experience a more robust economic future in comparison to other developed nations.

Elsewhere, aging of the society mostly means less children but a growing workforce. A favorable demographic trend for economic growth. In countries like India, Pakistan, Egypt, Nigeria, Kenya and South Africa the dependency ratios will decrease, a boon for economic growth.

Youth unemployment rates 2015



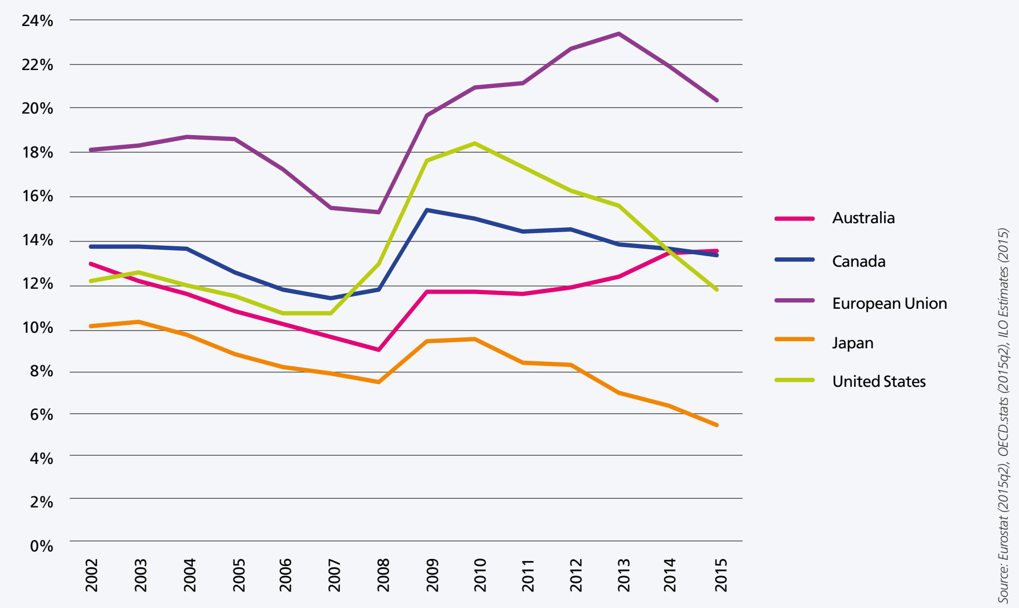
Source: Eurostat (2015q2), OECD stats (2015q2), ILO Estimates (2015)

I. Recovering Labor Markets

After a long period of high unemployment and underemployment labor market conditions are finally improving even in those countries hit hardest by the global financial and economic crisis. In many countries there has been a drop in unemployment numbers since the global financial crisis, but there is some evidence that this is not only due to jobs growth but also because long-term unemployed are giving up on trying to find a job.

In Europe labor market conditions are slowly improving and may continue to do so in the short term. The unemployment rate in the European Union has reached 9.5 percent in 2015, down from 10.8 in 2013 and 10.1 in 2014 – the lowest rate since 2011. Improvements have been most notable in Southern Europe. In Greece, Portugal and Spain, the unemployment rates have fallen from their very high peaks, declining on average by almost 2 percentage points in the past year alone (although in the case of Greece and Spain they remain above 20 per cent). In the United States the unemployment rate has been falling since 2010 from 9.6 percent to 5.3 percent in 2015. Also in Japan and

Development youth unemployment rates



Canada unemployment has been falling for over 5 years. In Australia on the other hand unemployment has been slowly increasing since 2011.

The EU unemployment rate is projected to continue to fall steadily over the next couple of years. Nonetheless, virtually all the countries in Europe, with the exception of Germany and the United Kingdom, will continue to post unemployment rates higher than the pre-crisis level. In addition, the long-term unemployed continue to comprise a large share of the total number of unemployed. In 2015, around half of all unemployed persons in Europe had been without work for one year or longer. Workers unemployed for long periods risk losing their skills, face reduced employability and are at greater risk of poverty.

YOUTH, SCARS OF THE RECESSION

It is not easy to be young in the labor market today. Young people have suffered a disproportionate share of job losses during the global economic crisis. In 2015 there were over 4.5 million young people unemployed in the European Union, 0.5 million more than before the crisis. In the United States, with 2.5 million young people unemployed it is back to pre-crisis levels.

Coping with unemployment is difficult for everyone. But for low-skilled youth, and especially those who have left school without qualifications, failure to find a first job or

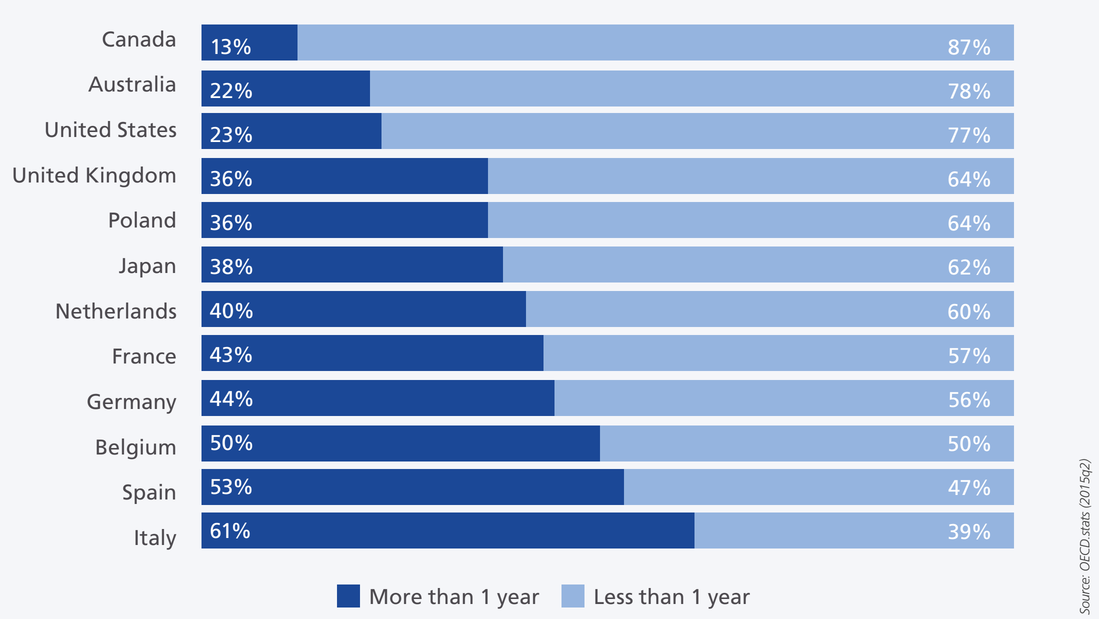
How to give youth a boost on the labor market

Persistent long-term unemployment

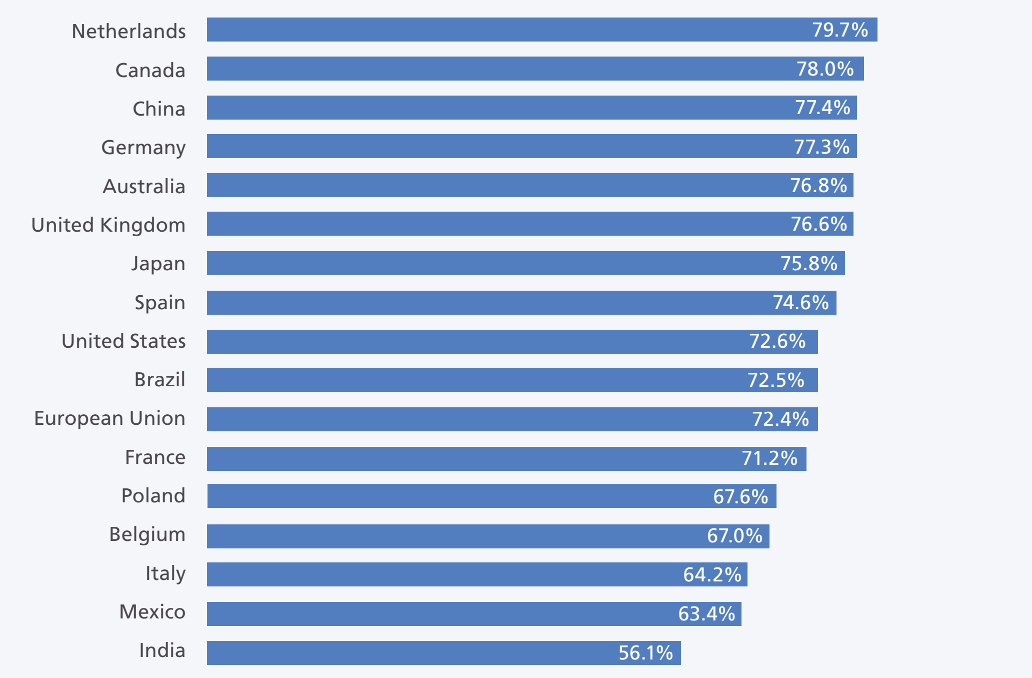
Long-term unemployment has likely peaked but remains a major concern. In countries hardest hit, notably in Southern Europe, this has led to a rise in structural unemployment which will not be automatically reversed by a pick-up in economic growth. Long-term unemployment reveals an important problem of labor market. Because the longer one stays unemployed, the smaller becomes the chance of getting back into employment. This means that high unemployment on itself is not necessarily the problem, but the persistence of unemployment is. As long as mobility is high, people won't stay unemployed for too long.

In the US long-term unemployment has been limited until the latest crisis, but increased sharply since then. While in the EU the average has always been much higher (around 40 percent of all unemployed persons) but decreased in 2009 because so many new people became unemployed. As not all of these newly unemployed could find jobs immediately, the share of long-term unemployment rose again in the last years. These figures point at a serious problem because this kind of unemployment is persistent. Chances that these people will return into employment have become quite low during the unemployment period, and it will take a lot of extra effort to make labor market policy work for this group.

Long term unemployment



Activity rates 2015



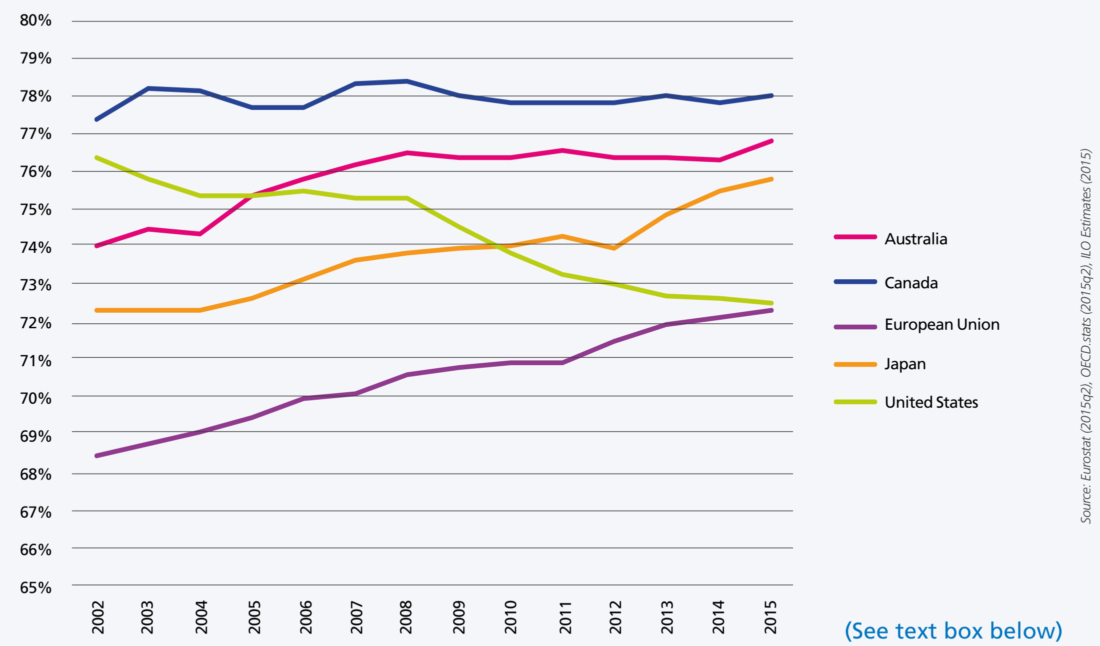
keep it for long can have negative long-term consequences on career prospects – a phenomenon often referred to as "scarring". The risks posed by a "scarred" generation have motivated many governments to take vigorous action, notably by scaling up funds for youth labor market programs.

In the context of today's fragile recovery and mounting fiscal pressures, there is a strong need to keep momentum, by maintaining adequate resources for cost-effective measures for youth. But governments cannot do everything alone, and well-coordinated supports and incentives must come from all key stakeholders, including employers, trade unions, NGOs, and naturally from youth themselves.

NEED TO INCREASE ACTIVITY RATES

Globally, there are over 2 billion working-age people who are not participating in the labor market. Some 26 million joined these ranks in 2015. The share of the population over the age of 15 that is active in the labor market varies tremendously. Variation in participation rates are due to both cyclical and structural factors. When jobs are scarce due to recession or slow recovery in the economic cycle, some jobseekers become discouraged and drop out of the labor market. In terms of structural factors, population ageing and increasing years spent in education in many countries result in shrinking or slower growth in the working-age population. These two effects need to be differentiated

Development activity rates



(See text box below)

to provide a clearer understanding of the future path of labor force participation and to design and implement an effective set of policy interventions.

In the case of developed economies, the decline in participation rates in the aftermath of the crisis stemmed from weak labor market prospects, particularly for young people who often chose to extend their education. Indeed, some developed countries that experienced sharp declines in employment also saw a significant drop in participation rates. This is especially so in the United States. As labor markets improve, some of the downward trend is likely to be reversed – this is evident from the stabilization in participation rates in many of the developed economies.

Participation rates have also been declining in emerging economies and some developing economies. Some of this decline is due to more young people moving into or staying longer in education rather than entering the world of work, while in some cases fewer women are joining the labor market due to income and wealth effects.

THE GENDER GAP IN LABOR PARTICIPATION

As for women, their participation has been rising in all countries for several decades. Each new generation of women has had a stronger attachment to the labor market than the previous one. There are probably important cultural reasons for this, but the increase has also been enabled by technical progress, allowing housework

Labor participation in the United States is falling

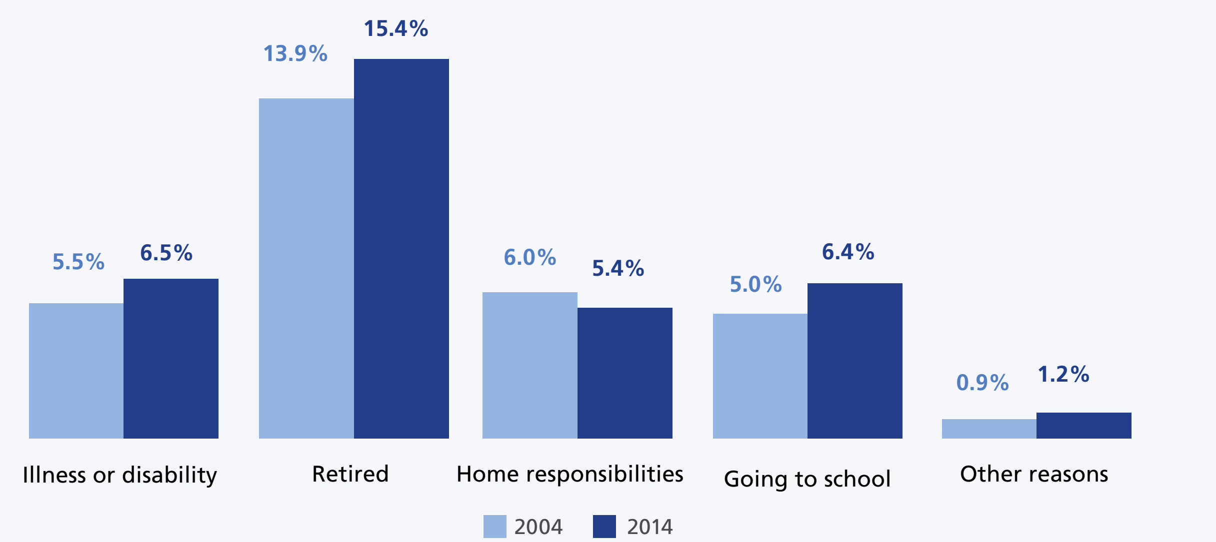
A study by the U.S. Bureau of Labor Statistics provide insight into why people who were not in the labor force did not work. From 2004 to 2014, there was an increase in the proportion of the population 16 years and older that was not in the labor force and that cited school attendance, illness or disability, or retirement as the main reason for not working. The percentage of people who were not in the labor force and the reasons they gave for not working varied by age and gender.

Among younger people, the percentage not in the labor force rose sharply and the most often cited reason for not working was school attendance. The percentage not in the labor force also rose for both men and women 25 to 54 years, and nearly all reasons cited recorded an increase. Women in this age group were more likely than men to cite home responsibilities as the main reason for not working.

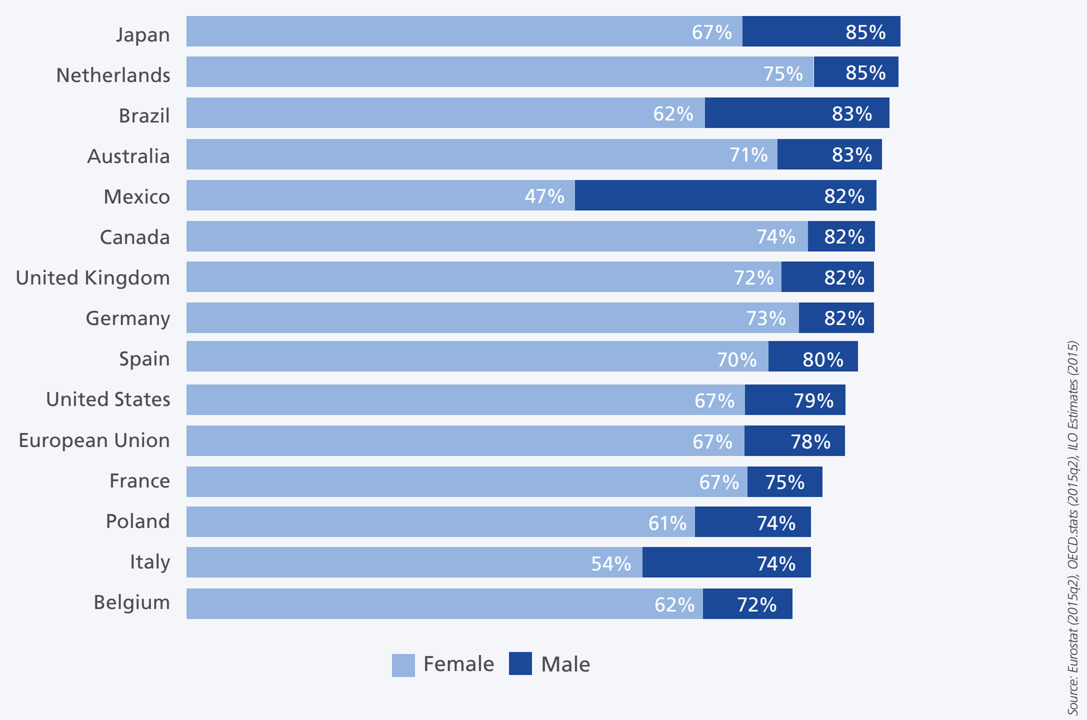
The increase of men and women not in the labor force were larger for those with less education. Men and women 25 to 54 years with less education were more likely to be labor force nonparticipants than their counterparts with more education. People with less education were more likely than those with more education to cite illness or disability as the main reason for not working.

The proportion of older adults who were not in the labor force declined from 2004 to 2014. Older adults were most likely to cite retirement as the main reason for not working, although the percentage who cited this reason fell. The older adult population saw an increase in the proportion who cited illness or disability as the main reason for not working.

US Proportion of the inactive labor force by reason



Gender gap in activity rates



to be done more easily, while higher educational attainment has also played a role in luring women into the job market.

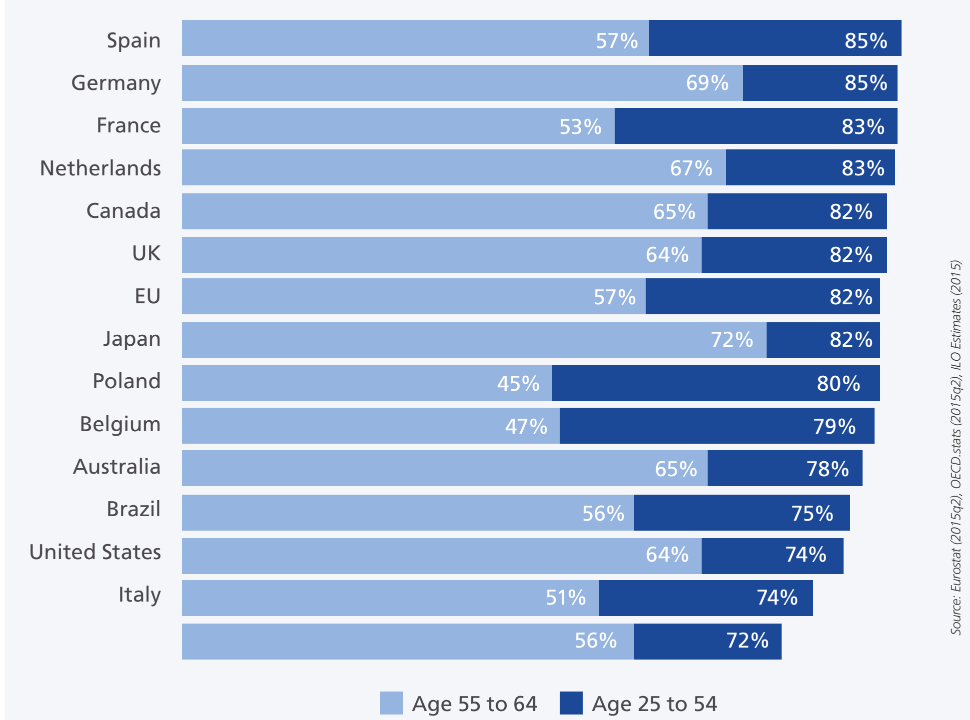
Policies have also affected this trend and appear to play an important role in explaining cross-country differences in female participation. Taxation is one such policy. Married women are widely considered as the second earner in a couple and when their income is taxed jointly with that of their husband, the marginal tax rate can be very high. This is unfortunate since women's participation reacts more to tax changes than that of men. Most countries have moved towards taxing each earner in the couple separately, but joint taxation still exists in a number of countries, including France and Germany. Better participation can also be achieved by subsidising childcare, either directly or through the tax system. Most Nordic countries have gone pretty far in this respect and also have high female labor force participation. Childcare support may be seen more as a subsidy to female full-time work than to part-time work, and indeed, the share of part-time work in Nordic countries has declined. But the money to pay for childcare subsidies obviously has to come from taxes, and higher taxes in general reduce people's desire to work, so there are limits to how far this policy can go. Other countries, such as the United States, manage however to achieve high female participation without large-scale subsidisation of childcare. In this case, because of a wide dispersion of wages, many households can afford to meet the costs of childcare by themselves.

THE AGE GAP IN LABOR PARTICIPATION

In contrast to women, older men have reduced their labor force participation in all countries over the past three decades – in some cases sharply. It may seem ironic that effective retirement ages have fallen at the same time as people are living longer and healthier lives. This fall may reflect a stronger appetite for leisure as real incomes have gone up. But it also owes a lot to policies.
Early retirement, invalidity and unemployment benefit schemes in many countries provide people in their 50s with strong incentives to retire. These often misguided policies led to a sharp drop in participation in the 1970s and 1980s. There has been some moderate roll-back since then, but most of these policies remain in place in many continental European countries, with detrimental consequences for employment.

Old-age pension schemes also stack the cards in favor of people retiring early. If people postpone their retirement by a year, this is rarely reflected in correspondingly higher pensions later on, despite their extra contributions. This is already problematic at ages between 60 and 65, but after 65 the disincentives to work become almost prohibitive in some countries. In our society where people are fitter for a lot longer, we should be free to engage in "active ageing".

Age gap in activity rates



Ways to increase labor participation

There is a strong presumption that those countries which achieved high labor force participation also had the best policy framework. The time has come to implement a new set of policies conducive to stronger growth, higher employment and sounder pension systems. To cope with mounting financial pressures due to the ageing of society, governments have to make hard choices. In particular, to avoid increasing the tax burden or impoverishing pensioners, they are now looking at ways of inducing more people to enter or stay in work.

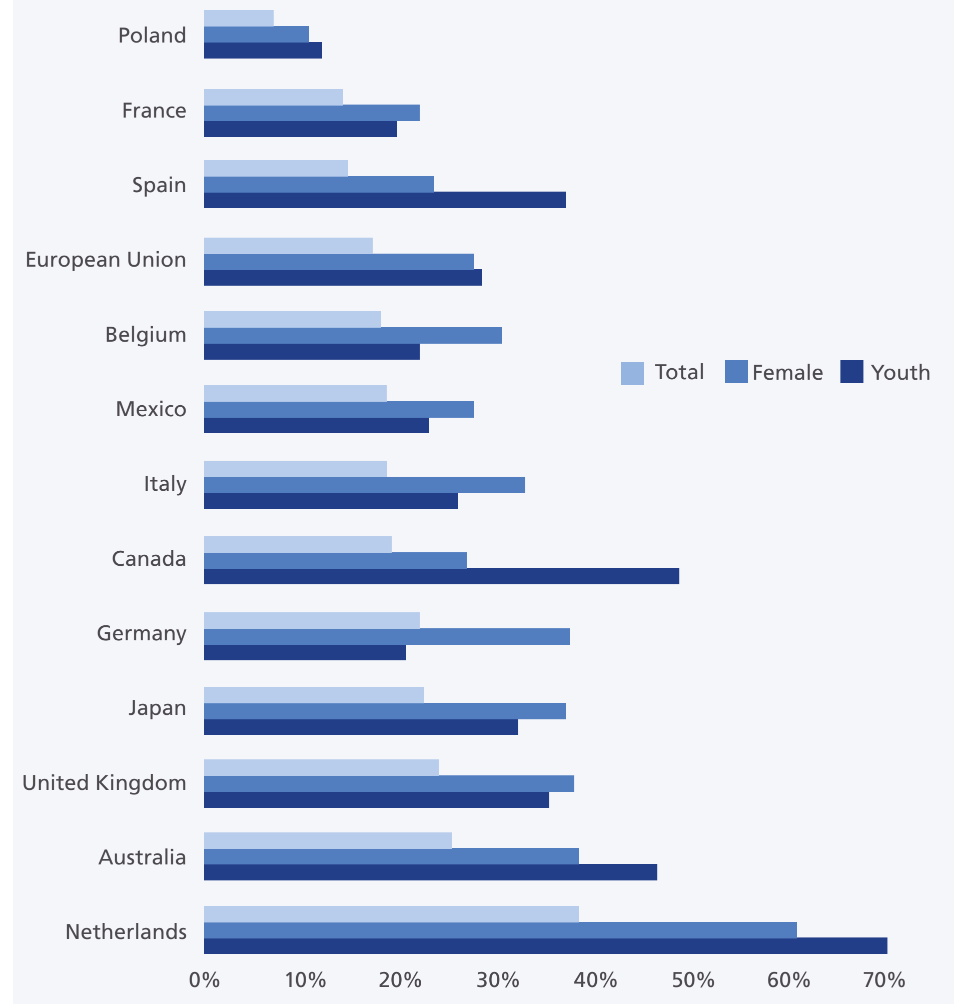
These policies will have to be tailored to meet the specific needs of the various groups that make up the active population. One group in the labor market almost fully employed is that of prime-age males (25-54), whose labor-force participation rate generally exceeds 90 percent. By contrast, there is wide variation in the extent to which women, as well as young and older persons, participate in the labor market. Those groups are most likely to be influenced by government policies, for better or worse.

In the short term measures could well be needed to ensure the full employment of more people coming onto the job market. But it is reassuring to note that those countries which have promoted active labor force participation also benefit from high employment. Given time, employers have been able to create the jobs needed to match a more abundant supply of labor.

A policy package to increase labor participation would include the following steps:

- eliminate early retirement schemes and raise standard retirement ages;
- increase childcare subsidies;
- eliminate tax discrimination against female participation;
- enhance the role of part-time work;
- make the school-to-work transition more effective.

Share of part-time employment



PART-TIME EMPLOYMENT

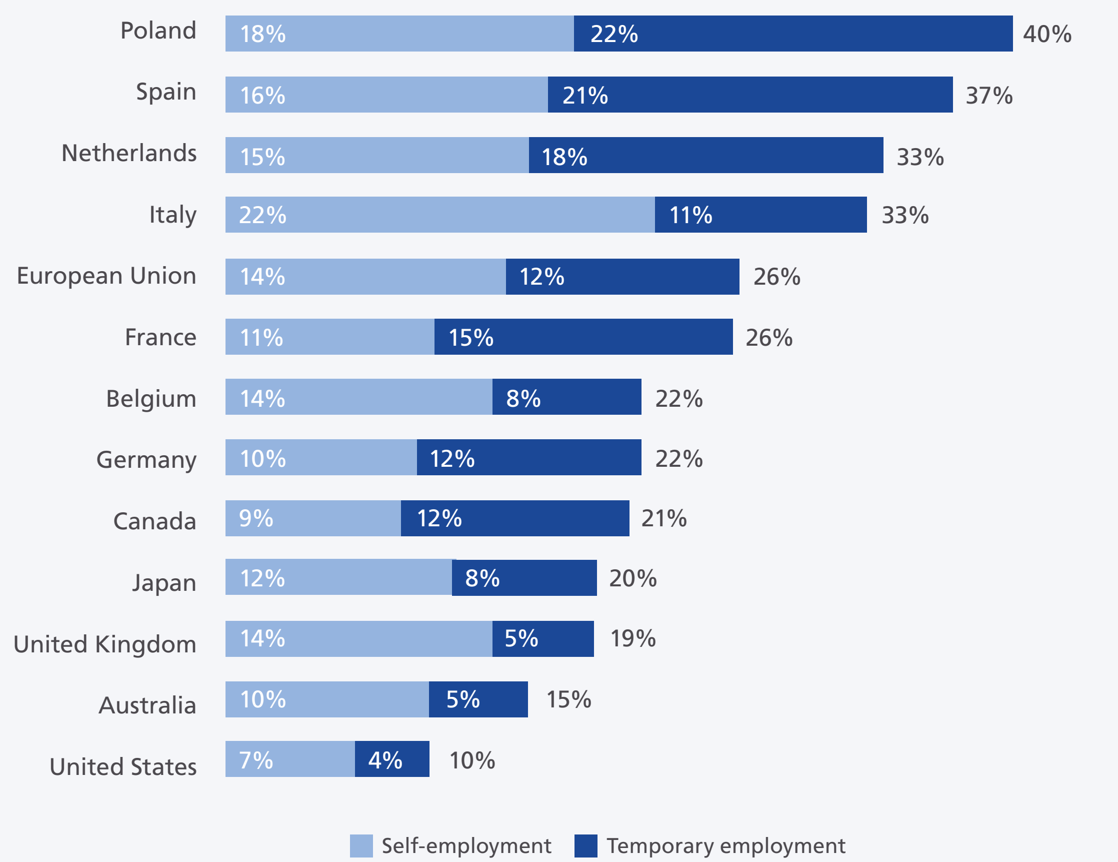
Regarding the increase of participation, one might state that the rise in participation owes to a large extent to the possibility of part-time jobs, which stimulated many households to participate with both members. In the last decades some countries faced a transition from the standard 'breadwinner household' to the more modern '1.5 jobs per family' households, gaining popularity among young families with children. Part-time work is still a female and young phenomenon. Most of the increased female participation during the nineties, was through women entering the labor market in part-time jobs. When looking at the incidence of part-time work we see that the Netherlands take a special position. Nearly 40 percent of all employed Dutch persons are working in a part-time job of less than 30 hours/week (mostly women).

Flexible labor relations 2015

Flexible labor relations enable companies to quickly adjust the size and composition of their workforce when innovations change their product lines and production methods. These flexible labor relations also enable companies to screen workers with respect to their productivity and creativity before adding them to their more permanent workforce. Through this way of matching, long-term labor relations become more efficient to the employer. If flexible labor relations are used to support innovation processes and optimize the quality of the workforce, it enables further economic growth.

Although the traditional open-ended labor contract is still the standard labor relation, many other forms of more flexible labor relations have developed over the last decades. These other forms of labor relations vary in the type of flexibility: flexibility in the duration of the contract (fixed-term contracts), flexibility in the company people work for (e.g. triangular labor relations such as agency work), and flexibility in the labor relation (e.g. self-employed workers). For that reason, all these other types of contracts can be interpreted as flexible labor contracts as opposed to the traditional open-ended labor contract with a direct employer.

Share of flexible labor relations in total employment

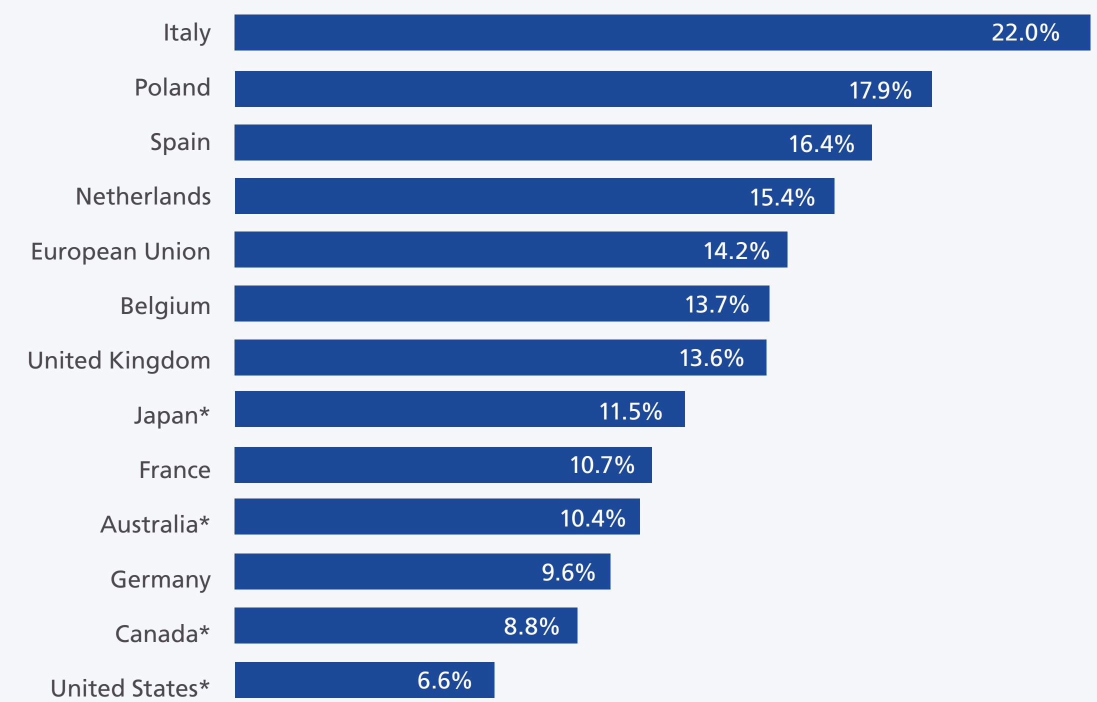


Source: Eurostat (2015q2), OECD.stats (2014), ILO Estimates (2015)

In Canada, Japan and most European countries, all forms of flexible labor together account for 15 to 30 percent of total employment. Particular high shares of flexible labor are found in the Mediterranean countries (more than 30 percent), but also in Poland (40 percent) and in the Netherlands (33 percent). The Mediterranean countries have a long tradition in flexible labor, particularly through self-employed workers. Poland and the Netherlands have experienced the largest growth in flexible labor relations during the last decade for different reasons.

The lowest share of flexible labor is found in the United States. Only around 10 percent of employment comes in the form of some type of flexible labor. Also Australia, the United Kingdom and Canada are countries with a traditionally low demand for flexible labor and a relatively low employment protection of workers, in particular those with a fixed-term contract against (individual) dismissal.

Share of self-employment in total employment



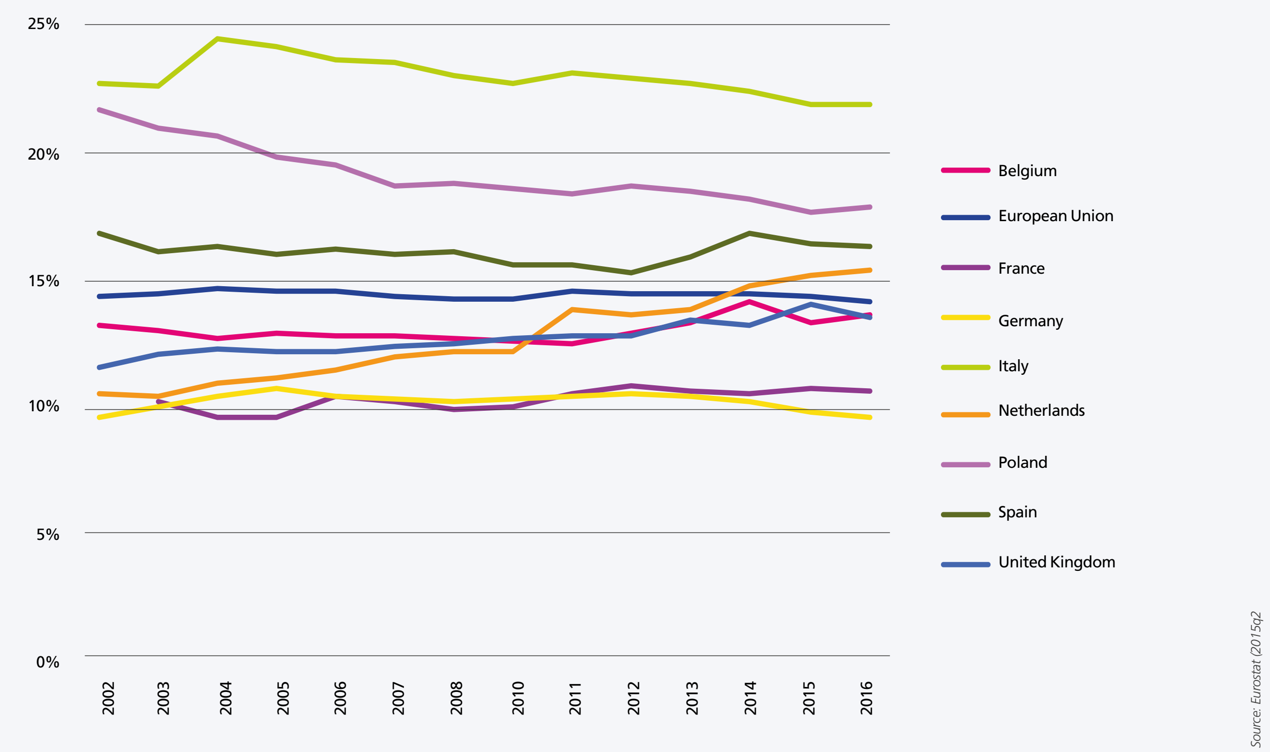
Source: Eurostat 2015q2, *ILO 2013

SELF-EMPLOYMENT

Self-employment includes both owners of businesses, who can be considered employers rather than employees, and own-account workers. Many self-employed workers can be found in the agricultural sector and small retail. Therefor, countries with a large share of employment in these sectors have a high rate of self-employment. This is especially so in the developing and emerging regions of the world like Southern and Southeastern Asia and Latin-America where by far the highest rates of self-employment can be found. Self-employment rates here easily exceed 25 percent and reach up to over 80 percent in India. Often distinction between self-employment and informal work is difficult to make in these regions.

In the western world however self-employment rates are more moderate. About half of all flexible labor relations consist of self-employment. In the European Union nearly 14.5 percent of all employment is self-employment. The highest shares of self-employment can be found in Southern- and Eastern-European countries where – again - agricultural businesses and small retail still hold a large part of total employment. The United States, Canada and Scandinavian countries have the lowest share of self-employment, all below 10 percent.

Development self-employment in Europe



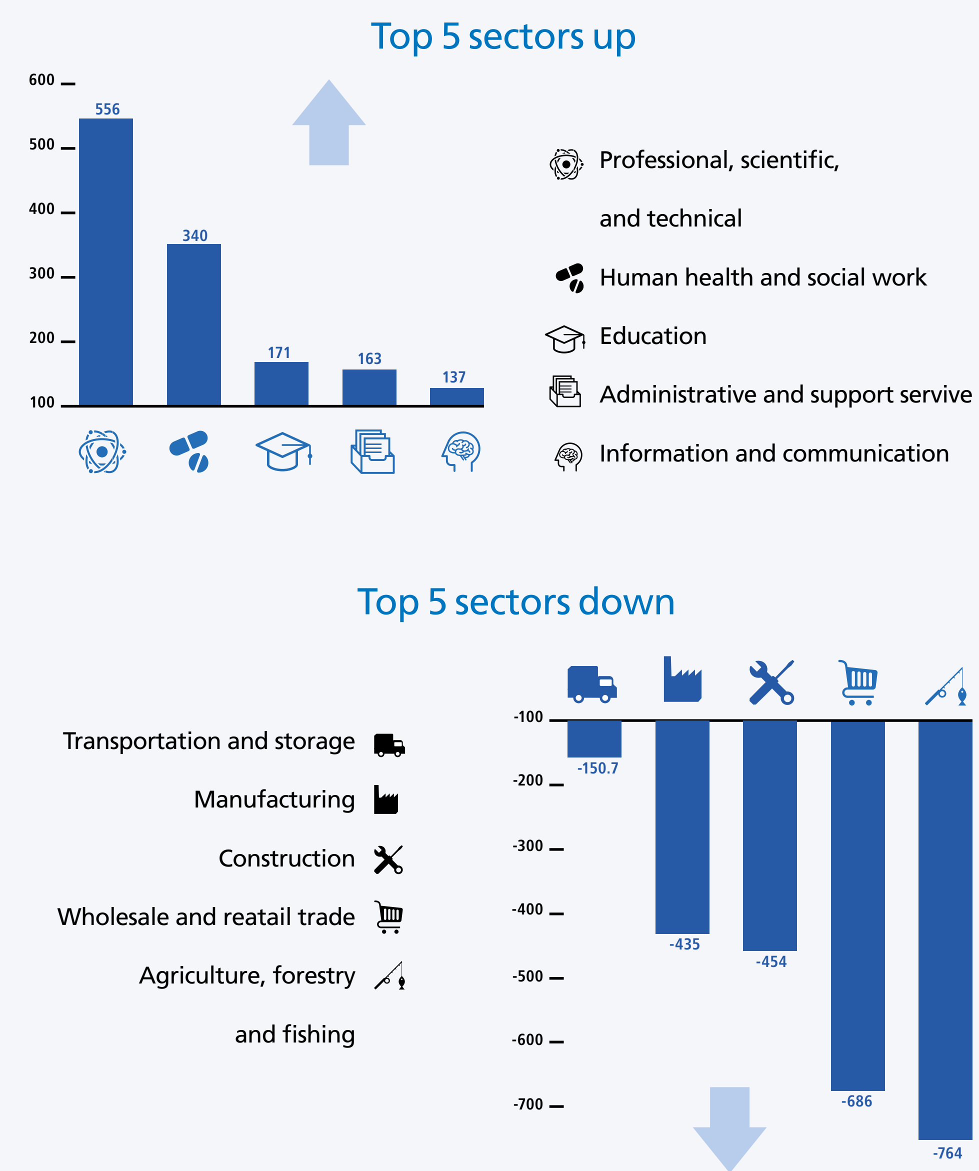
In general self-employment rates drop in countries when employment in agriculture and small retail drop. In the western world self-employment rates have stabilized and remained fairly equal in the last decade. There has been no clear effect on self-employment levels by the recent crisis. In times of economic recession, when jobs are scarce, employees who lose their job may decide to offer their services to companies. These flexible labor services may be attractive to companies as they offer comparable labor productivity in the short run and at lower risks. In the long run however, self-employment may not always provide the right substitution for traditional employees, who have more opportunities to invest in company-specific knowledge and skills (firm-specific human capital) which would eventually lead to a decline in the share of self-employed workers.

However, these stable self-employment rates hide a strong variety. Variety between countries, sectors and educational attainment. When we look closer at the figures for Europe it is clear there has been a decline of self-employment in Southern- and Eastern Europe. On the other hand, self-employment in France, the UK and especially the Netherlands self-employment has been rising in the past decade.

Sectoral shift of self-employment

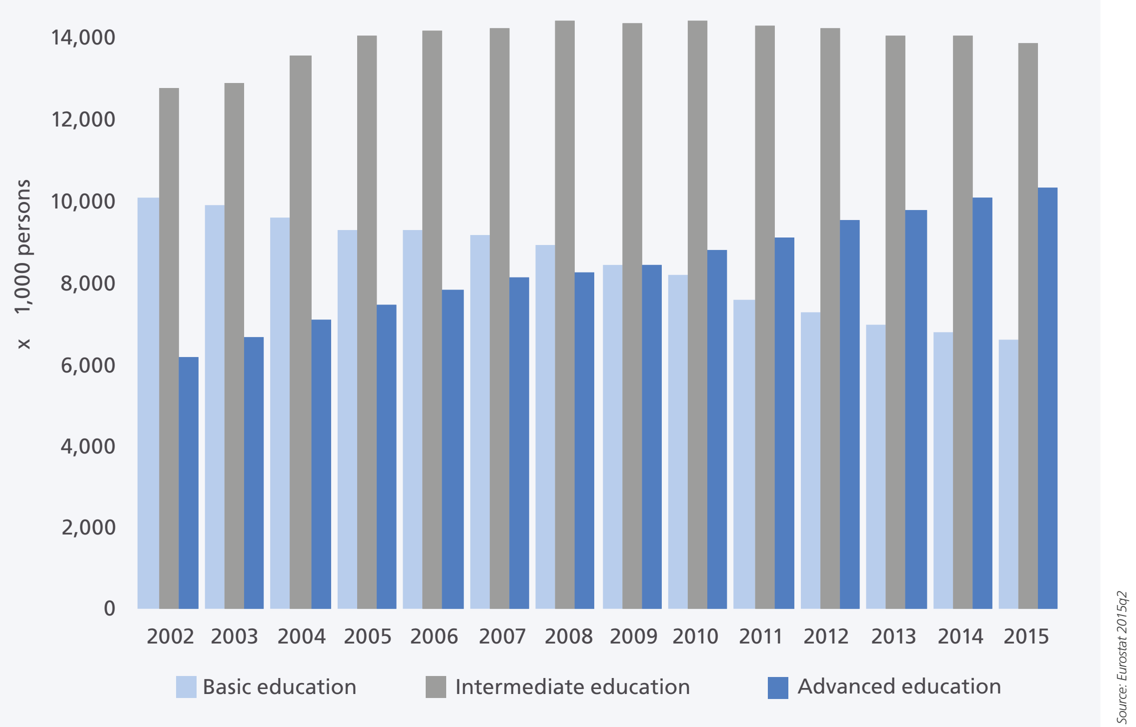
The variety in growth of self-employment between the countries partly be explained by a shift of self-employment between the sectors. Since 2008 in the European Union self-employment in agriculture and retail continuous decreased with in total 1.5 million jobs. Furthermore, self-employment dropped with nearly 0.5 million jobs each in manufacturing and construction explaining the drop in most Mediterranean and Eastern European countries. However, recently self-employment is increasing in service sectors. Especially in the professional, science and technical sector (up nearly 0.6 million) and health care (up over 0.3 million) which can explain the increase in several Western European countries.

Sectoral shift in self-employment: EU 2008-2015 (in 1,000's)

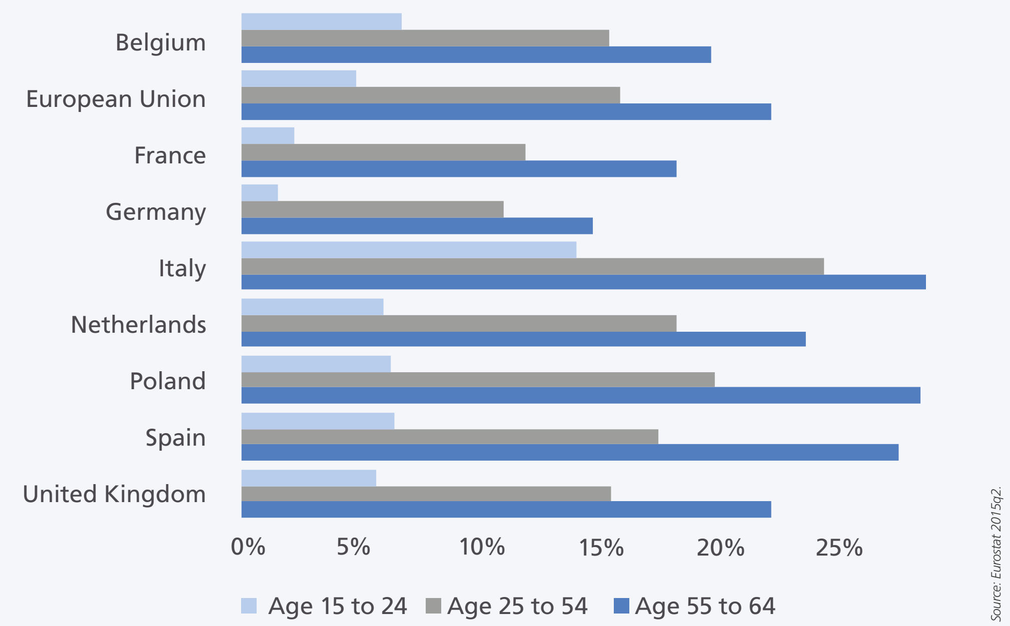


This sectoral shift of self-employment is reflected in the level of education of self-employed workers. The total amount of self-employed workers went up only marginally from 28.7 to 30.4 million since 2002 in the European Union but the average level education changed drastically. In 2002, 10 million self-employed only had a basic level of educational attainment opposed to 6 million self-employed with an advanced level of education. By 2015 this picture has reversed completely, in a near perfect mirror image 10.2 million self-employed had an advanced level of education and 6.5 million a basic level.

Self-employment by level of education (EU)



Self-employment by age group



In nearly all countries the probability of being self-employed is higher for men than for women. In North-America this gender gap in self-employment is quite moderate with 44 percent of self-employed being women in Canada and 40 percent in the United States, but it Europe less than a third of all employed is a woman. Countries in Southern and South-eastern Asia are the only exception to this rule but very often self-employment in this region involve informal low-quality jobs.

The likelihood of being self-employed does increase with age. In Europe of all young workers, age between 15 to 24, only 4.3 percent are self-employed. The probability triples to nearly 14.1 percent for the core working age-group of 25 to 54 year olds, and of all workers over 55 year olds one in five is self-employed. Elderly workers have better access to capital, can take advantage of their aggregated skills and network and are more likely to want the freedom and independence associated with self-employment.

Push or pull to self-employment

In Flexibility@work2015 Blanchflower argues the self-employed are either pushed or pulled to work for themselves. Push factors are those that push individuals into self-employment due to lack of alternatives while pull factors are those that provide incentives for individuals to become self-employed. It is likely that a considerable proportion of those who have recently become self-employed in the recession have done so because of 'push' factors, driven out of wage work because of a lack of jobs. Push self-employment is more likely to occur when unemployment is high.

In good times 'pull' factors tend to become more important; demand is booming and a currently employed person thinks 'I can do that' and sets up his or her own business. The reason for being able to do this is demand is booming and there are opportunities for all. Those who are 'pulled' to self-employment, who make a positive decision to go it alone, frequently after a long planning period, perhaps during which they are able to raise enough capital to go it alone, are generally much closer to our idea of an entrepreneur, the job creator who made a job for him or herself and potentially down the road, will create jobs for others. Pull self-employed frequently are job-makers. Pull self-employment is more likely to take place when unemployment is low.

There is no one way to approach the different faces of self-employment. Tailor-made policies to increase the job quality (social protection and employee benefits) of self-employed are needed yet they should not impede the entrepeneurship and freedom self-employed aspire to maintain innovation and job creation they bring.

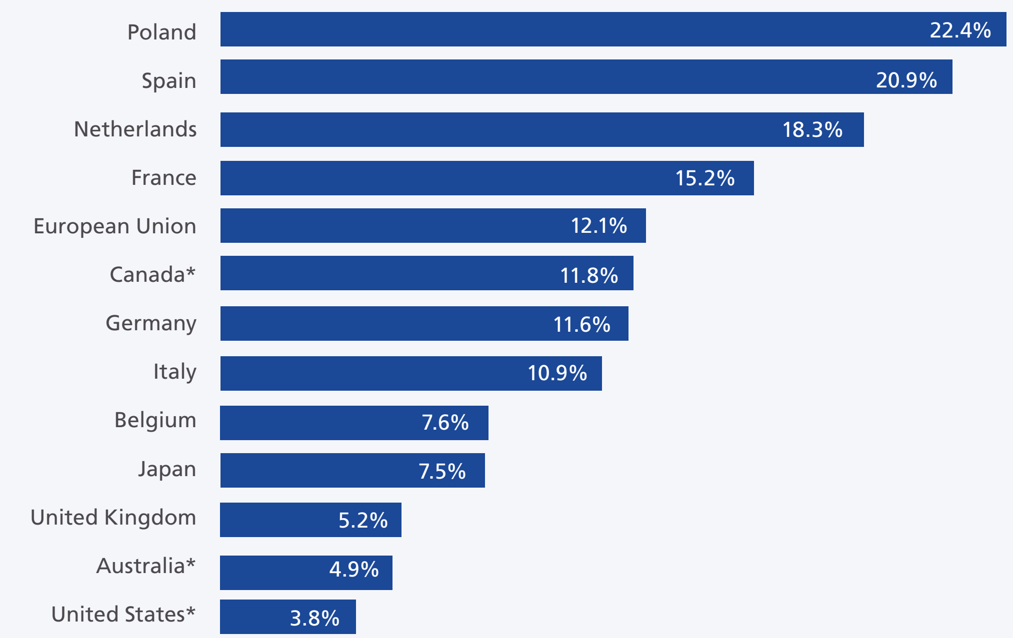
TEMPORARY EMPLOYMENT

In many countries temporary work has been an important component of employment growth in the last one or two decades. Temporary contracts may facilitate job matching, by providing an initial work experience especially for youths (either during their educational period, for starters or for drop-outs) while also allowing employers to screen suitable candidates. For employers temporary jobs also offer the opportunity to adapt the size of their workforce to the economic conditions.

Currently, about half of all flexible labor consists of fixed-term contracts (the other half being self-employment). Most western countries between 5 and 20 percent of all workers have fixed-term contracts. The United States, Australia and the United Kingdom show traditionally the lowest figures due to the less stringent employment protection. The type of temporary contracts differs between countries in average duration. The average duration of a temporary contract in the EU is 17 months. However, 60 percent of the contracts agree on a duration of less than 12 months. In Scandinavia and the German-speaking countries temporary workers have longer contracts than in other countries, especially France, Belgium and Spain.

When the recent economic crisis kicked in, the share of fixed-term contracts declined in most European countries. The crisis was assimilated by businesses through not renewing fixed-term contracts. As a result, the share of fixed-term contracts in total employment fell seriously in the financial

Share of temporary employment in total employment



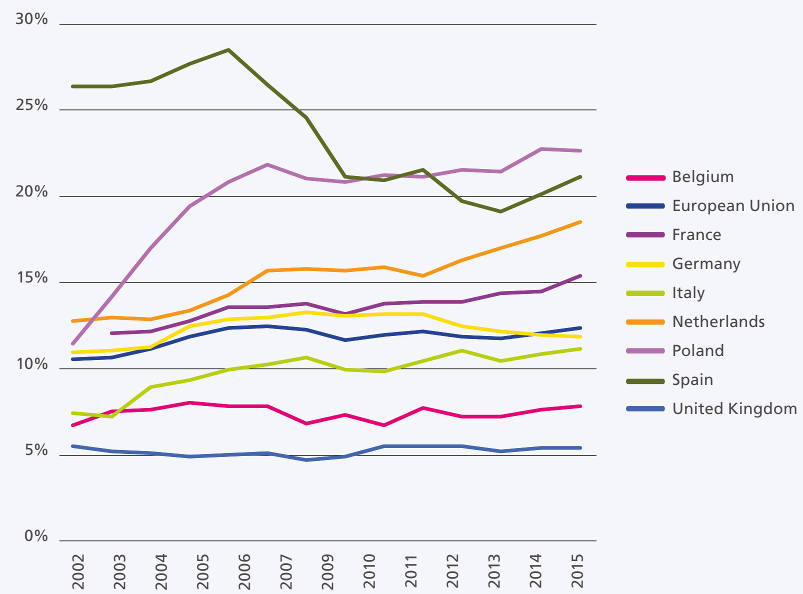
Source: Eurostat 2015q2. *OECD 2014 **OECD2013. *** OECD 2005

crisis, particularly in Spain. Since the early nineties close to 30 percent of all Spanish workers had a temporary contract. The share of temporary contracts dropped as a consequence of the recession, which struck the Spanish labor market more than in most other countries (and temporary workers even more).

In Poland temporary work increased in a seven-year period in the beginning of the century from less than 6 percent to over 20 percent and remained on the same level ever since reaching 22.4 percent in 2015. Strong growth of the temporary employment rate in the Netherlands, from 12 percent at the beginning of the century to 18.7 percent in 2015 was driven by institutional factors, which made it easier for employers to offer fixed-term contracts. France and Italy have seen a more moderate, yet continuous growth of the temporary employment rate. In Germany there was a directly increase of the temporary employment rate after the Hartz reforms in 2004, peaking at 13.1 percent in 2008, but it has fallen since to 11.6 percent close to the level before the Hartz reforms.

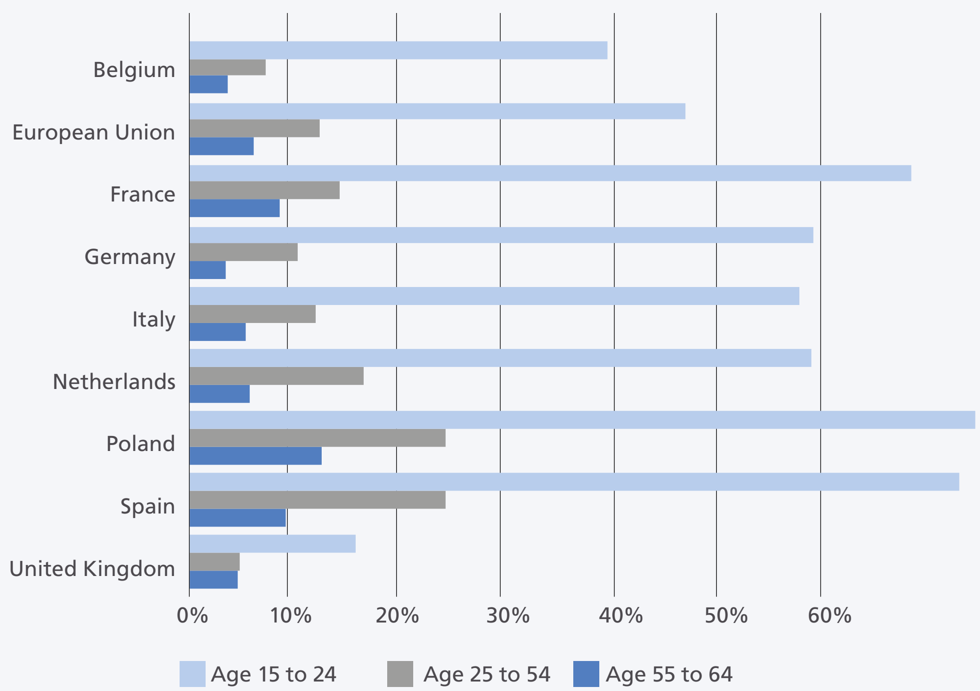
Incidence of temporary work differs by age but not by gender. In most countries women are only slightly overrepresented, However, as expected, temporary work is more common among youth. Part of this effect is caused by the fact that many young people are still in education, and therefore not available for a fulltime job. The relations in temporary employment rates between the age-groups has been

Development temporary employment in Europe



Source: Eurostat 2015q2.

Temporary employment by age group



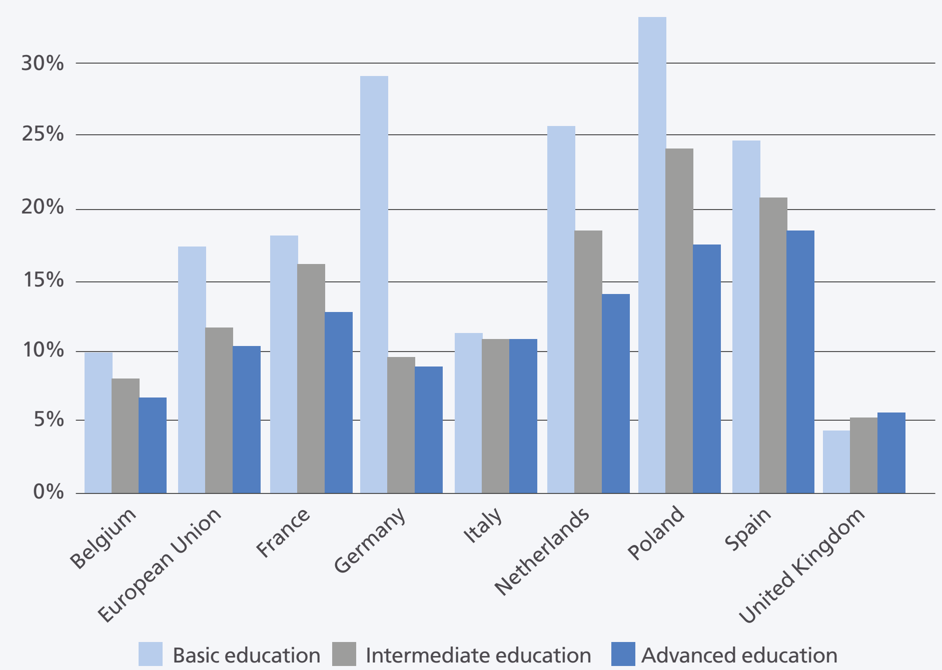
Source: Eurostat 2015q2.

very constant over the years which indicates most youth who are in temporary employment do step into open-ended employment by the time they reach their thirties or before.

Temporary work is not only characterized by relatively young workers, it is also characterized by overrepresentation of low-skilled workers. The most dramatic example of this being Germany where the likelihood of being in temporary work is three times higher for low-skilled workers. Two possible explanations can be thought of. Firstly, if people are still in education, their skill level is not measured correctly by 'highest successfully completed education' because they have not completed their educational track yet. Secondly, early school leavers ('drop-outs') do not get a permanent job easily because they lack certain minimum qualifications. Starting with temporary jobs is often their only option. However, in Spain and Italy temporary work is not distinguished as 'typically low-skilled': high-skilled temporary work is also very common in these countries.

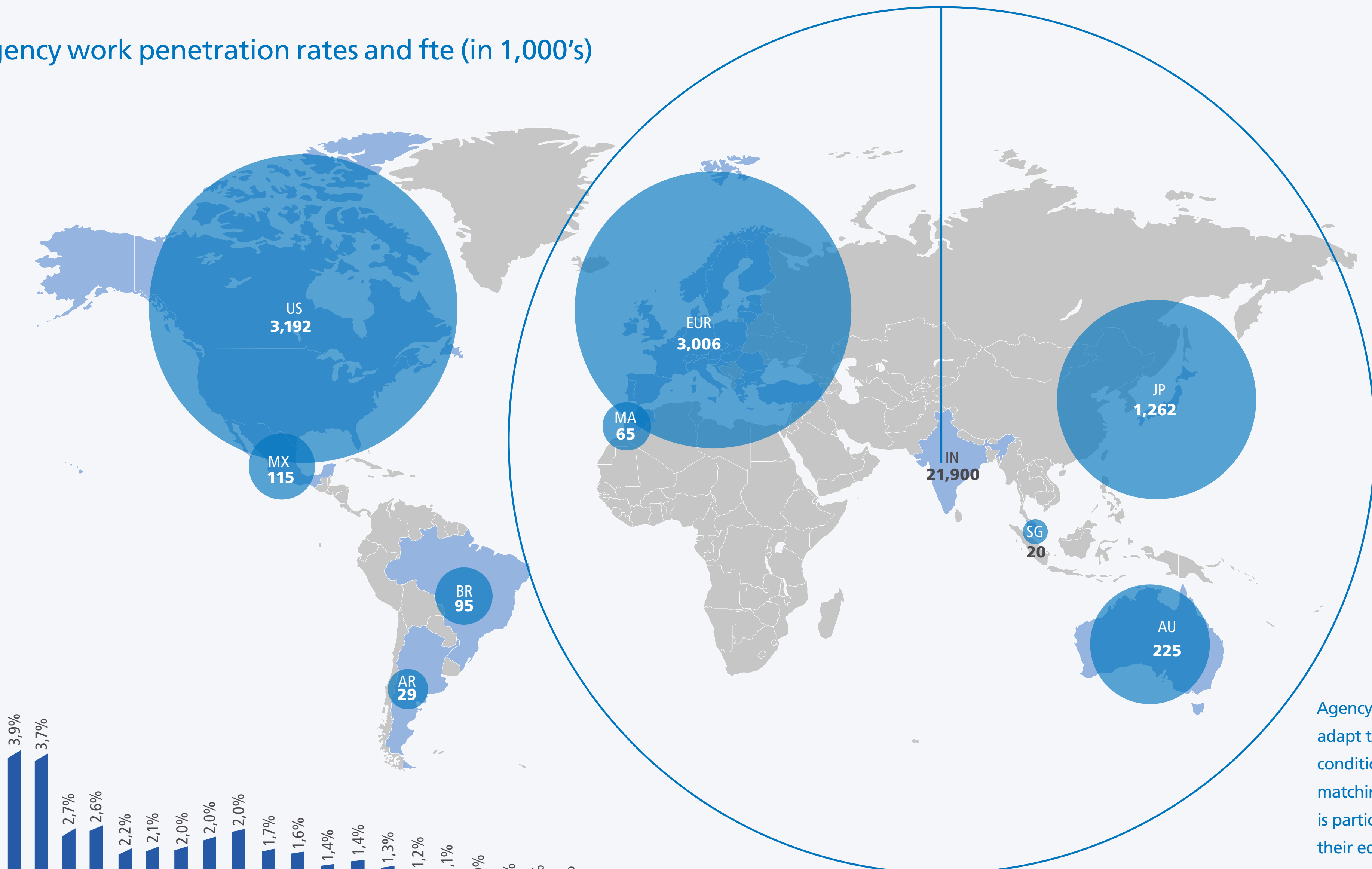
Temporary workers can be found in different economic sectors like manufacturing, retail, health care, education, construction and business services. There is no clear pattern but it varies by country. Manufacturing is the most important sector for temporary workers in the Germany, France, Italy and Portugal. Construction is more dominant in Spain, Portugal and Greece. Furthermore, in the Netherlands, Germany, France, Sweden and the UK the health sector plays

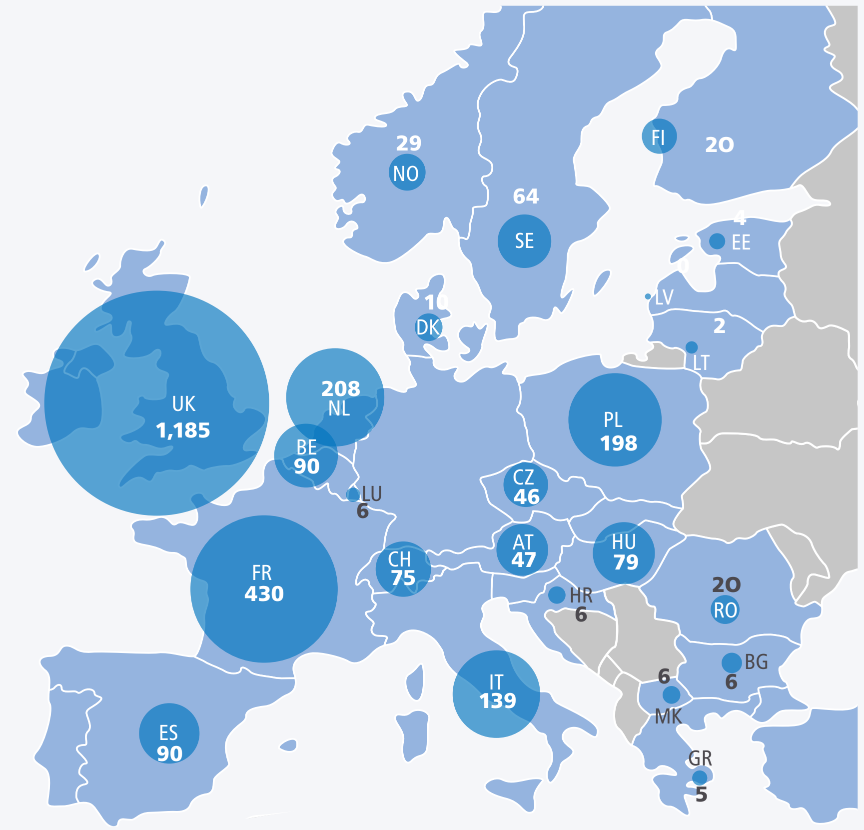
Temporary employment by educational attainment

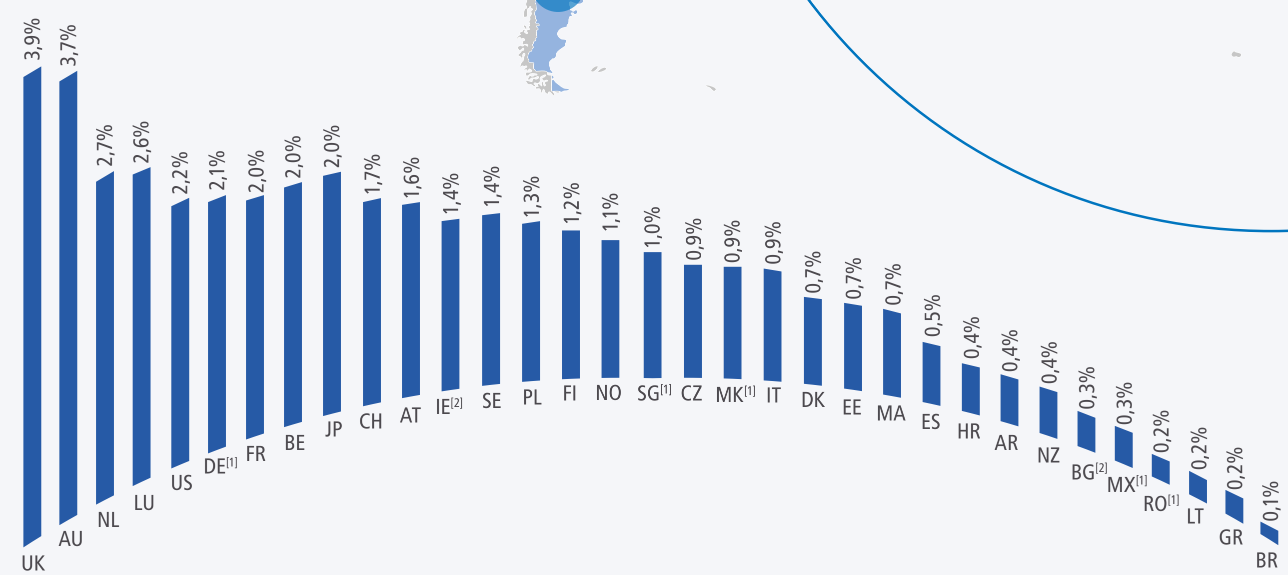


Source: Eurostat 2015q2.

Agency work penetration rates and fte (in 1,000's)







Source: Ciett Economic report 2016, data 2014

Agency work give employers the opportunity to adapt the size of their workforce to economic conditions and at the same time facilitate job matching by providing initial work experience. This is particularly true for younger people, either during their educational period or when starting on the labor market, but also for the unemployed to find their way back to the labor market. People who start doing agency work out of unemployment will often not return to unemployment after their assignment. Although there are significant differences between the countries, each show that agency work is a stepping stone out of unemployment into work. Clearly, people use the experience and skills they obtain while working as an agency worker to make a next move on the labor market.

People who start working as an agency worker can do so either from employment or unemployment, but also from education or inactivity. Through agency work, they do not only have a good point of entry to the labor market, but they are also able to stay in employment after their agency work assignment ended. In many countries agency workers receive formal training, either directly through the agency, or through bipartite funds set up by the agencies and the trade unions. This makes sure that agency workers get opportunities to keep developing themselves in order to take another step on the labor market. Being close to the labor market, employment and recruitment agencies are excellently suited to advice workers on the type of training to follow in order to enhance their employability.

an important role in the labor market for temporary workers. At least 15 percent of the temporary workforce in these countries works in the health sector. In the UK many temporary workers are also found in the education sector (although the overall share of temporary workers in total employment is considerably low in the UK).
The reasons for working in a temporary job differ substantially between countries. Roughly speaking: in the German-speaking countries, Scandinavia and the Netherlands temporary work is a voluntary choice for the majority of temporary workers. In contrast, in Belgium and the Mediterranean countries the majority of temporary workers opt for temporary work only as a second choice. A correlation does exist between employment participation and whether temporary work is voluntary: countries with higher participation have less people working involuntary in a fixed term contract. In other words, higher participation levels come hand in hand with more voluntary temporary workers. Apparently some part of the higher participation countries might be connected to their labor markets providing 'good quality' temporary jobs.

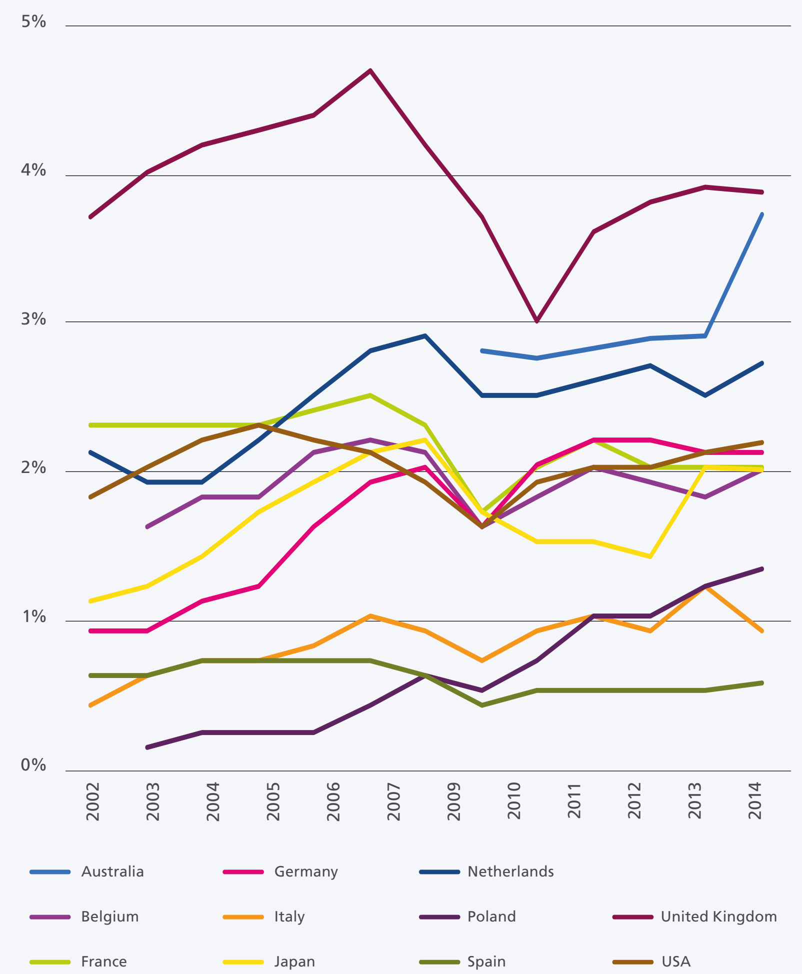
AGENCY WORK

With agency work, the employer does not hire an employee directly on a fixed-term contract, but through a private employment agency. Typically, the employee is hired directly by the employment agency, mostly on a fixed-term basis but occasionally on an open-ended contract. During the contract period, the employee can be assigned to different user companies. After the contract expires, a renewed contract with the employment agency is one of the possibilities, but also a contract with one of the user companies.

In 2014 the 39 million individuals who worked as an agency worker at some point during the year, together filled about 8.3 million full time equivalent jobs. That means it takes about 4.7 agency workers to fill one full time job, or an average job takes about 11 weeks. Of course, these figures differ significantly from one country to another. After one agency work assignment, many people transition into other working roles.

Agency work accounts for a relatively small but important part of total employment. It has a long tradition in the United States, with a long-term share in total employment of around 2 percent. In Europe, agency work has the highest employment share in the United

Development agency work

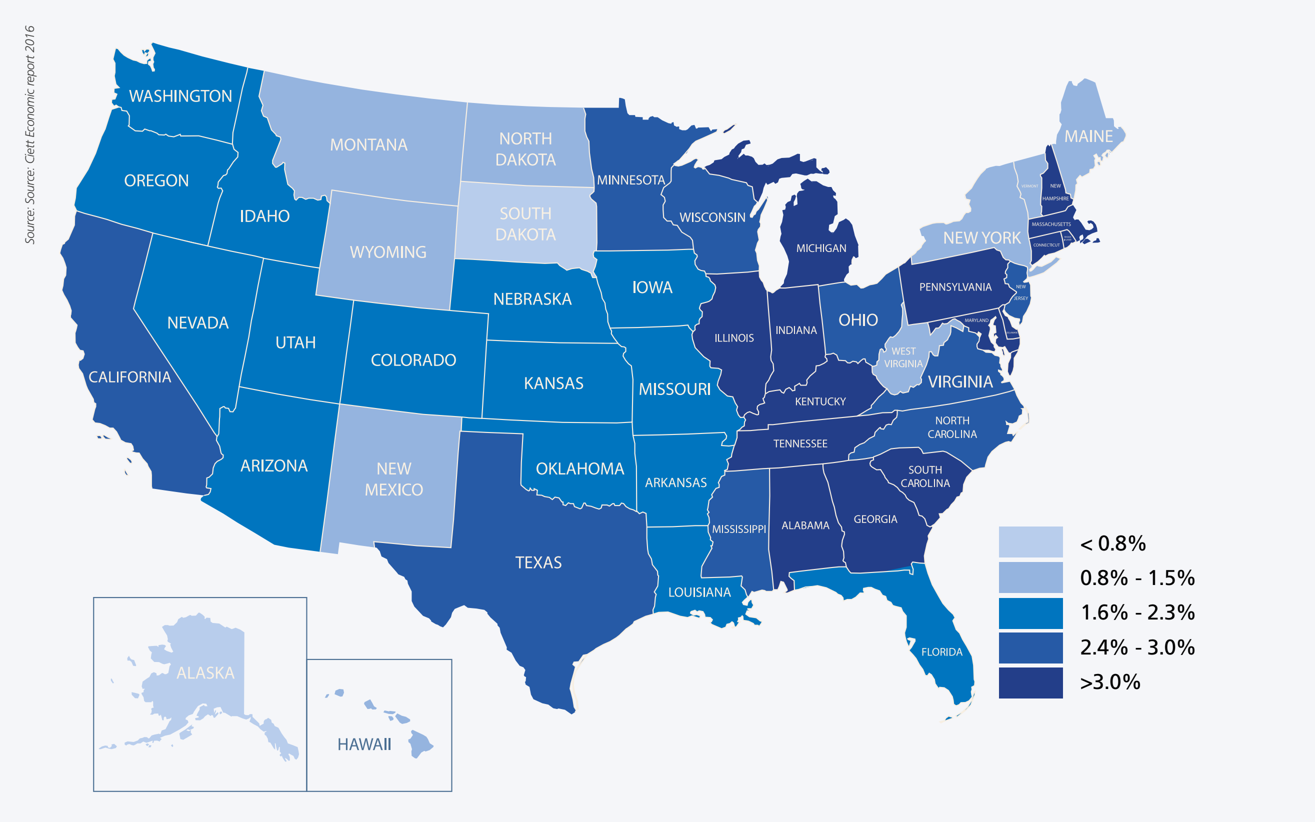


Agency work in the United States has hit an all-time high

This U.S. Department of Commerce states in their July 2015 'Temporary Help Workers in the U.S. Labor Market' report jobs in the temporary help services industry have hit an all-time high as the labor market recovery continues in the United States. Temporary help has been and continues to be a way for workers and firms to enter into flexible employment relationships. Variations in the concentration of temporary help across states are likely a result of the industries and occupations that tend to rely on temporary workers. Almost one quarter of temporary workers are employed in production occupations; among workers directly-hired into production occupations, the vast majority work in the manufacturing sector. Thus, perhaps not surprisingly, the states where temporary workers constitute a larger share of the employed, are in the Midwest and South, areas known for manufacturing.

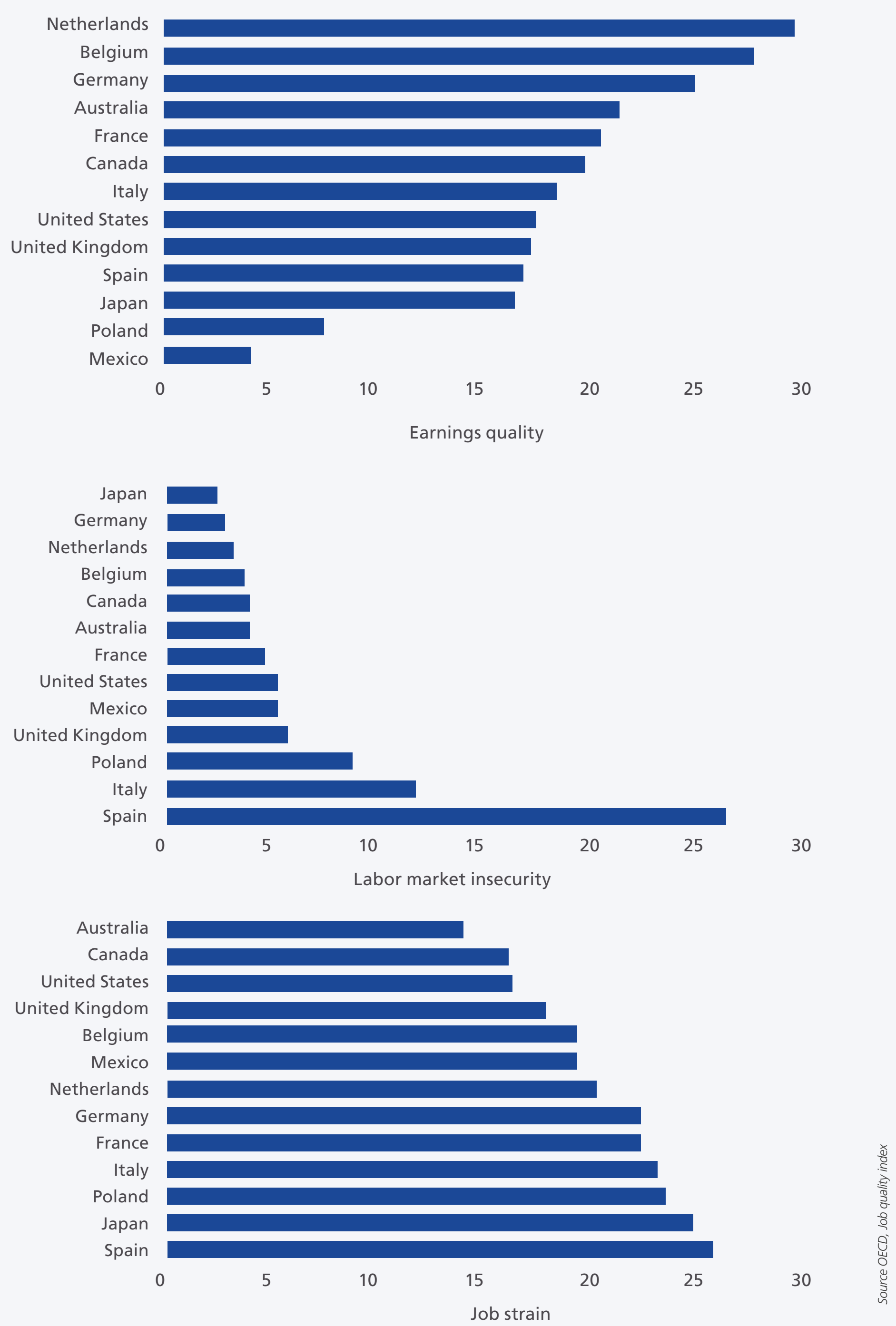
Although it is difficult to estimate using official statistics how much manufacturers are using temporary workers to fill their labor needs, there has been anecdotal evidence that manufacturers' use of temporary workers is growing. After experiencing uncertainty over the past decade or more, manufacturers may be making use of the flexibility of temporary work arrangements in some cases, rather than entering into longer term labor contracts.

Agency work penetration rates in US States



Note: Preliminary data were used in these calcualtions.

OECD Job quality index



OECD introduces the Job Quality Index

The OECD focuses the job quality index on the outcomes for workers in three broad areas that are most important for their well-being:

- Earnings quality. How does employment contribute to material living conditions? How are earnings distributed across the workforce?
- Labor market security. What is the level of risk of becoming and staying unemployed? What are the economic consequences for workers of being laid off?
- Job strain, the quality of the working environment. What is the nature and content of the work? How much pressure does it involve?

Kingdom, followed traditionally by the Benelux countries and France, where agency work has been well-established for four to five decades now. In Germany agency work has become much more popular over the last decade after the changed regulation on labor in the Hartz reforms. In Japan, agency work has become more popular since 2000, with the current share at around 1.5 to 2 percent. After the financial crisis agency work penetration rates went down in many countries but have recovered since to pre-crisis rates. In Australia, the United States and Poland even reached an all-time high in 2014.

JOB QUALITY IN THE FUTURE OF WORK

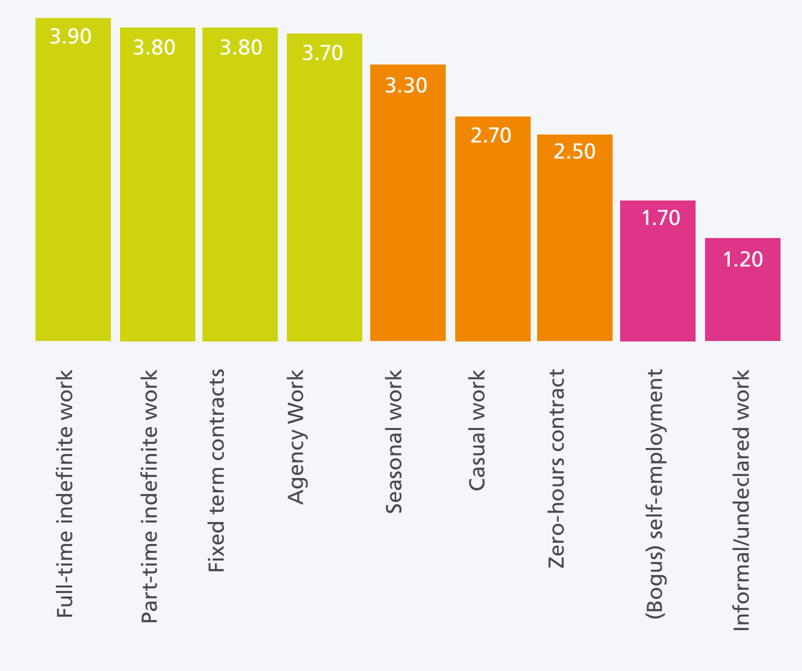
Most people spend a substantial amount of time at work, and work for a significant part of their life. The jobs people hold are therefore one of the most important determinants of their well-being. But what are the features of job quality that affect well-being? Good pay, labor market security and a decent working environment can go hand in hand with high employment, according to OECD findings on the quality of jobs in 45 countries.
Job quality is the highest in Australia, German-speaking countries and the Nordics. These countries are performing relatively well along at least two of the three dimensions of job quality. Relatively low job quality on the other hand is found in countries in Eastern and Southern Europe.

The OECD data also reveal big differences across groups of workers. Youths and the unskilled tend to have the worst performance in terms of employment as well as lower earnings and considerably higher labor market insecurity and higher job strain (especially the low skilled). Women suffer from substantially lower employment rates than men and face a large pay gap. At the same time, they are less likely than men to experience job strain.

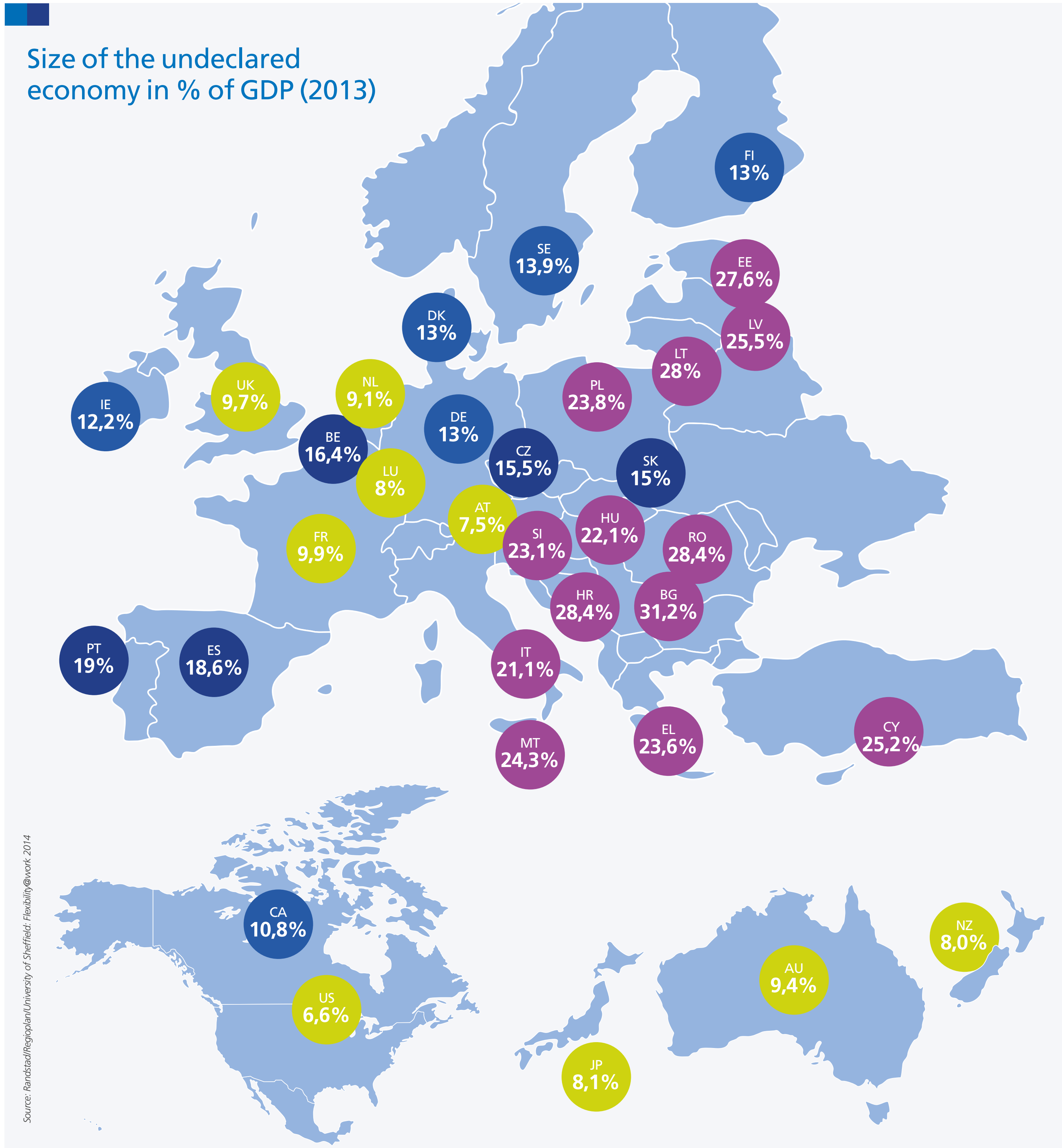
A study by the London Metropolitan University on precarious work compared different types of employment contracts on job quality. The research showed fulltime open-ended contracts, part-time open-ended contracts, direct fixed term contracts and agency work are all comparable in terms of overall job quality. Informal work and bogus or false self-employment are the forms of work that offer the worst job quality. Agency work, being a well-regulated form of work in most countries, offers high job quality, especially in terms of access to welfare and pension, working time limits, discrimination protection and also on job security.

Comparing job quality of different employment relations

(0 = lowest, 5 = highest)



Size of the undeclared economy in % of GDP (2013)



HOW TO TACKLE UNDECLARED WORK

It is widely recognized that the undeclared economy is prevalent in many global regions. In fact, out of a global working population of some 3 billion, almost two-thirds (some 1.8 billion) work in the undeclared economy. It is also generally acknowledged that the undeclared economy lowers the quality of work and working conditions, undermines the business environment through unfair competition, and puts at risk the financial sustainability of social protection systems. Clearly, therefore, undeclared activities should not merely be discouraged, but should rather be transformed into regular work.

As to what causes undeclared work, there are two perspectives. On the one hand, the liberal, open-market perspective argues that the undeclared economy is a direct result of high taxes, state corruption and burdensome regulations and controls. On the other hand, there is the 'structuralist' perspective, which argues that undeclared work is the by-product of inefficient regulation, combined with a lack of labor market intervention and social protection. The study for Flexibility@work2013 - conducted by the University of Sheffield and Regioplan Policy Research - showed that countries with a smaller undeclared economy are those in which it is easier for companies to resort to temporary employment opportunities to meet labor demands and in which, at the same time, there is greater intervention (in the form of labor market policies that protect and support vulnerable groups of workers). By creating the right environment these relatively successful economies reduce the supply and demand of undeclared work by providing both workers and employers with better alternatives.

This report reveals no correlation between higher tax rates and larger undeclared economies. Instead, it reveals that nations:

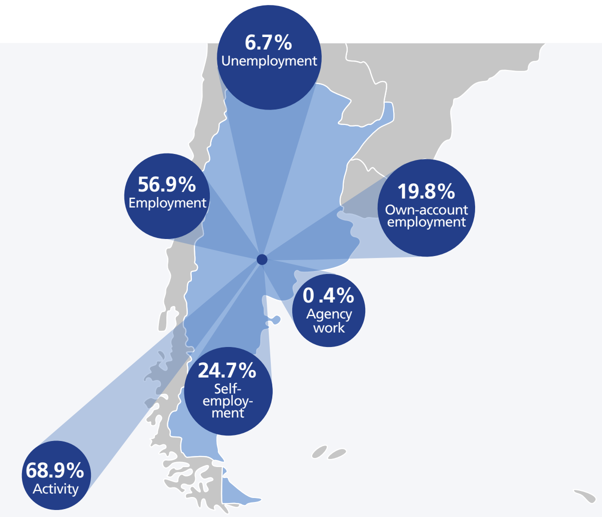
- in which larger intervention in the form of labor market policies to protect vulnerable groups occurs;
- in which higher levels of social protection occur;
- in which it is easier for firms to resort to temporary employment and temporary work agencies to meet labor demands;
- have smaller undeclared economies. These economies reduce the supply of undeclared labor by providing workers with alternatives for undeclared work such as social protection and labor market policy interventions to help them enter the formal labor market. On the other hand, by making it easier for businesses to turn to temporary employment and TWAs to meet their flexible labor demands, the demand for undeclared labor also diminishes.

The study therefore encourages a greater recognition of the need to take an active approach to labor markets by:

- stepping up labor market policy interventions as for instance training, employment incentives, start up incentives, job rotation and job sharing;
- creating a mature system of social protection and labor market policy supports like out-of-work income maintenance and support;
- putting in place the measures necessary to reduce the demand for and supply of undeclared labor, like he creation of accessible, well regulated market for temporary employment and temporary work agencies.

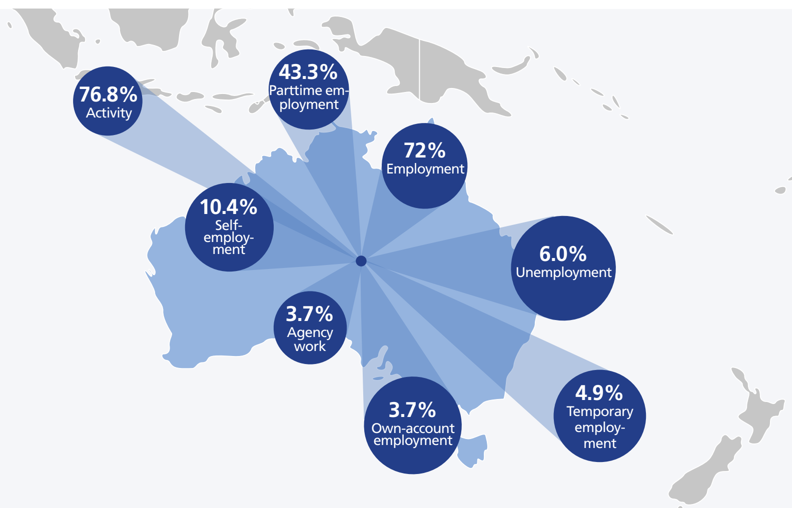
country tables

Argentina



	Activity	Employment	Unemployment	Self-employment	Own-account employment	Agency work
Total	68.9%	56.9%	6.7%	24.7%	19.8%	0.4%
Men	81.7%	70.3%	5.6%	28.8%	23.0%	
Women	56.3%	44.4%	8.2%	18.9%	15.3%	
Age 15 to 24	41.7%	33.8%	19.1%			
Age 25 to 54	81.5%	63.2%				
Age 55 to 64	62.2%					

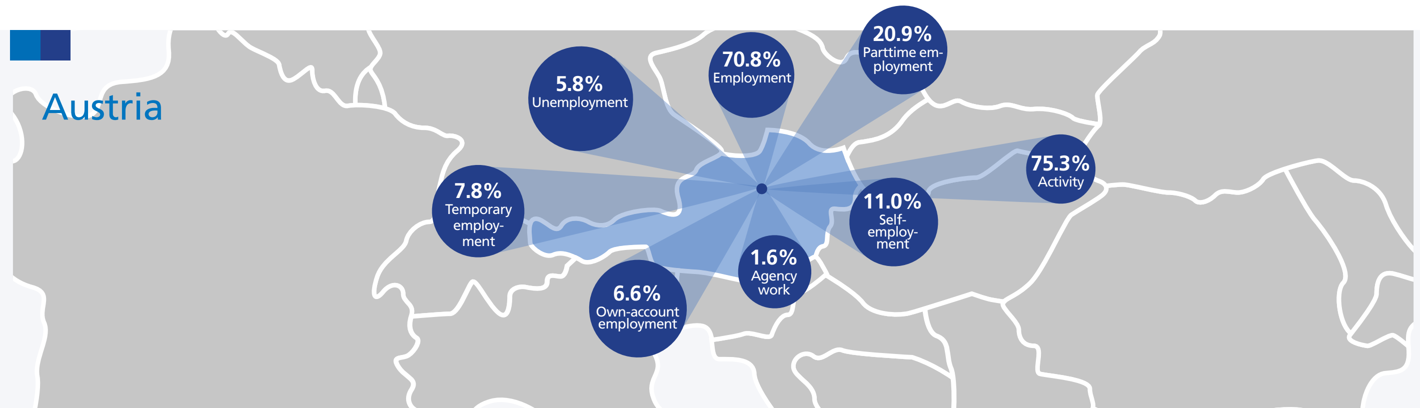
Australia



	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	76.8%	72.0%	6.0%	25.2%	10.4%	3.7%	4.9%	3.7%
Men	82.6%	77.5%	6.1%	14.0%	12.2%	12.0%	4.3%	
Women	71.0%	66.6%	6.0%	38.3%	8.1%	7.9%	5.6%	
Age 15 to 24	67.2%	58.3%	13.4%	46.6%			5.3%	
Age 25 to 54	83.3%	79.4%	4.8%	18.9%			4.8%	
Age 55 to 64	64.7%	62.0%	4.2%	24.9%			3.8%	

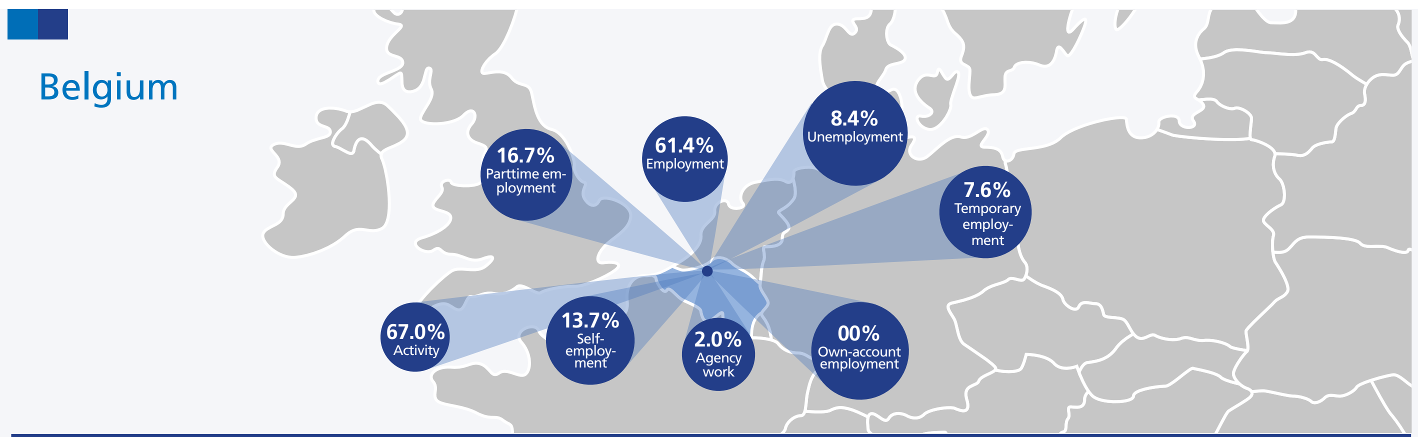
Definitions and sources see page 127

Austria



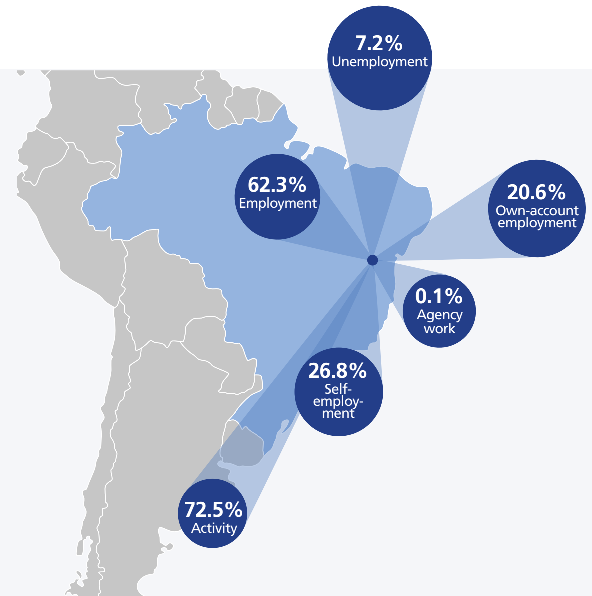
	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	75.3%	70.8%	5.8%	20.9%	11.0%	6.6%	7.8%	1.6%
Men	80.0%	75.0%	6.2%	8.5%	13.4%	7.0%	7.7%	
Women	70.5%	66.7%	5.4%	34.9%	8.4%	6.0%	7.9%	
Age 15 to 24	55.8%	50.2%	10.2%	19.9%	1.8%	1.5%	33.0%	
Age 25 to 54	88.2%	83.4%	5.4%	19.6%	11.3%	6.8%	4.6%	
Age 55 to 64	48.2%	46.1%	4.4%	23.2%	18.2%	10.4%	2.7%	
Education: basic	52.6%	46.4%	11.5%		7.3%	5.3%	22.0%	
Education: intermediate	77.8%	73.6%	5.4%		9.4%	5.7%	4.6%	
Education: advanced	86.7%	83.1%	4.1%		15.0%	8.4%	7.4%	

Belgium



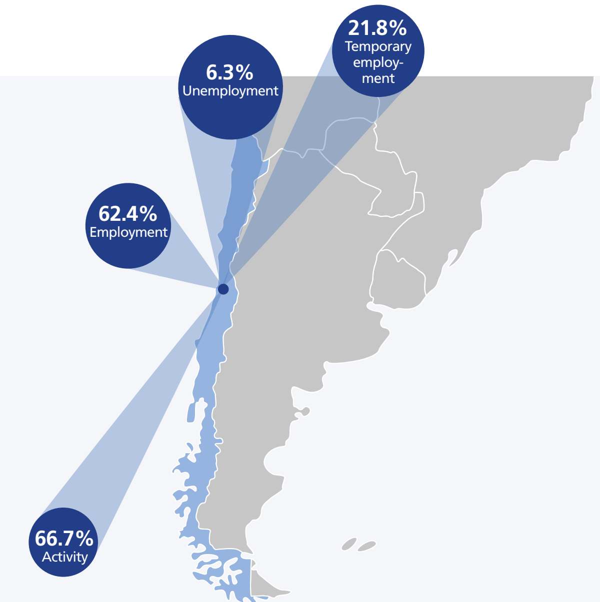
	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	67.0%	61.4%	8.4%	18.1%	13.7%	9.8%	7.6%	2.0%
Men	71.9%	65.1%	9.3%	7.2%	17.7%	12.2%	6.5%	
Women	62.1%	57.6%	7.2%	30.5%	9.1%	7.0%	8.8%	
Age 15 to 24	28.6%	22.8%	20.4%	22.0%	6.0%	5.3%	34.1%	
Age 25 to 54	84.6%	78.1%	7.6%	16.3%	13.7%	9.7%	6.2%	
Age 55 to 64	46.6%	43.8%	6.1%	24.5%	17.5%	12.4%	3.1%	
Education: basic	42.4%	35.0%	17.2%		11.8%	7.9%	9.7%	
Education: intermediate	70.1%	64.3%	8.1%		13.5%	9.2%	7.9%	
Education: advanced	86.0%	82.0%	4.5%		14.6%	11.0%	6.5%	

Brazil



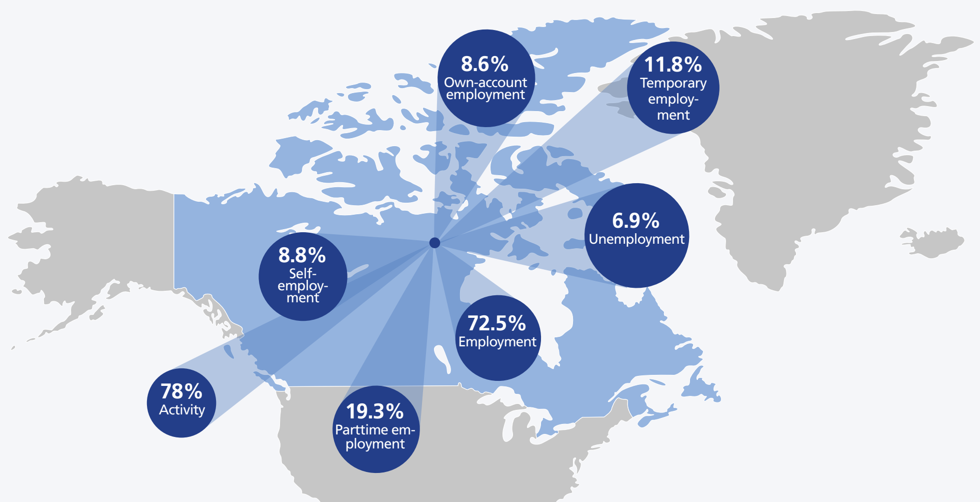
	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Agency work
Total	72.5%	62.3%	7.2%	16.4%	26.8%	20.6%	0.1%
Men	83.3%	74.1%	5.6%	10.2%	30.9%	24.5%	
Women	62.0%	51.1%	9.2%	24.7%	21.4%	15.3%	
Age 15 to 24	57.4%	47.8%	16.8%	18.9%			
Age 25 to 54	81.5%	66.2%		13.7%			
Age 55 to 64	55.8%			21.6%			

Chile



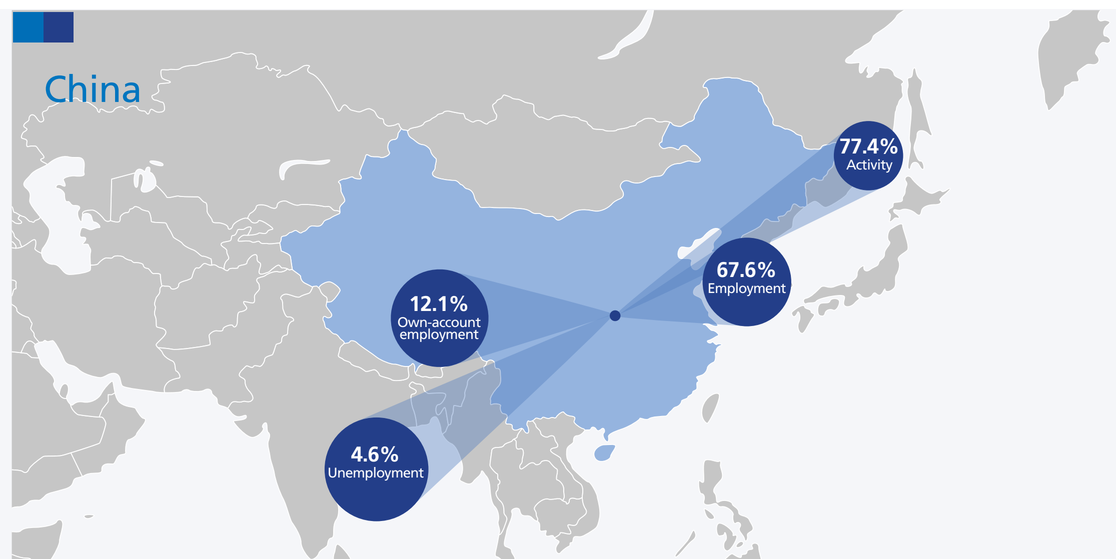
	Activity	Employment	Unemployment	Parttime employment	Temporary employment
Total	66.7%	62.4%	6.3%	17.0%	21.8%
Men	77.7%	73.1%	5.6%	11.5%	23.7%
Women	55.7%	51.6%	7.2%	25.0%	19.1%
Age 15 to 24	36.0%	30.1%	16.2%	25.2%	40.2%
Age 25 to 54	79.3%	74.9%	5.6%	13.7%	20.3%
Age 55 to 64	66.2%	64.2%	3.0%	17.6%	12.0%

Canada



	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment
Total	78.0%	72.5%	6.9%	19.3%	8.8%	8.6%	11.8%
Men	81.8%	75.6%	7.5%	12.3%	9.4%	9.3%	11.0%
Women	74.2%	69.4%	6.3%	27.0%	8.0%	7.9%	12.6%
Age 15 to 24	64.2%	55.8%	13.2%	48.9%			29.9%
Age 25 to 54	86.4%	81.4%	5.8%	12.0%			8.4%
Age 55 to 64	64.8%	60.9%	6.1%	18.3%			7.4%

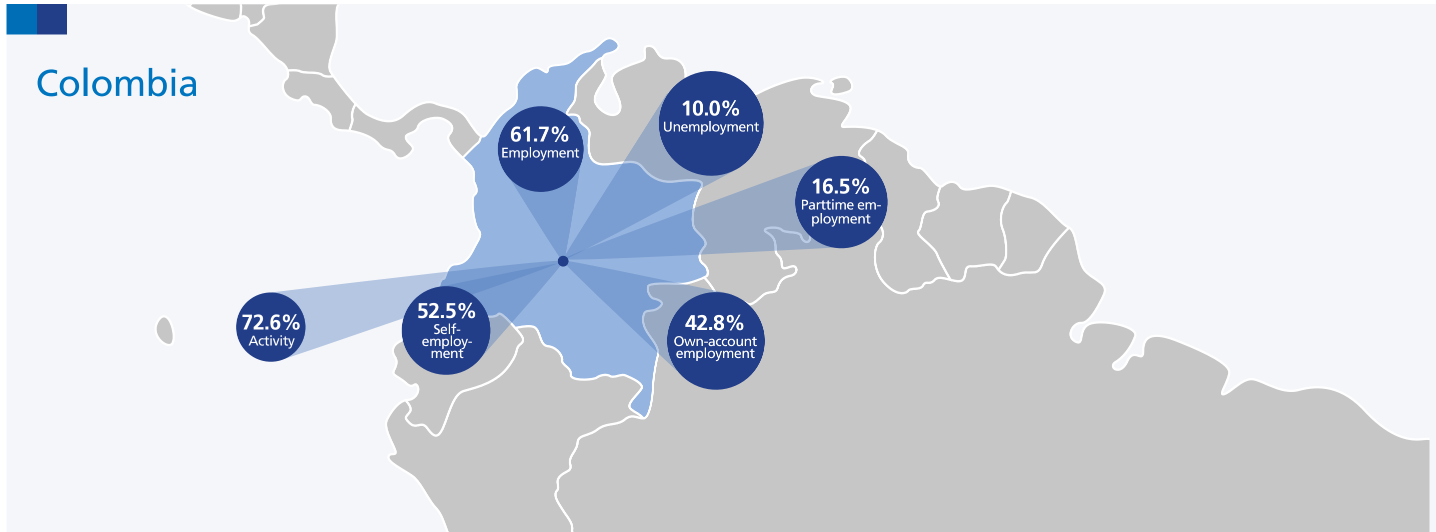
China



	Activity	Employment	Unemployment	Own-account employment
Total	77.4%	67.6%	4.6%	12.1%
Men	84.0%	74.0%	5.1%	
Women	70.3%	61.0%	4.0%	
Age 15 to 24	54.3%	47.7%	12.1%	
Age 25 to 54	88.1%	71.5%		
Age 55 to 64	59.1%			

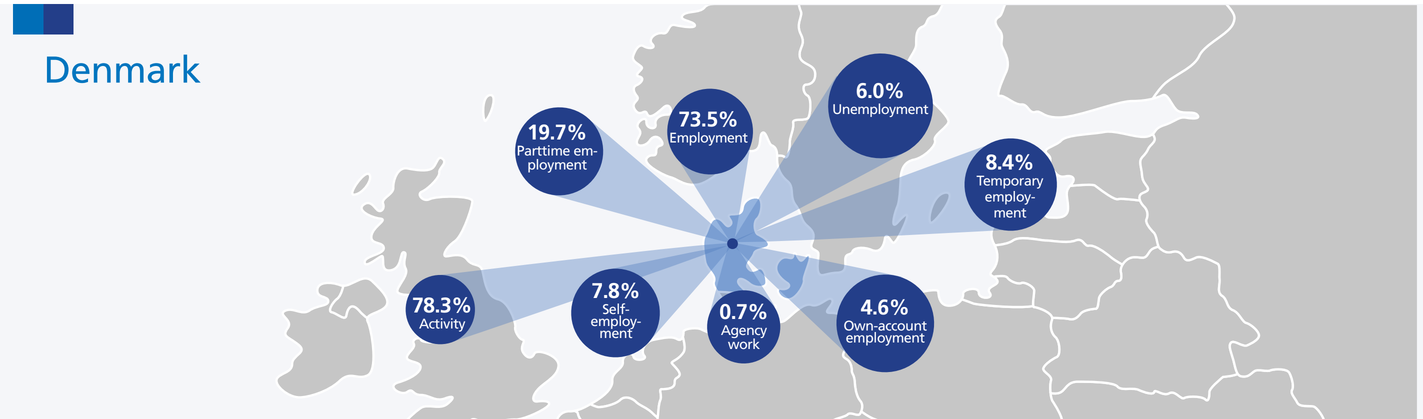
Definitions and sources see page 127

Colombia



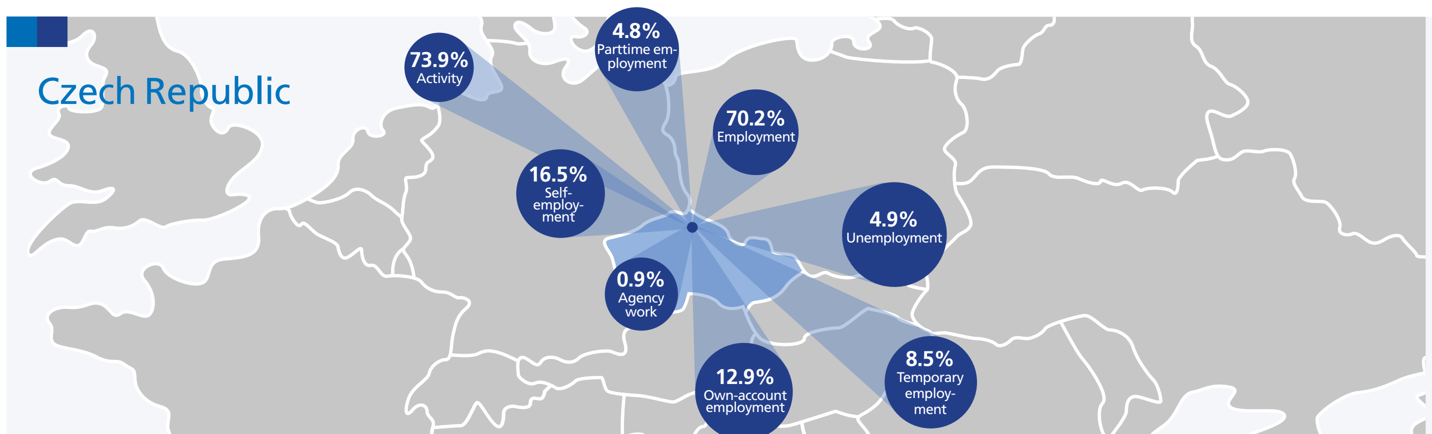
	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment
Total	72.6%	61.7%	10.0%	16.5%	52.5%	42.8%
Men	83.0%	73.8%	7.6%	9.2%	52.9%	43.6%
Women	62.4%	50.4%	13.0%	26.6%	51.9%	41.6%
Age 15 to 24	44.5%	35.3%	20.5%	24.0%		
Age 25 to 54	85.0%	69.5%		15.0%		
Age 55 to 64	66.3%					

Denmark



	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	78.3%	73.5%	6.0%	19.7%	7.8%	4.6%	8.4%	0.7%
Men	81.5%	76.6%	5.8%	14.6%	10.2%	5.7%	7.3%	
Women	75.1%	70.3%	6.3%	25.4%	5.0%	3.3%	9.7%	
Age 15 to 24	61.9%	55.9%	9.7%	63.9%	1.0%		23.4%	
Age 25 to 54	86.9%	81.8%	5.9%	10.8%	8.4%	5.1%	6.5%	
Age 55 to 64	68.0%	65.3%	3.9%	12.8%	11.1%	6.6%	2.9%	
Education: basic	59.3%	53.9%	8.9%		7.4%	4.3%	14.3%	
Education: intermediate	83.4%	78.6%	5.6%		8.5%	4.8%	6.8%	
Education: advanced	89.9%	85.7%	4.5%		7.1%	4.4%	7.0%	

Czech Republic



	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	73.9%	70.2%	4.9%	4.8%	16.5%	12.9%	8.5%	0.9%
Men	81.2%	77.8%	4.2%	2.5%	20.3%	15.5%	7.0%	
Women	66.3%	62.3%	5.9%	7.7%	11.5%	9.6%	10.5%	
Age 15 to 24	31.9%	28.1%	12.0%	9.3%	4.6%	4.5%	29.6%	
Age 25 to 54	88.5%	84.5%	4.5%	3.1%	16.5%	13.0%	7.4%	
Age 55 to 64	58.1%	55.6%	4.3%	6.4%	21.0%	16.0%	5.8%	
Education: basic	28.7%	22.3%	21.9%		9.7%	8.7%	20.0%	
Education: intermediate	79.1%	75.4%	4.7%		16.9%	13.6%	8.1%	
Education: advanced	84.8%	82.9%	2.2%		16.2%	11.4%	7.8%	

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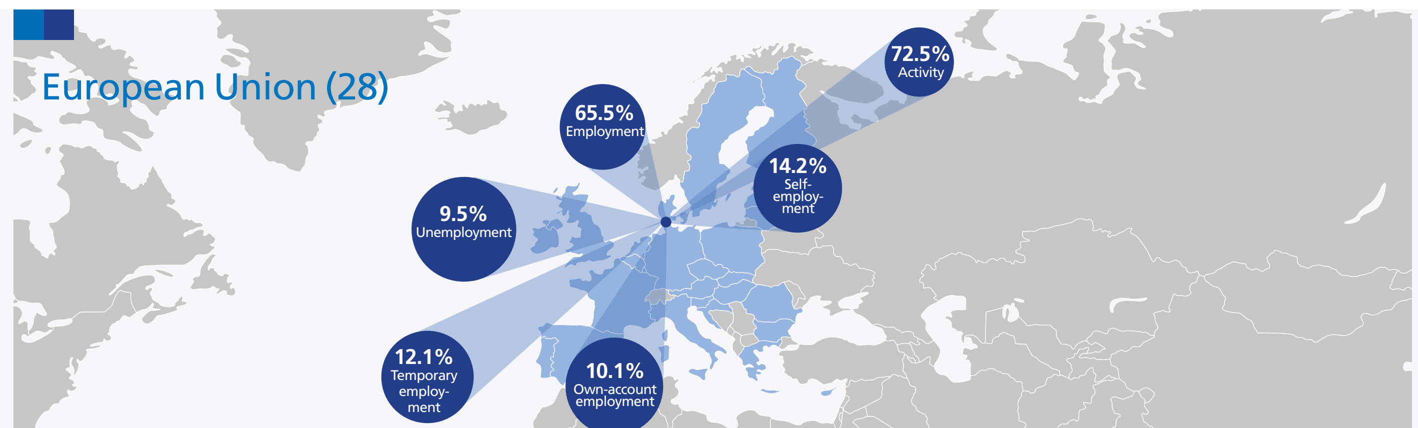
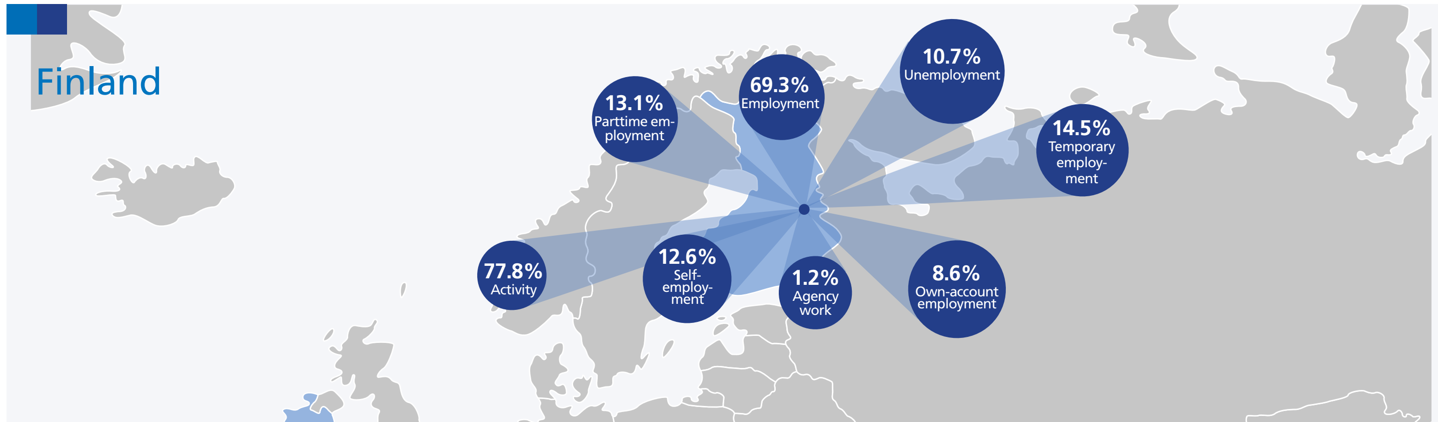
European Union (28)



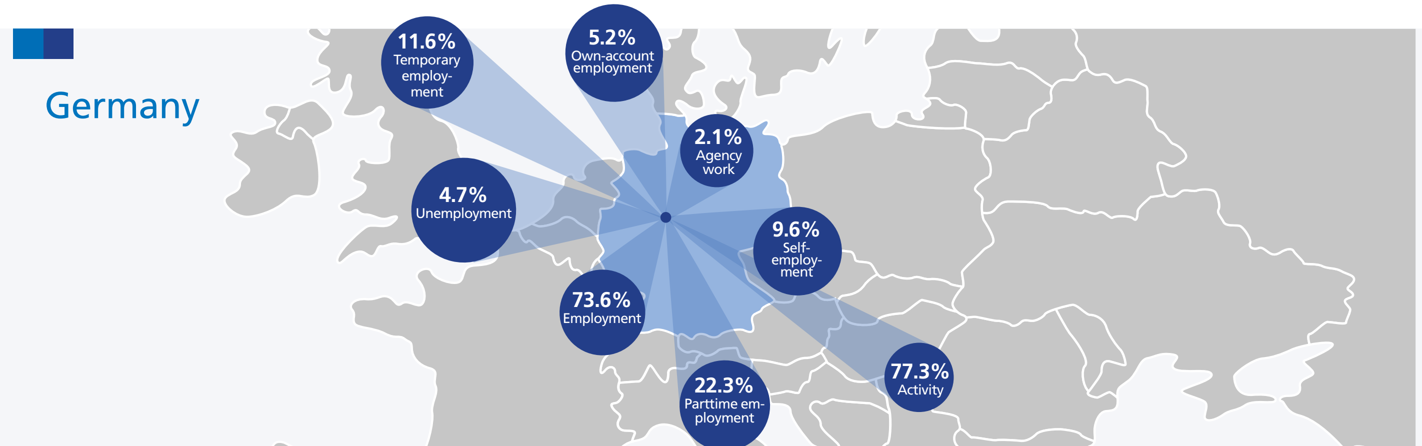
	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment
Total	72.4%	65.5%	9.5%	17.5%	14.2%	10.1%	12.1%
Men	78.1%	70.6%	9.5%	8.5%	17.9%	12.3%	11.3%
Women	66.8%	60.4%	9.5%	28.0%	9.9%	7.6%	13.1%
Age 15 to 24	40.9%	32.5%	20.4%	28.6%	4.3%	3.9%	40.4%
Age 25 to 54	85.5%	78.0%	8.8%	14.7%	14.1%	10.0%	10.5%
Age 55 to 64	57.1%	53.1%	7.0%	19.6%	19.7%	13.8%	5.1%
Education: basic	52.9%	43.3%	17.7%		16.9%	12.9%	17.2%
Education: intermediate	75.8%	69.2%	8.7%		13.2%	9.5%	11.5%
Education: advanced	87.7%	82.8%	5.5%		14.2%	9.6%	10.3%

Finland



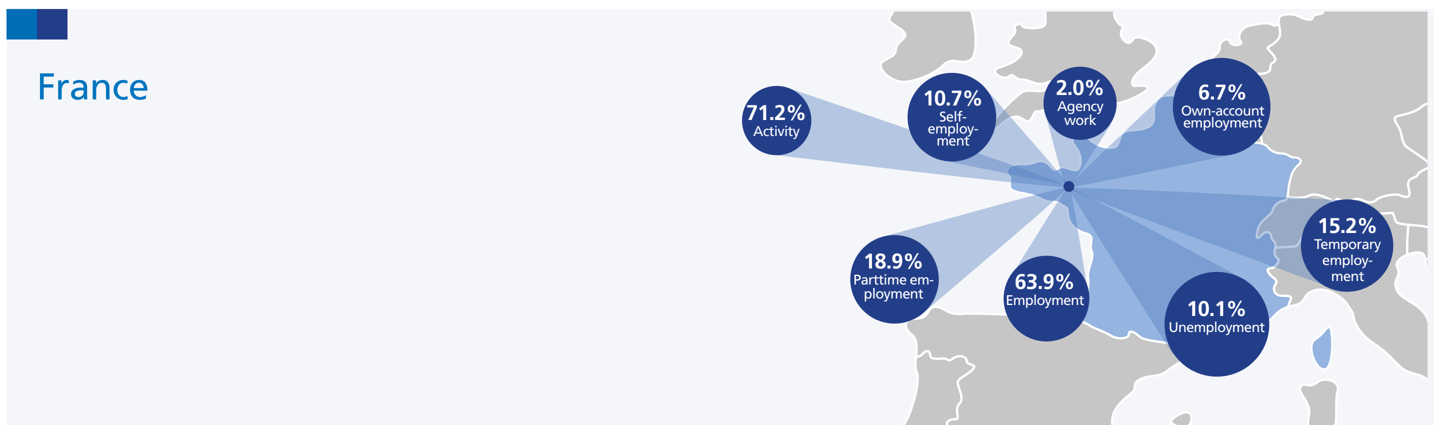
	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	77.8%	69.3%	10.7%	13.3%	12.6%	8.6%	14.5%	1.2%
Men	79.2%	70.1%	11.2%	10.0%	16.4%	10.5%	11.8%	
Women	76.4%	68.5%	10.2%	16.8%	8.6%	6.5%	17.3%	
Age 15 to 24	62.9%	44.6%	29.0%	36.8%	2.9%	2.5%	44.6%	
Age 25 to 54	86.8%	80.2%	7.7%	7.4%	13.1%	8.7%	11.7%	
Age 55 to 64	64.9%	59.5%	8.2%	15.4%	16.9%	12.0%	5.8%	
Education: basic	52.6%	39.6%	23.4%		17.2%	10.4%	20.9%	
Education: intermediate	80.0%	71.0%	11.0%		13.9%	9.9%	15.3%	
Education: advanced	88.5%	83.1%	6.0%		9.9%	6.6%	11.8%	

Germany



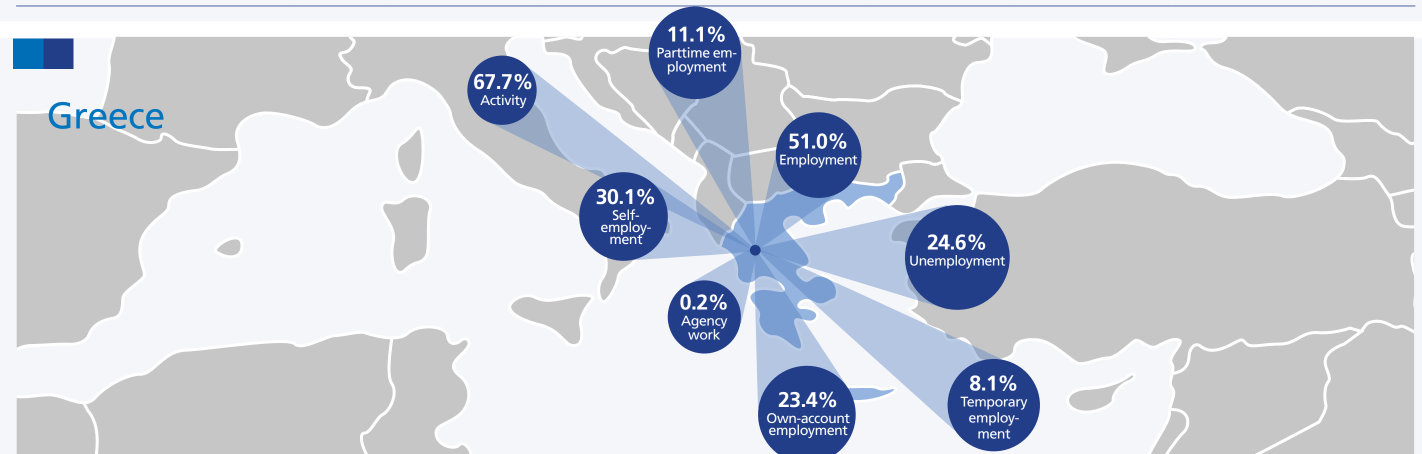
	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	77.3%	73.6%	4.7%	22.3%	9.6%	5.2%	11.6%	2.1%
Men	81.5%	77.3%	5.1%	9.1%	12.2%	5.9%	11.1%	
Women	73.0%	69.9%	4.2%	37.5%	6.7%	4.4%	12.2%	
Age 15 to 24	47.1%	43.8%	7.0%	20.7%	1.4%	1.1%	50.8%	
Age 25 to 54	87.6%	83.7%	4.5%	20.5%	9.8%	5.4%	8.7%	
Age 55 to 64	68.9%	65.7%	4.7%	24.3%	13.1%	6.7%	2.9%	
Education: basic	51.0%	45.3%	11.1%		5.3%	3.1%	29.2%	
Education: intermediate	81.4%	77.8%	4.3%		7.6%	4.3%	9.4%	
Education: advanced	89.7%	87.6%	2.3%		15.9%	8.1%	8.8%	

France



	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	71.2%	63.9%	10.1%	14.2%	10.7%	6.7%	15.2%	2.0%
Men	75.3%	67.2%	10.6%	6.6%	13.9%	8.1%	13.8%	
Women	67.2%	60.8%	9.5%	22.3%	7.4%	5.1%	16.6%	
Age 15 to 24	36.2%	27.9%	23.1%	19.7%	2.0%	1.4%	58.8%	
Age 25 to 54	87.4%	79.5%	9.0%	12.3%	10.6%	6.6%	12.2%	
Age 55 to 64	53.0%	49.0%	7.6%	19.1%	16.2%	9.6%	7.3%	
Education: basic	47.7%	39.4%	17.2%		8.7%	5.8%	18.0%	
Education: intermediate	74.5%	66.7%	10.5%		10.4%	6.3%	16.2%	
Education: advanced	87.1%	81.8%	6.0%		12.0%	7.4%	12.6%	

Greece



	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	67.7%	51.0%	24.6%	11.2%	30.1%	23.4%	8.1%	0.2%
Men	75.7%	59.3%	21.6%	7.5%	35.6%	27.0%	7.0%	
Women	59.9%	42.8%	28.3%	16.2%	22.6%	18.4%	9.6%	
Age 15 to 24	26.0%	13.1%	49.5%	19.3%	8.9%	7.1%	25.7%	
Age 25 to 54	85.4%	64.9%	24.1%	10.8%	27.6%	21.1%	7.8%	
Age 55 to 64	40.9%	34.0%	17.0%	9.5%	53.1%	43.3%	3.9%	
Education: basic	54.4%	40.0%	26.1%		44.0%	37.8%	8.7%	
Education: intermediate	67.7%	49.0%	27.6%		27.3%	20.0%	8.8%	
Education: advanced	84.7%	68.2%	19.3%		23.2%	16.7%	6.6%	

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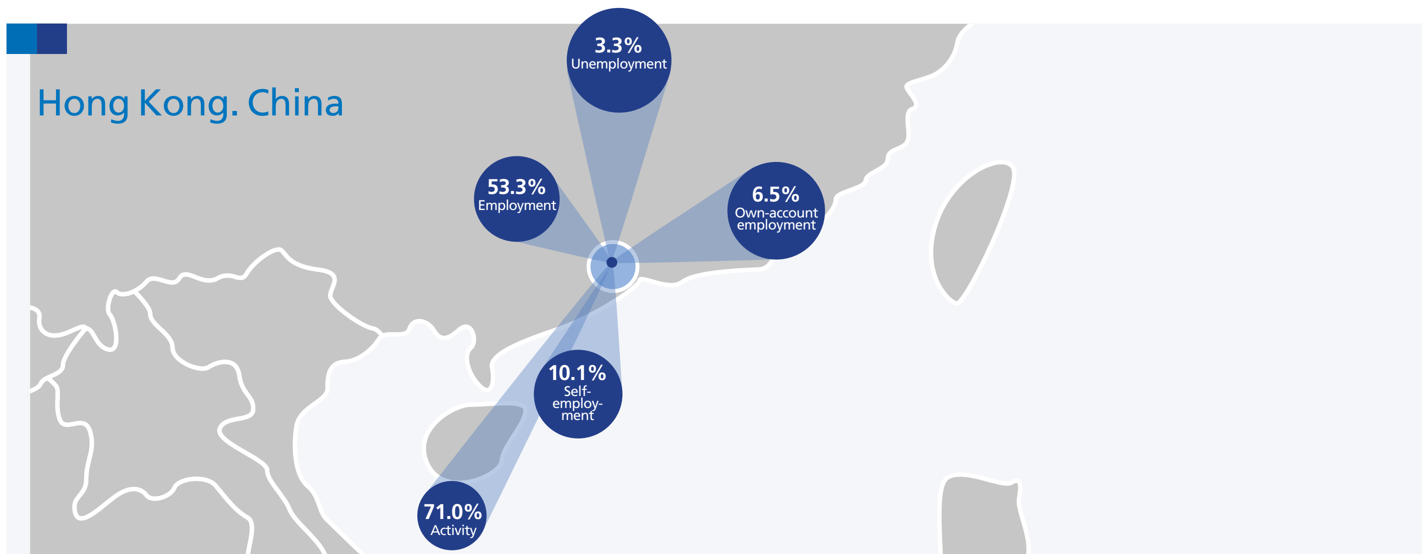
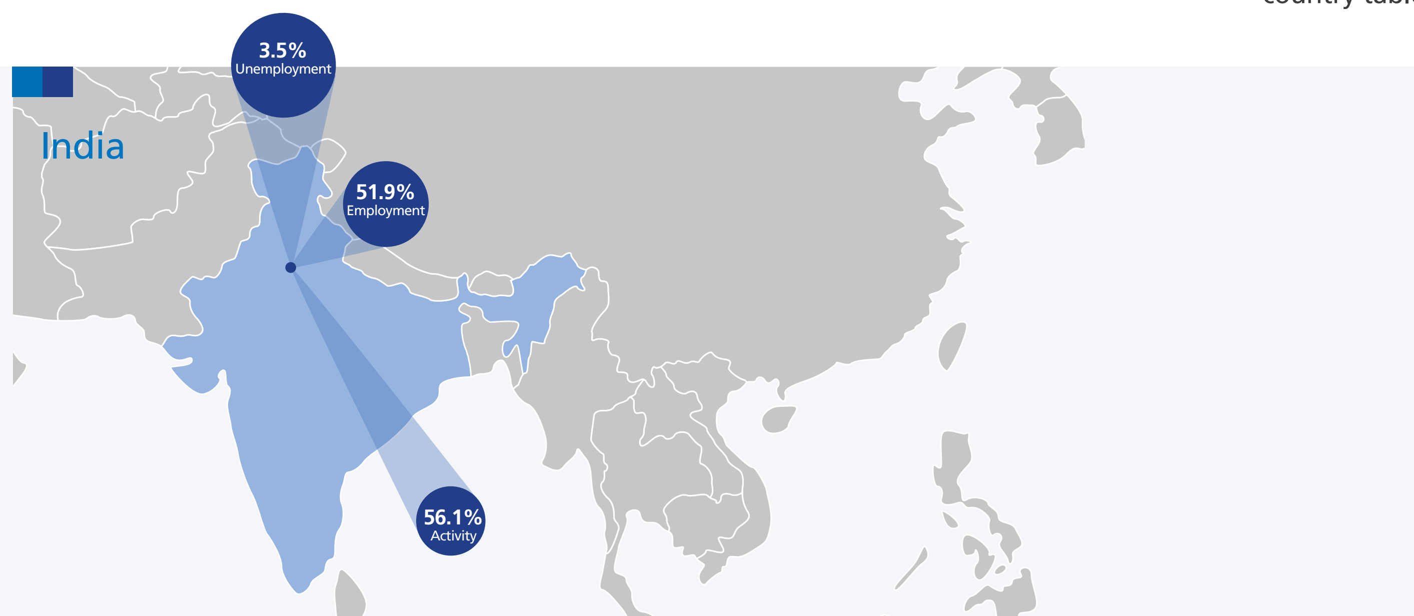
Hong Kong. China



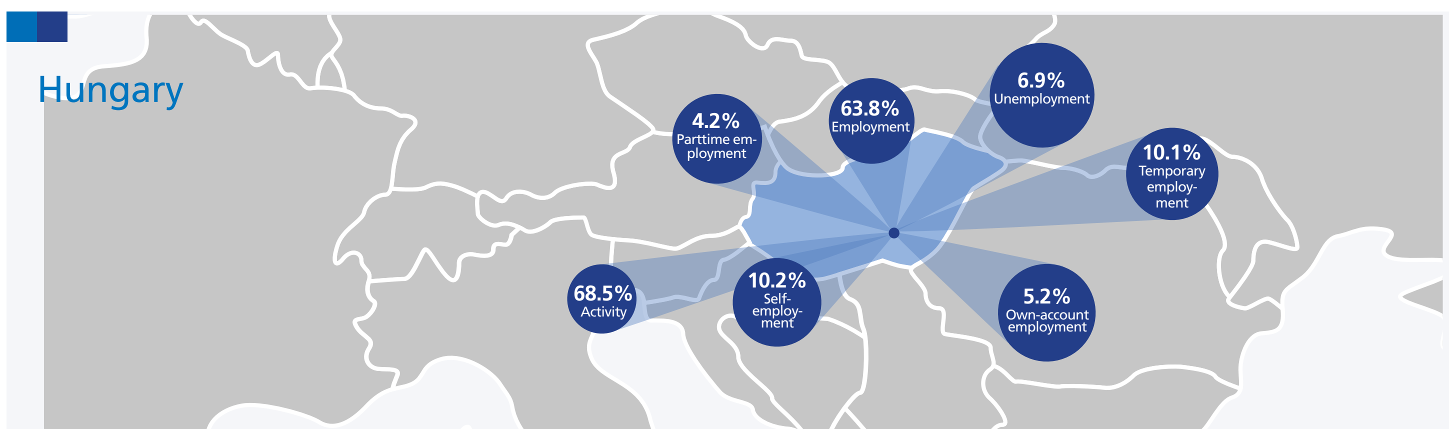
	Activity	Employment	Unemployment	Self-employment	Own-account employment
Total	71.0%	58.3%	3.3%	10.1%	6.5%
Men	79.8%	66.0%	3.6%	14.4%	9.3%
Women	63.5%	51.7%	3.0%	5.6%	3.6%
Age 15 to 24	39.7%	35.9%	9.5%		
Age 25 to 54	83.8%	61.6%			
Age 55 to 64	54.5%				

India



	Activity	Employment	Unemployment
Total	56.1%	51.9%	3.5%
Men	81.9%	76.4%	3.4%
Women	28.3%	25.8%	3.8%
Age 15 to 24	34.2%	30.9%	9.7%
Age 25 to 54	66.5%	59.2%	
Age 55 to 64	54.4%		

Hungary



	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment
Total	68.5%	63.8%	6.9%	4.5%	10.2%	5.2%	10.1%
Men	75.2%	70.1%	6.7%	3.2%	12.6%	5.9%	10.2%
Women	62.0%	57.6%	7.1%	6.0%	7.4%	4.4%	10.0%
Age 15 to 24	30.7%	25.2%	17.8%	5.2%	2.4%	1.9%	23.5%
Age 25 to 54	85.8%	80.6%	6.1%	3.5%	9.6%	4.8%	9.2%
Age 55 to 64	47.9%	45.1%	5.8%	7.4%	17.0%	8.9%	9.2%
Education: basic	40.7%	33.4%	17.9%		3.4%	2.1%	31.4%
Education: intermediate	73.5%	68.8%	6.4%		10.5%	5.8%	8.9%
Education: advanced	84.0%	82.0%	2.4%		12.5%	5.3%	3.7%

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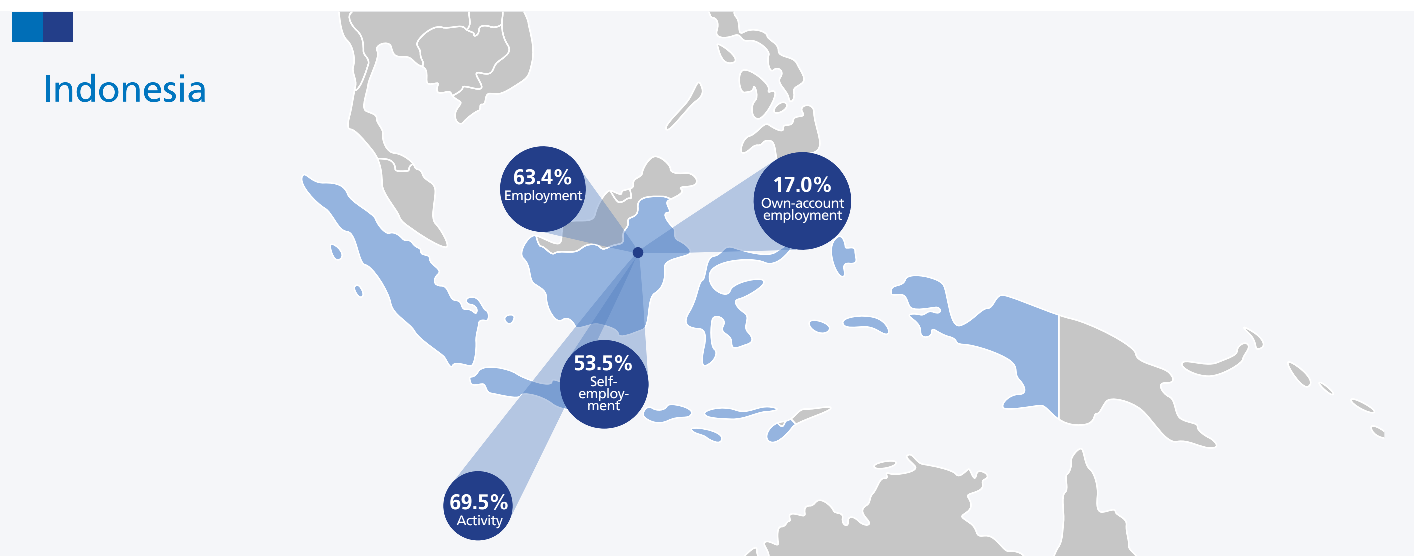
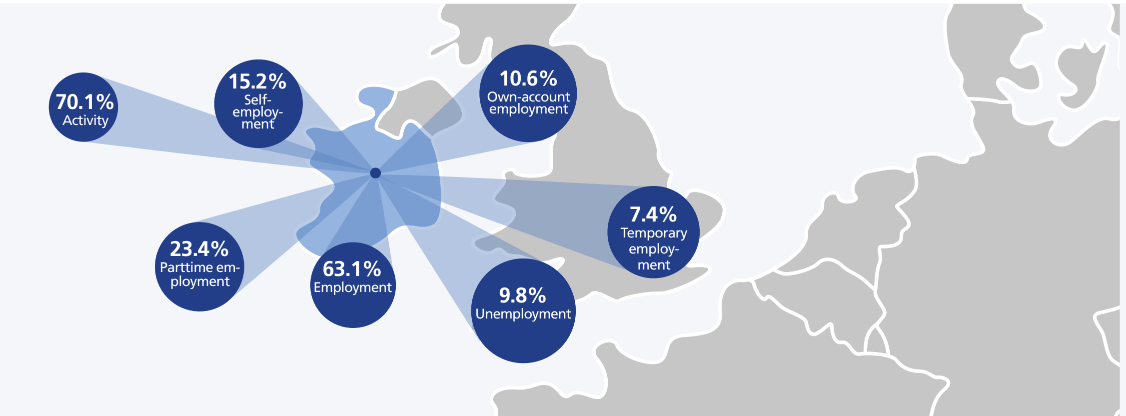
Indonesia



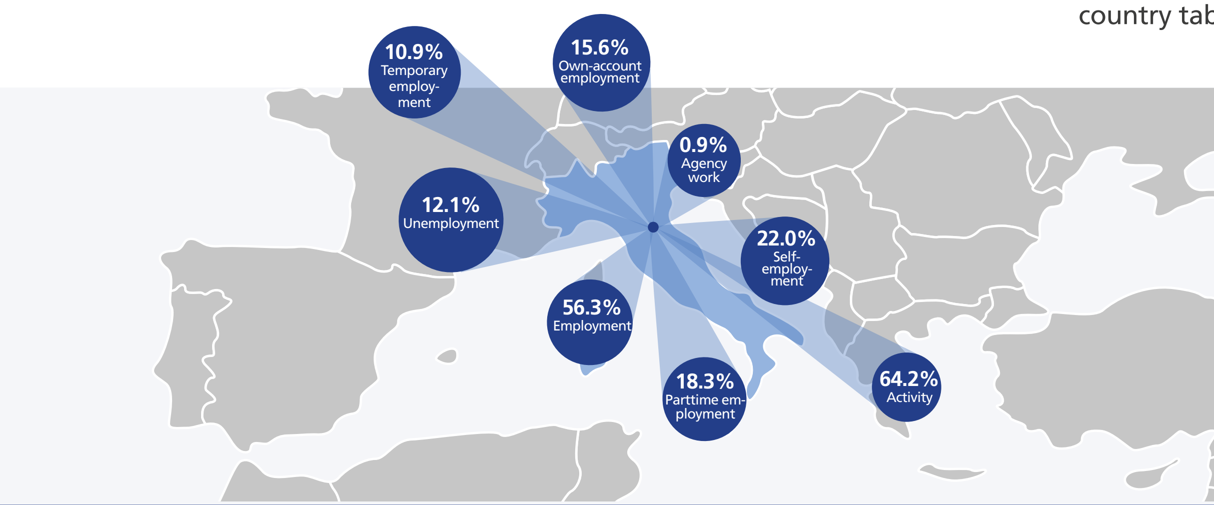
	Activity	Employment	Unemployment	Self- employment	Own-account employment
Total	69.5%	63.4%		53.5%	17.0%
Men	85.9%	79.3%		49.5%	17.3%
Women	52.8%	47.5%		60.3%	16.6%
Age 15 to 24	49.3%	39.7%	19.3%		
Age 25 to 54	77.8%	70.8%			
Age 55 to 64	67.8%				

Ireland



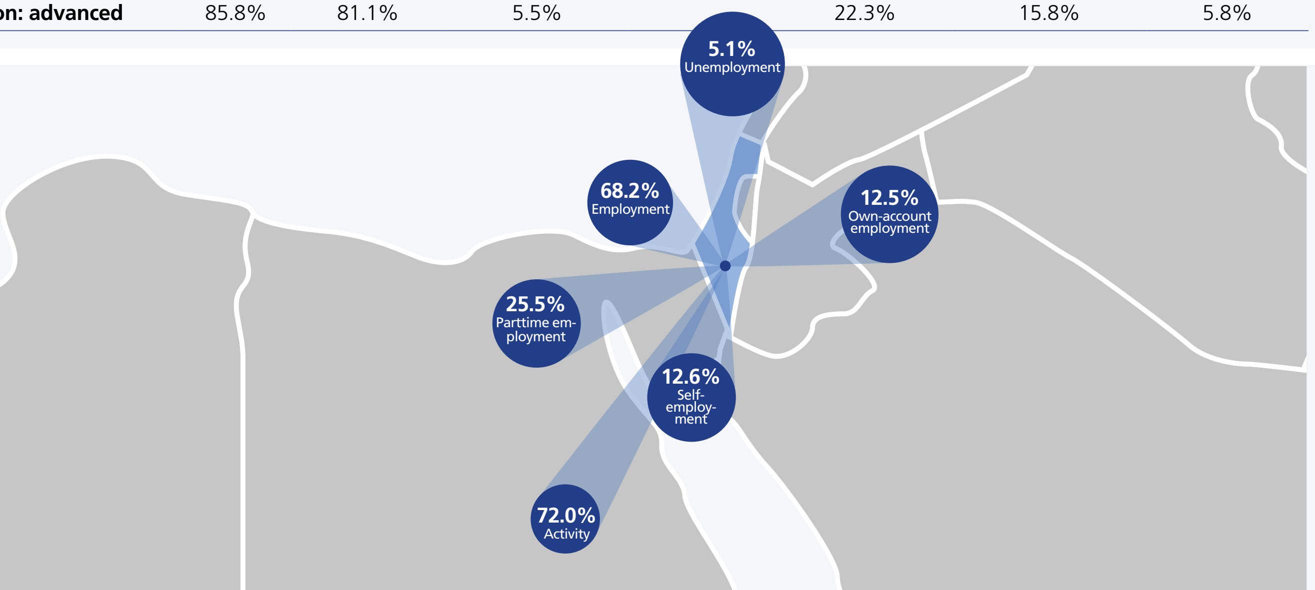
	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment
Total	70.1%	63.1%	9.8%	23.4%	15.2%	10.6%	7.4%
Men	77.6%	68.7%	11.1%	12.5%	6.9%	4.7%	6.7%
Women	62.8%	57.6%	8.2%	35.4%			8.2%
Age 15 to 24	36.1%	28.0%	22.4%	40.0%	14.3%	9.8%	32.4%
Age 25 to 54	81.4%	74.1%	9.0%	20.3%	28.1%	20.6%	5.6%
Age 55 to 64	60.1%	55.4%	7.8%	29.2%	23.7%	18.7%	4.0%
Education: basic	42.7%	34.5%	17.6%		16.2%	11.3%	9.7%
Education: intermediate	72.5%	63.9%	11.6%		12.4%	8.0%	8.5%
Education: advanced	85.8%	81.1%	5.5%		22.3%	15.8%	5.8%

Italy



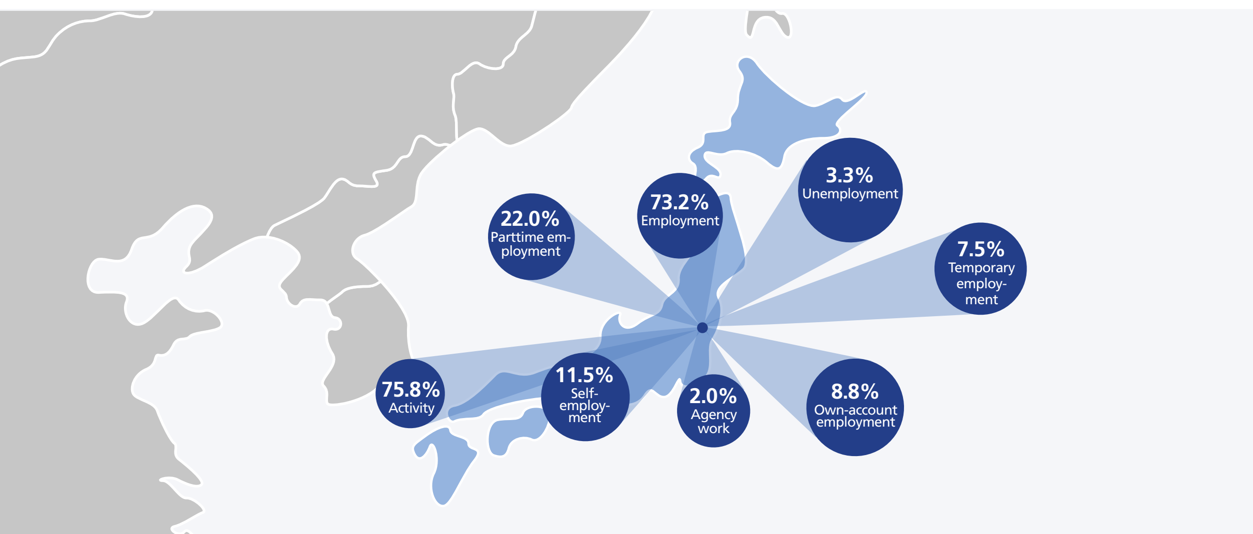
	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	64.2%	56.3%	12.1%	18.8%	22.0%	15.6%	10.9%	0.9%
Men	74.1%	65.3%	11.7%	8.6%	26.2%	18.2%	10.0%	
Women	54.4%	47.4%	12.8%	32.9%	16.1%	12.1%	12.1%	
Age 15 to 24	25.6%	15.1%	41.1%	26.1%	12.5%	11.2%	49.7%	
Age 25 to 54	77.1%	68.2%	11.5%	18.0%	21.7%	15.5%	10.2%	
Age 55 to 64	51.4%	48.6%	5.5%	19.1%	25.5%	17.1%	4.5%	
Education: basic	50.3%	42.0%	16.1%		23.1%	15.9%	11.0%	
Education: intermediate	71.7%	63.3%	11.5%		19.4%	13.2%	10.8%	
Education: advanced	82.5%	76.6%	7.0%		26.1%	20.5%	10.7%	

Israel



	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment
Total	72.0%	68.2%	5.1%	16.0%	12.6%	12.5%
Men	76.2%	72.3%	5.1%	9.4%	15.8%	15.7%
Women	67.8%	64.2%	5.1%	23.5%	9.0%	8.8%
Age 15 to 24	48.6%	44.0%	8.6%	20.7%		
Age 25 to 54	82.5%	78.9%	4.4%	12.9%		
Age 55 to 64	68.7%	66.2%	3.7%	18.0%		

Japan



	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	75.8%	73.2%	3.3%	22.7%	11.5%	8.8%	7.5%	2.0%
Men	84.9%	81.8%	3.5%	12.0%	12.4%	11.5%	5.2%	
Women	66.7%	64.5%	3.1%	37.2%	10.4%	5.1%	10.4%	
Age 15 to 24	42.9%	40.6%	5.4%	32.5%			14.0%	
Age 25 to 54	85.2%	85.2%	3.4%	17.2%			5.0%	
Age 55 to 64	71.8%	69.5%	3.2%	25.4%			7.6%	

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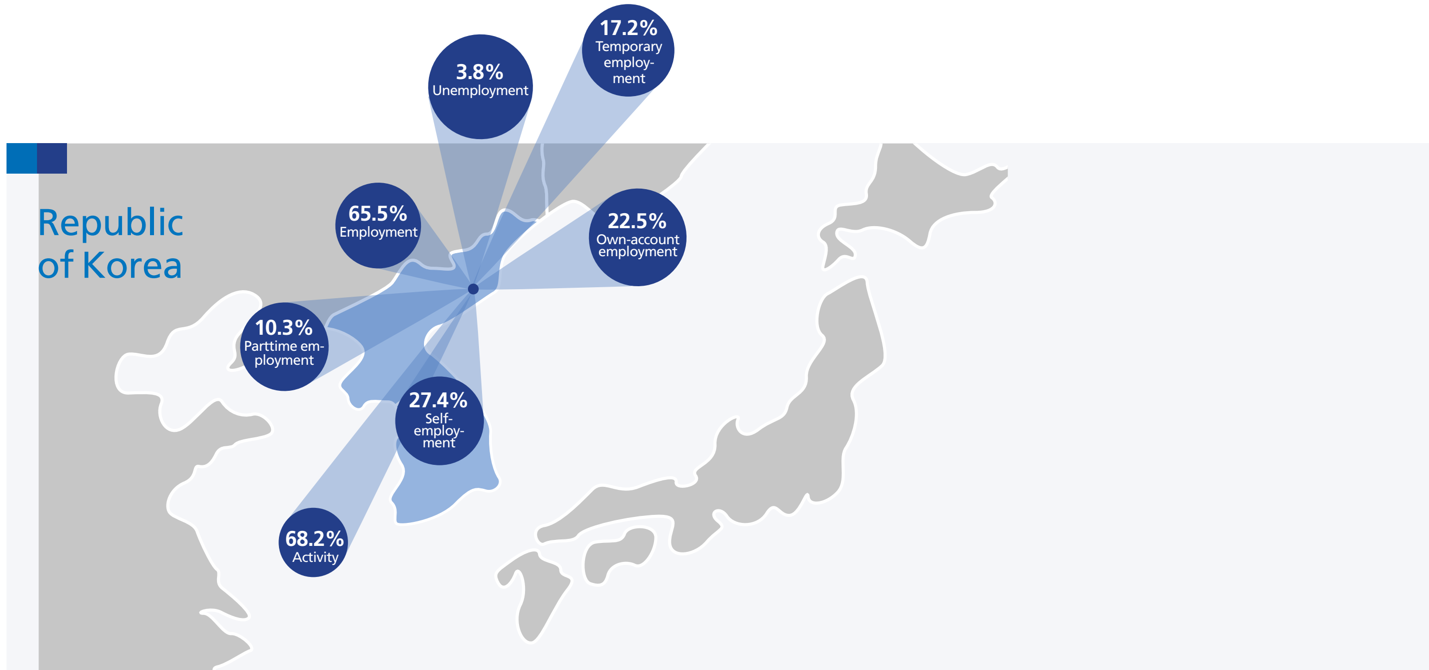
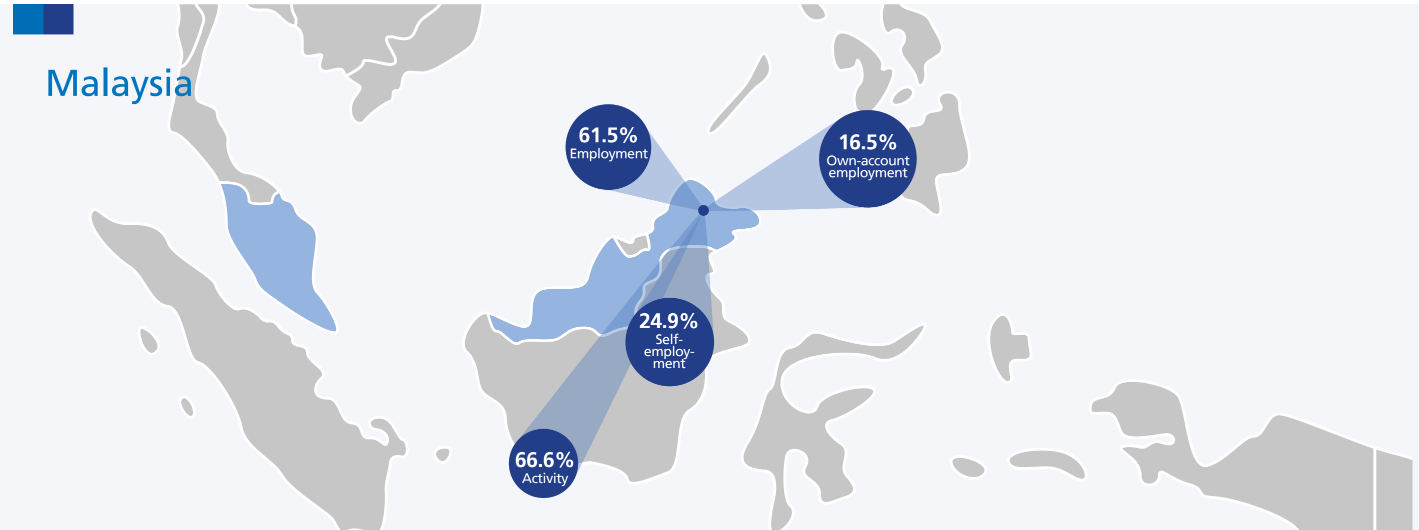
Republic of Korea



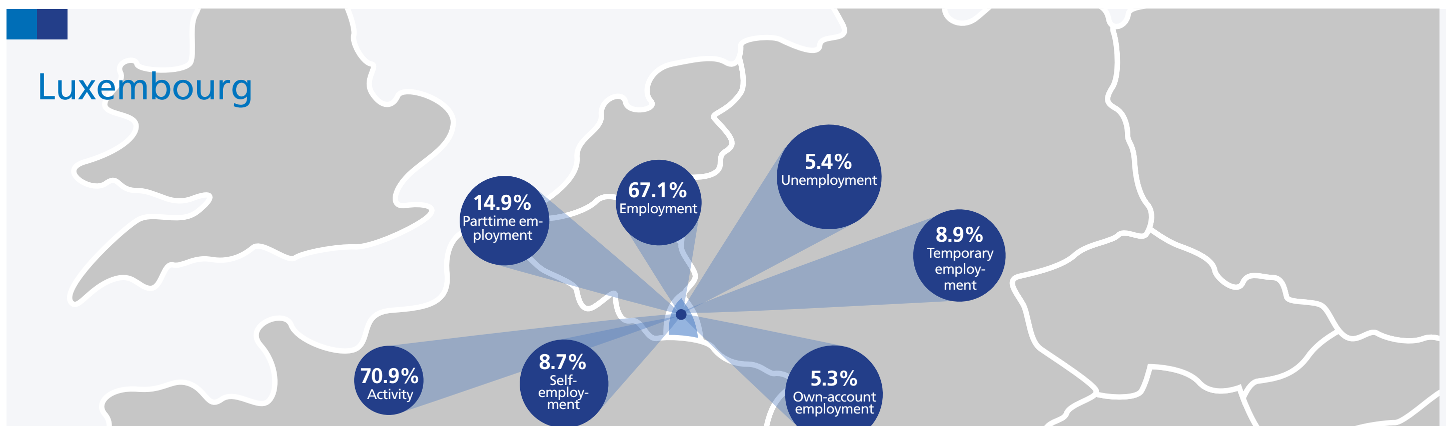
	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment
Total	68.2%	65.5%	3.8%	10.5%	27.4%	22.5%	17.2%
Men	78.6%	75.6%	3.8%	6.8%	29.0%	27.8%	15.5%
Women	57.6%	55.4%	3.8%	15.6%	25.3%	15.2%	19.6%
Age 15 to 24	30.3%	27.0%	11.1%	23.9%			25.9%
Age 25 to 54	78.3%	75.6%	3.4%	6.4%			12.7%
Age 55 to 64	67.3%	65.5%	2.8%	11.8%			19.4%

Malaysia



	Activity	Employment	Unemployment	Self- employment	Own-account employment
Total	66.6%	61.5%		24.9%	16.5%
Men	80.9%	75.5%	2.8%	24.7%	17.3%
Women	52.6%	47.7%	3.2%	25.1%	15.3%
Age 15 to 24	40.3%	36.1%	10.4%		
Age 25 to 54	80.9%	69.8%			
Age 55 to 64	50.6%				

Luxembourg



	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment
Total	70.9%	67.1%	5.4%	15.5%	8.7%	5.3%	8.9%
Men	75.9%	72.2%	4.8%	5.6%	9.8%	5.1%	8.8%
Women	65.9%	61.8%	6.1%	27.7%	7.4%	5.6%	9.1%
Age 15 to 24	33.0%	28.9%	12.3%	27.0%			33.5%
Age 25 to 54	87.9%	83.7%	4.9%	14.0%	8.6%	5.4%	7.8%
Age 55 to 64	42.0%	40.1%		18.5%	16.0%	9.0%	
Education: basic	53.1%	48.9%	7.9%		6.0%		12.7%
Education: intermediate	71.0%	67.3%	5.2%		9.2%	5.3%	6.5%
Education: advanced	86.7%	83.1%	4.1%		9.7%	6.5%	9.0%

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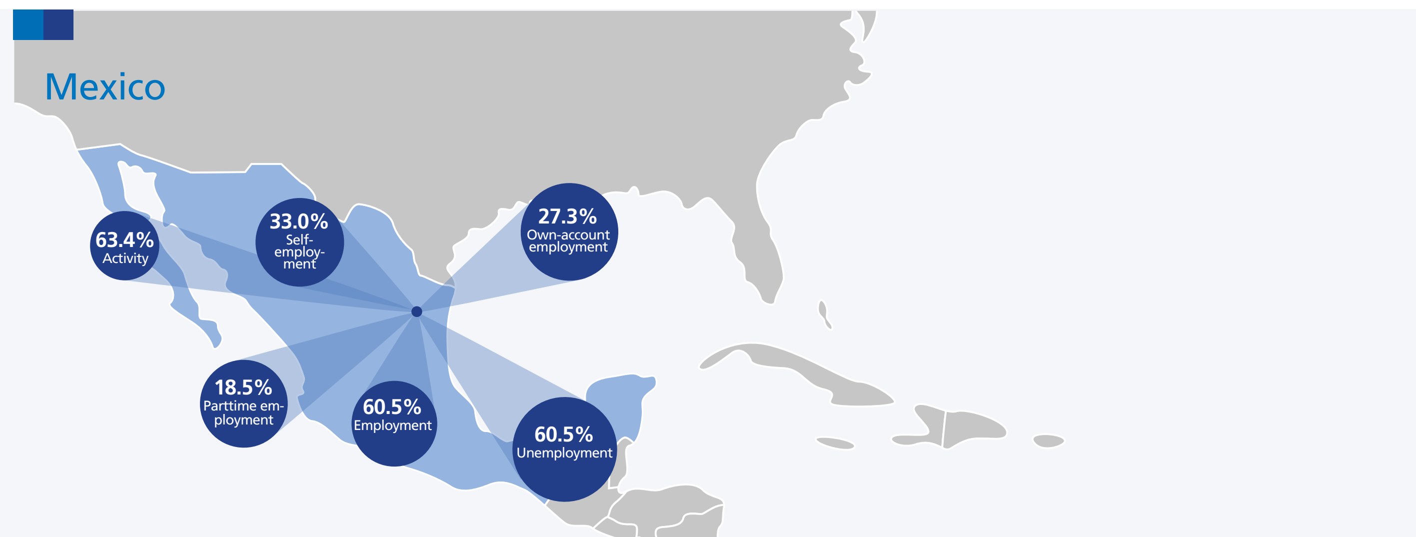
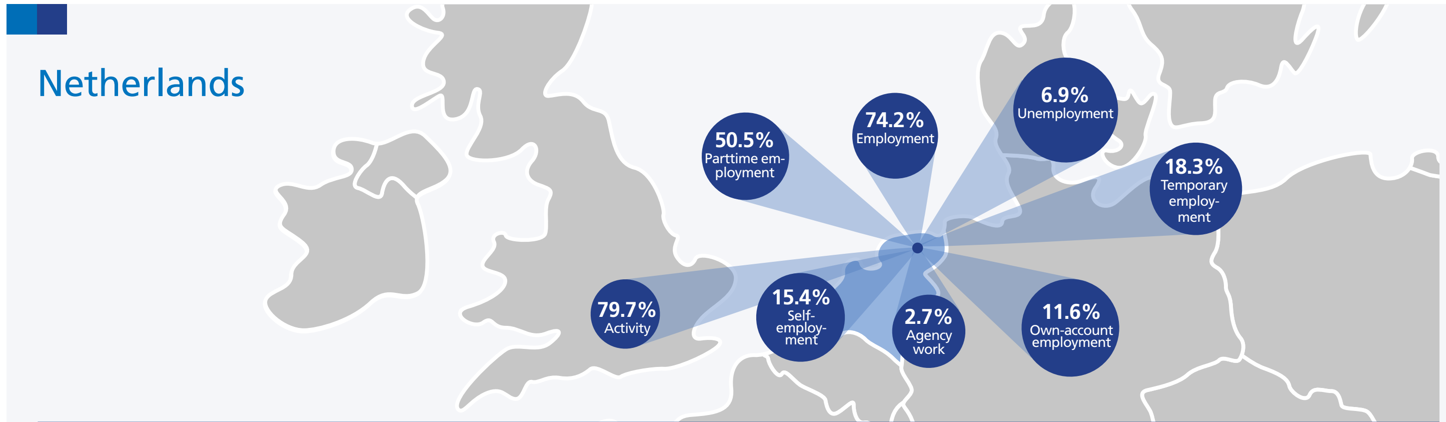
Mexico



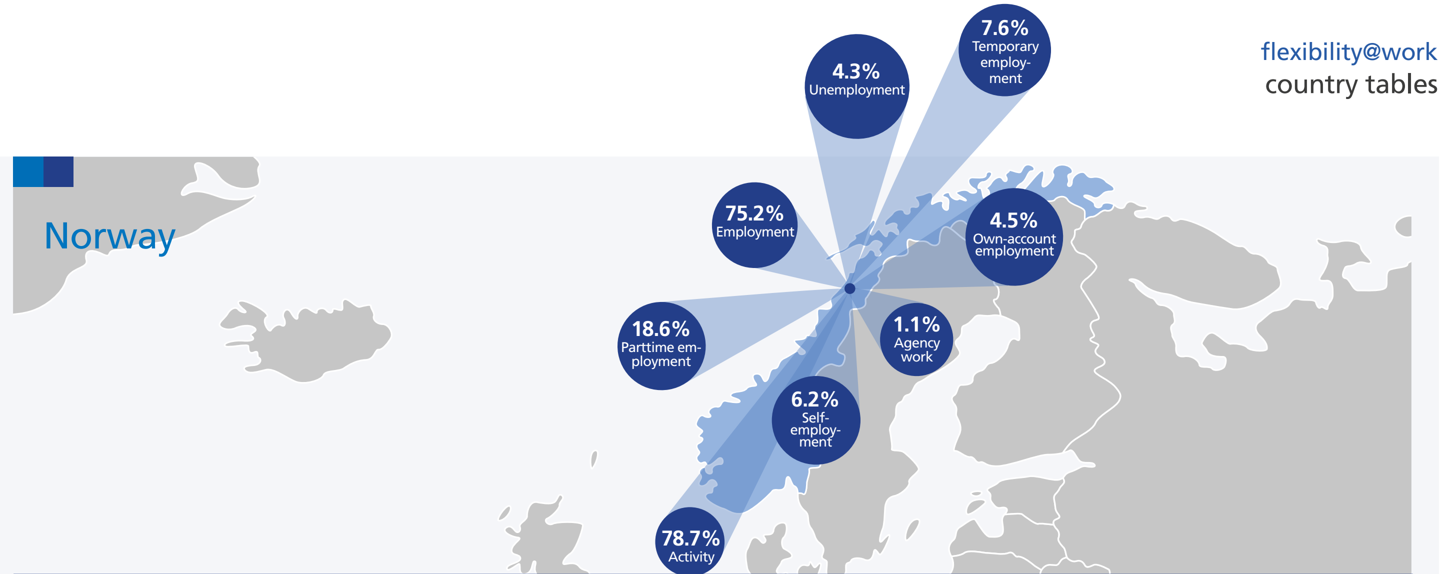
	Activity	Employment	Unemployment	Parttime employment	Self- employment	Own-account employment
Total	63.4%	60.5%	60.5%	18.7%	33.0%	27.3%
Men	81.9%	78.2%	78.2%	13.0%	32.5%	28.2%
Women	46.5%	44.3%	44.3%	27.9%	33.8%	25.8%
Age 15 to 24	44.5%	40.5%	40.5%	23.2%		
Age 25 to 54	73.4%	70.7%	70.7%	15.9%		
Age 55 to 64	55.7%	54.4%	54.4%	22.0%		

Netherlands



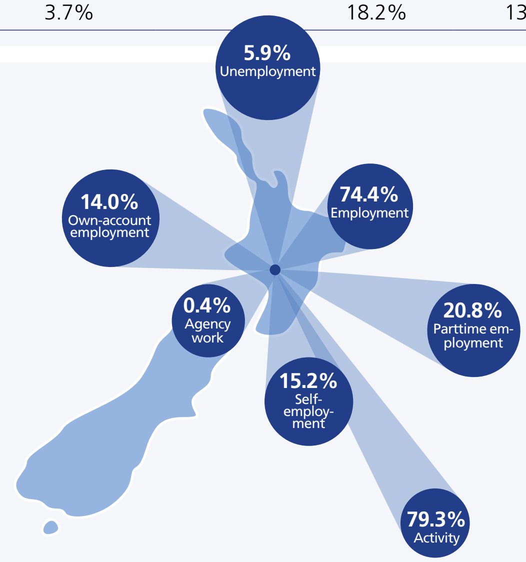
	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	79.7%	74.2%	6.9%	38.5%	15.4%	11.6%	18.3%	2.7%
Men	84.6%	84.6%	6.6%	19.6%	18.2%	12.9%	16.9%	
Women	74.8%	74.8%	7.2%	60.6%	12.1%	10.0%	20.0%	
Age 15 to 24	68.9%	61.3%	11.0%	70.2%	5.3%	5.1%	50.7%	
Age 25 to 54	87.0%	82.1%	5.6%	30.3%	16.2%	12.0%	14.2%	
Age 55 to 64	67.3%	74.2%	8.4%	36.4%	21.0%	15.6%	4.9%	
Education: basic	64.7%	61.3%	11.5%		12.4%	9.8%	25.6%	
Education: intermediate	82.3%	82.1%	7.0%		14.4%	10.5%	18.3%	
Education: advanced	91.0%	91.0%	3.7%		18.2%	13.8%	13.9%	

Norway



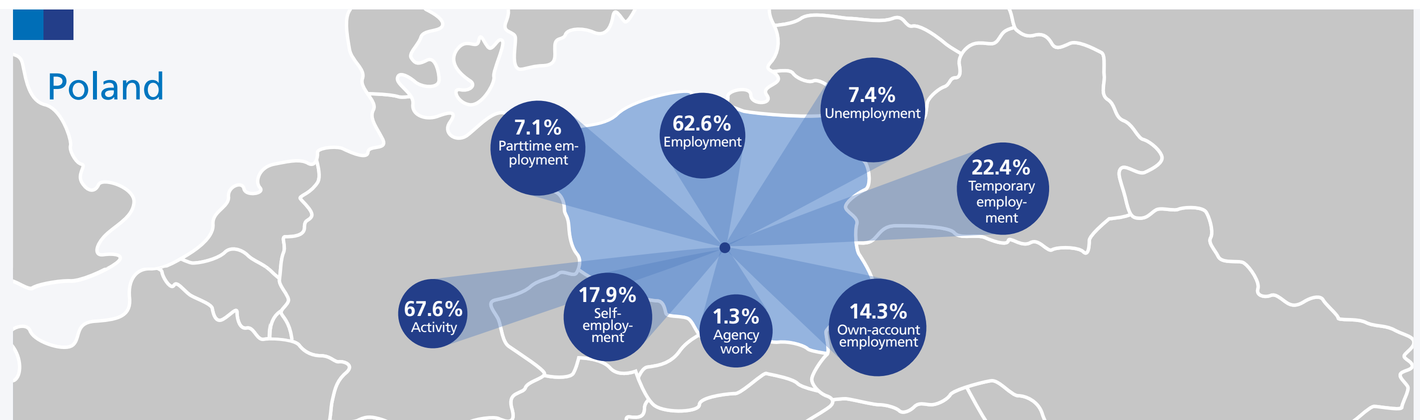
	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	78.7%	75.2%	4.3%	18.8%	6.2%	4.5%	7.6%	1.1%
Men	80.8%	76.8%	4.8%	10.8%	7.9%	5.4%	5.9%	
Women	76.5%	73.5%	3.8%	27.7%	4.3%	3.5%	9.4%	
Age 15 to 24	58.0%	51.4%	11.4%	47.7%	1.7%	1.4%	23.7%	
Age 25 to 54	86.6%	83.3%	3.8%	12.1%	6.2%	4.6%	6.0%	
Age 55 to 64	73.4%	72.4%	1.4%	18.3%	9.3%	6.8%	1.5%	
Education: basic	56.4%	50.6%	10.2%		6.8%	4.5%	10.4%	
Education: intermediate	81.7%	78.5%	3.8%		6.9%	4.9%	6.9%	
Education: advanced	90.4%	88.1%	2.5%		5.3%	4.3%	7.1%	

New Zealand



	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Agency work
Total	79.3%	74.4%	5.9%	21.5%	15.2%	14.0%	0.4%
Men	84.5%	79.9%	5.2%	11.4%	18.4%	17.5%	
Women	74.3%	69.2%	6.7%	32.7%	11.4%	10.0%	
Age 15 to 24	62.5%	53.5%	14.4%	40.4%			
Age 25 to 54	85.6%	81.6%	4.7%	15.9%			
Age 55 to 64	78.2%	75.6%	3.4%	19.6%			

Poland



	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	67.6%	62.6%	7.4%	7.1%	17.9%	14.3%	22.4%	1.3%
Men	74.2%	68.7%	7.4%	4.2%	22.0%	17.2%	21.4%	
Women	61.1%	56.4%	7.5%	10.7%	12.9%	10.7%	23.6%	
Age 15 to 24	32.5%	26.1%	19.8%	12.1%	5.6%	5.0%	64.1%	
Age 25 to 54	85.0%	79.3%	6.7%	5.4%	17.6%	14.0%	20.9%	
Age 55 to 64	45.4%	43.0%	5.3%	9.4%	25.3%	20.1%	10.7%	
Education: basic	27.5%	22.5%	17.8%		25.0%	23.8%	33.2%	
Education: intermediate	69.5%	63.6%	8.4%		19.8%	16.3%	24.1%	
Education: advanced	88.5%	85.3%	3.6%		13.2%	9.0%	17.3%	

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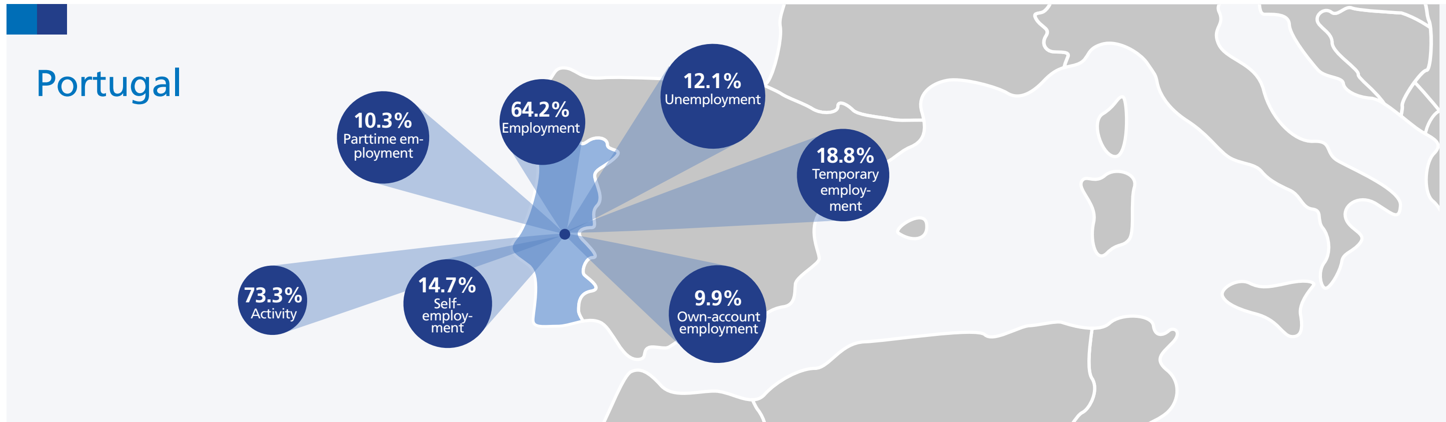
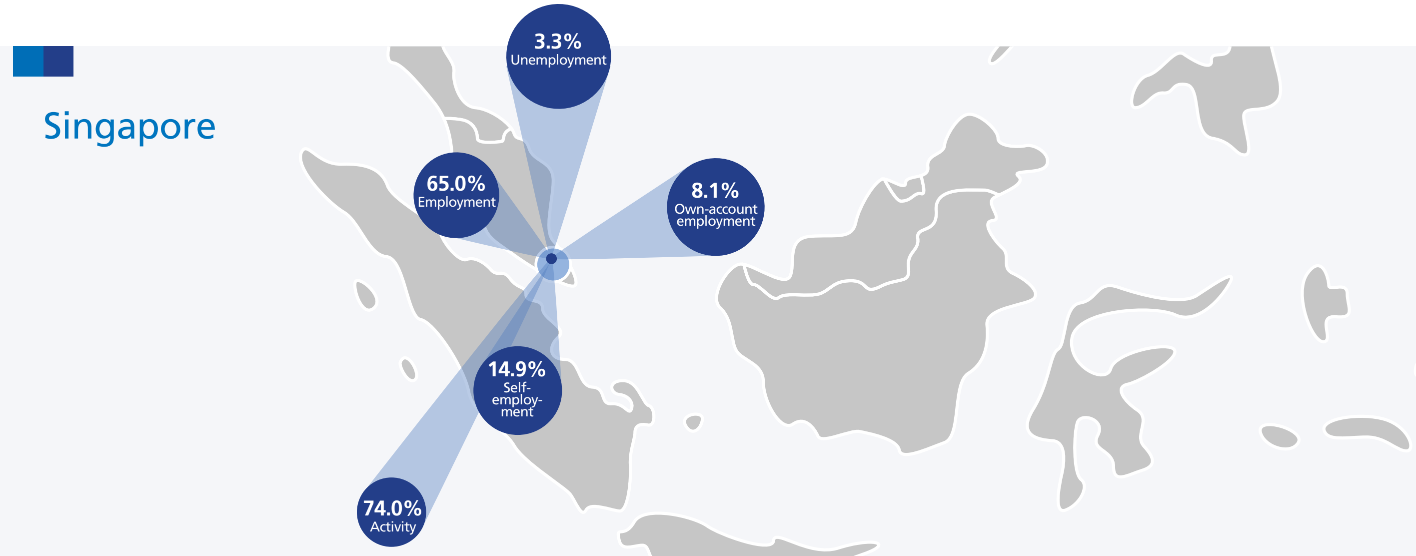
Portugal



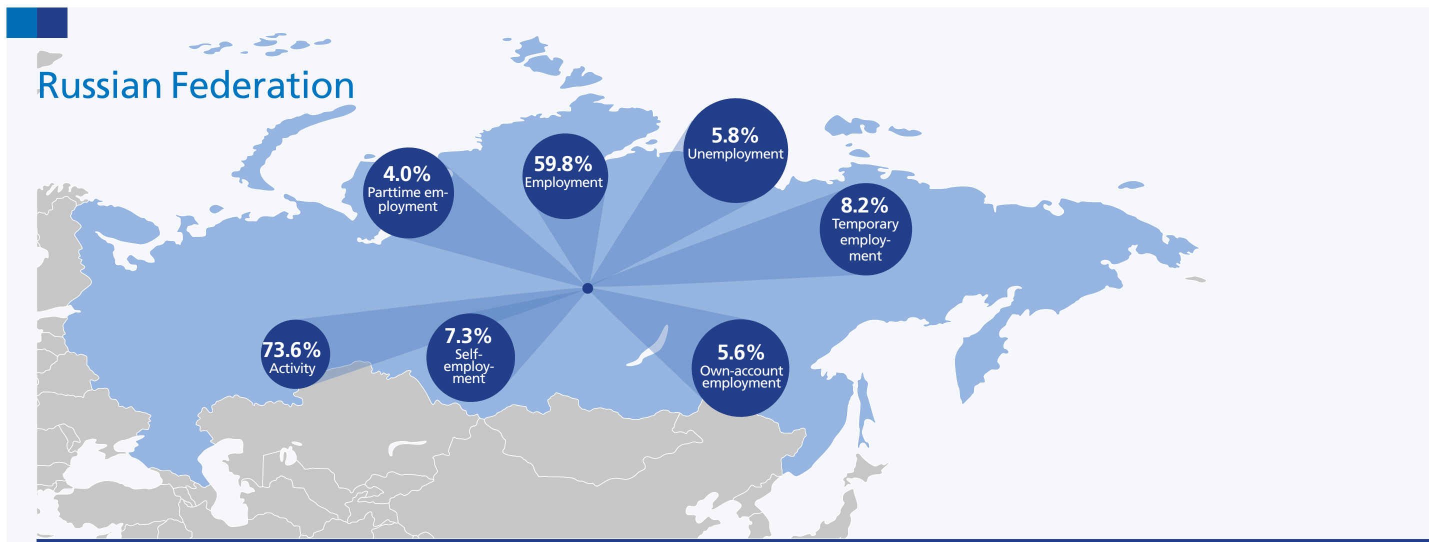
	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment
Total	73.3%	64.2%	12.1%	11.0%	14.7%	9.9%	18.8%
Men				9.1%			
Women				12.9%			
Age 15 to 24	31.8%	22.3%	29.8%	18.8%	3.9%	3.6%	63.4%
Age 25 to 54	88.9%	79.3%	10.9%	6.3%	13.1%	8.3%	17.8%
Age 55 to 64	57.3%	50.4%	12.0%	15.7%	27.1%	20.6%	8.0%
Education: basic	65.2%	56.1%	13.3%		18.8%	13.2%	16.1%
Education: intermediate	78.3%	67.9%	13.3%		10.6%	6.6%	22.1%
Education: advanced	89.1%	81.7%	8.3%		11.2%	7.2%	20.7%

Singapore



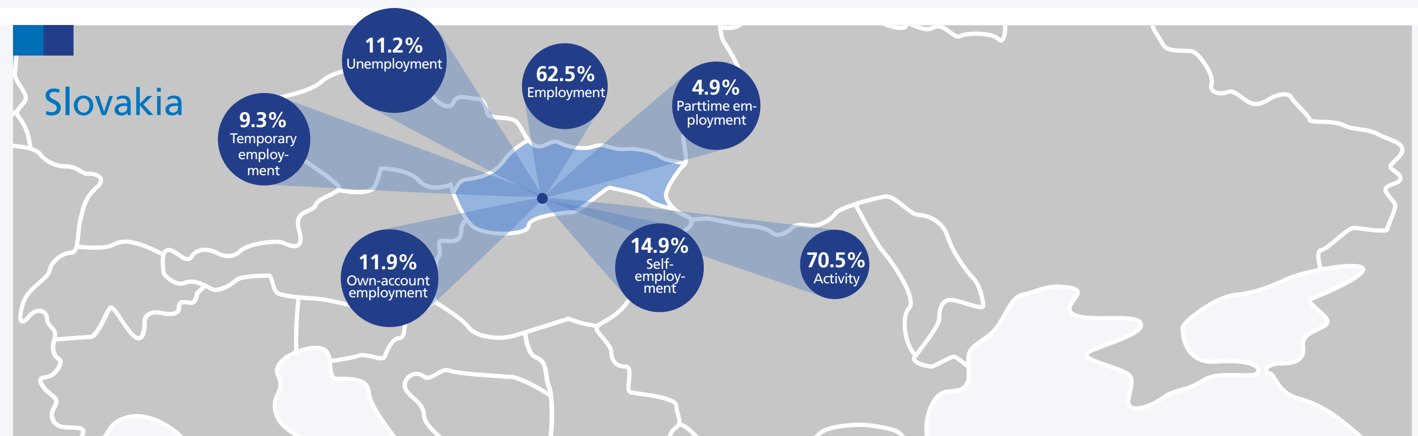
	Activity	Employment	Unemployment	Self-employment	Own-account employment
Total	74.0%	65.0%	3.3%	14.9%	8.1%
Men	82.4%	74.1%	3.1%	18.5%	10.3%
Women	65.8%	56.2%	3.5%	10.5%	5.4%
Age 15 to 24	37.7%	34.9%	7.3%		
Age 25 to 54	86.3%				
Age 25 to 64		70.5%			
Age 55 to 64	67.9%				

Russian Federation



	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment
Total	73.6%	59.8%	5.8%	4.0%	7.3%	5.6%	8.2%
Men	79.2%	67.3%	6.2%	2.7%	8.1%	6.0%	10.1%
Women	68.5%	53.6%	5.4%	5.3%	6.4%	5.1%	6.2%
Age 15 to 24	39.0%	33.2%	15.0%	5.7%			17.6%
Age 25 to 54	89.5%	63.7%		3.1%			
Age 25 to 64	49.0%			6.8%			

Slovakia



	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment
Total	70.5%	62.5%	11.2%	4.9%	14.9%	11.9%	9.3%
Men	77.2%	69.4%	10.0%	3.7%	18.8%	14.9%	8.3%
Women	63.7%	55.6%	12.7%	6.4%	10.1%	8.2%	10.4%
Age 15 to 24	30.5%	22.8%	25.3%	10.5%	8.3%	7.2%	28.8%
Age 25 to 54	87.2%	78.1%	10.5%	4.0%	15.3%	12.3%	8.3%
Age 55 to 64	51.1%	46.7%	8.5%	5.8%	15.7%	11.8%	6.2%
Education: basic	28.8%	17.7%	38.5%		5.8%	5.2%	41.3%
Education: intermediate	76.8%	68.6%	10.7%		15.3%	12.9%	8.9%
Education: advanced	81.5%	77.0%	5.4%		15.4%	10.0%	4.6%

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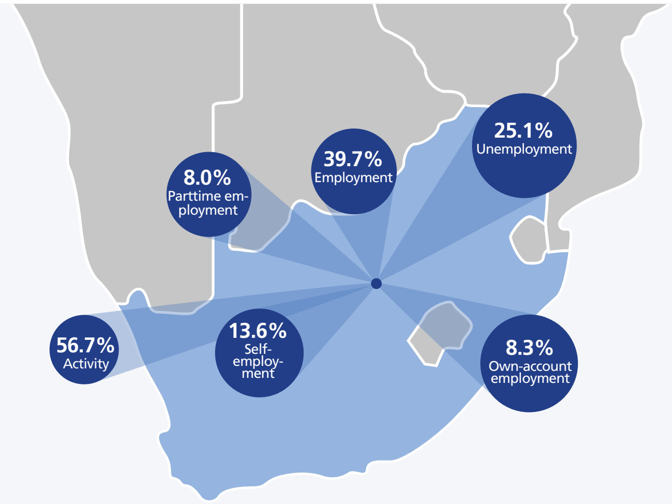
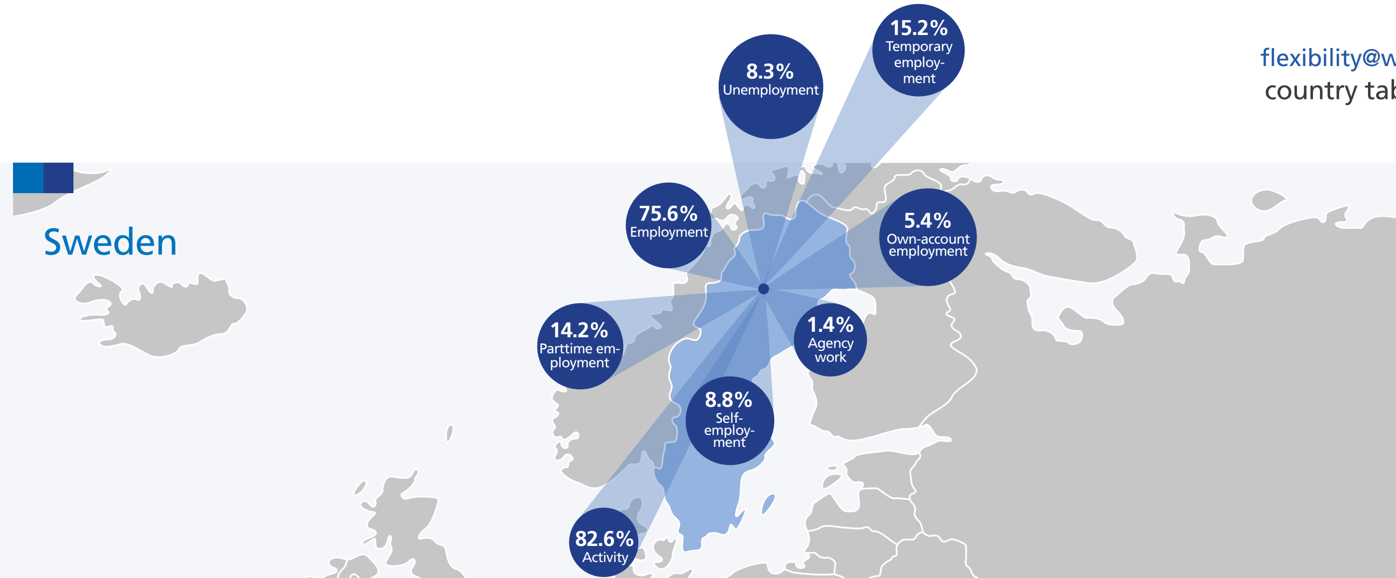
South Africa



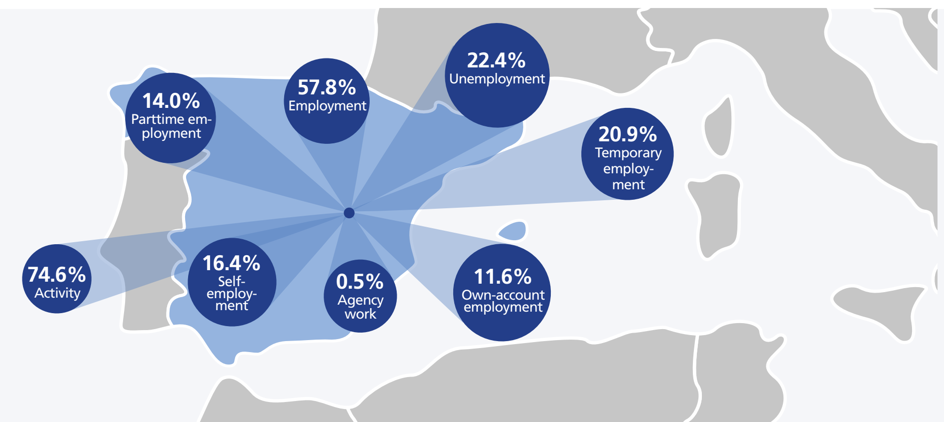
	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment
Total	56.7%	39.7%	25.1%	8.0%	13.6%	8.3%
Men	62.8%	46.2%	25.1%	5.0%	15.6%	8.1%
Women	50.7%	33.5%	50.0%	11.9%	11.0%	8.5%
Age 15 to 24	26.1%	13.1%	50.0%	7.8%		
Age 25 to 54	73.8%	49.7%		7.5%		
Age 55 to 64	41.9%			11.5%		

Sweden



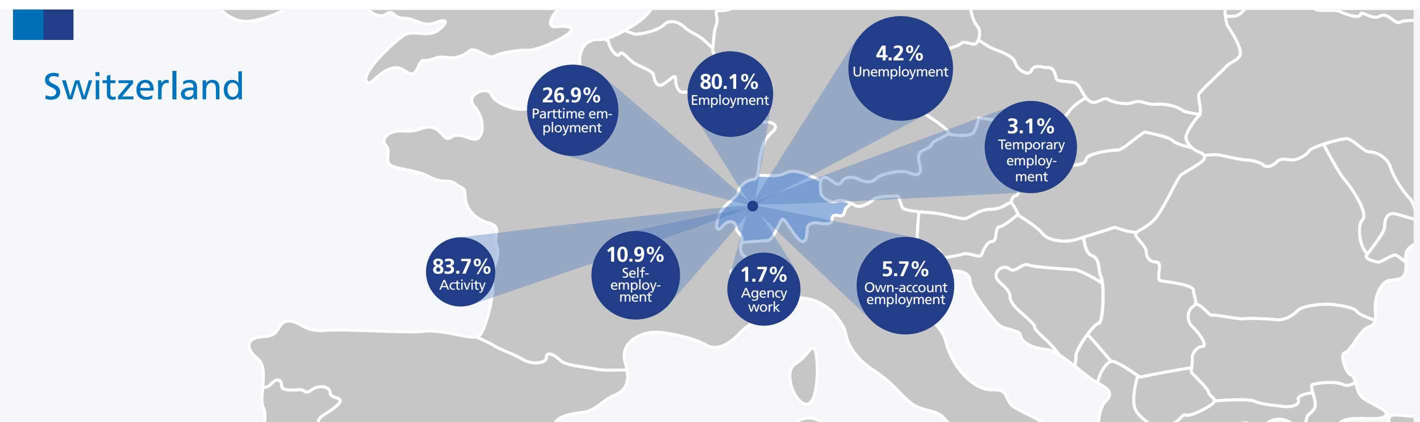
	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	82.6%	75.6%	8.3%	14.2%	8.8%	5.4%	15.2%	1.4%
Men	84.4%	77.1%	8.3%	10.5%	11.9%	6.9%	13.3%	
Women	80.8%	74.0%	8.3%	18.3%	5.4%	3.7%	17.3%	
Age 15 to 24	58.9%	44.0%	25.2%	37.2%	2.1%	1.6%	54.9%	
Age 25 to 54	91.2%	85.8%	6.0%	8.7%	8.8%	5.2%	11.2%	
Age 55 to 64	78.6%	74.4%	5.3%	12.0%	13.0%	8.3%	6.1%	
Education: basic	59.3%	45.6%	22.1%		10.9%	6.4%	26.1%	
Education: intermediate	87.2%	81.3%	6.6%		9.7%	5.6%	15.0%	
Education: advanced	92.2%	88.0%	4.5%		7.0%	4.8%	11.8%	

Spain



	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	74.6%	57.8%	22.4%	14.7%	16.4%	11.6%	20.9%	0.5%
Men	79.7%	62.9%	21.0%	7.1%	20.2%	14.0%	19.9%	
Women	69.5%	52.7%	24.0%	23.6%	11.9%	8.6%	22.0%	
Age 15 to 24	34.8%	17.7%	49.2%	37.1%	5.7%	5.0%	62.8%	
Age 25 to 54	87.8%	69.5%	20.9%	13.9%	15.5%	11.0%	20.9%	
Age 55 to 64	57.4%	46.7%	18.6%	11.8%	24.5%	17.1%	7.8%	
Education: basic	67.4%	46.1%	31.4%		19.5%	14.1%	24.5%	
Education: intermediate	73.8%	57.6%	21.8%		16.3%	11.1%	20.5%	
Education: advanced	88.8%	76.9%	13.3%		13.9%	9.7%	18.1%	

Switzerland



	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	83.7%	80.1%	4.2%	26.9%	10.9%	5.7%	3.1%	1.7%
Men	88.1%	84.5%	4.1%	10.8%	12.4%	5.1%	11.6%	
Women	79.2%	75.6%	4.3%	45.6%	9.3%	6.4%	11.9%	
Age 15 to 24	64.5%	60.4%	6.4%	20.1%	1.0%	0.7%	36.9%	
Age 25 to 54	91.0%	87.3%	4.0%	25.1%	10.6%	5.4%	7.3%	
Age 25 to 64							8.4%	
Age 55 to 64	75.4%	72.6%	3.7%	37.9%	20.1%	10.7%	11.6%	
Education: basic	65.3%	59.2%	9.1%		5.1%	2.9%	11.9%	
Education: intermediate	84.5%	81.3%	3.7%		10.9%	6.2%	7.3%	

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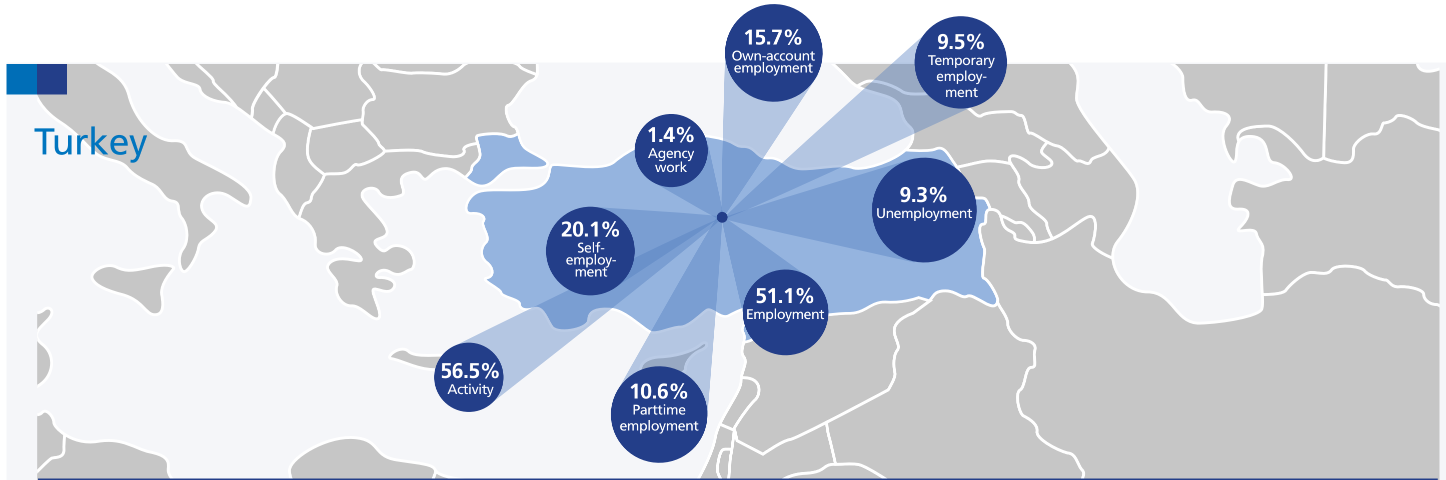
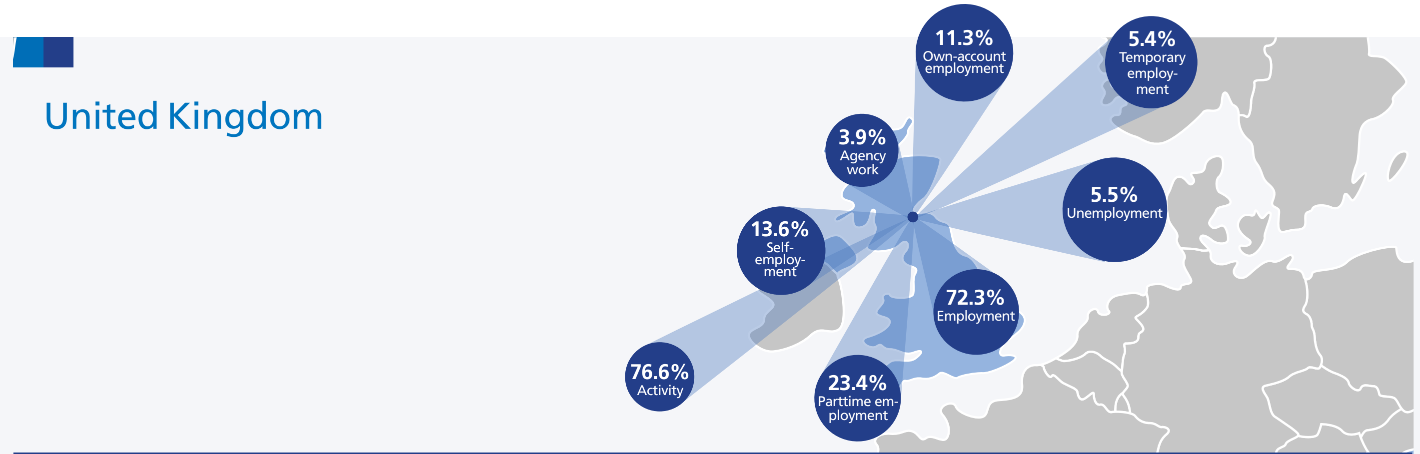
Turkey



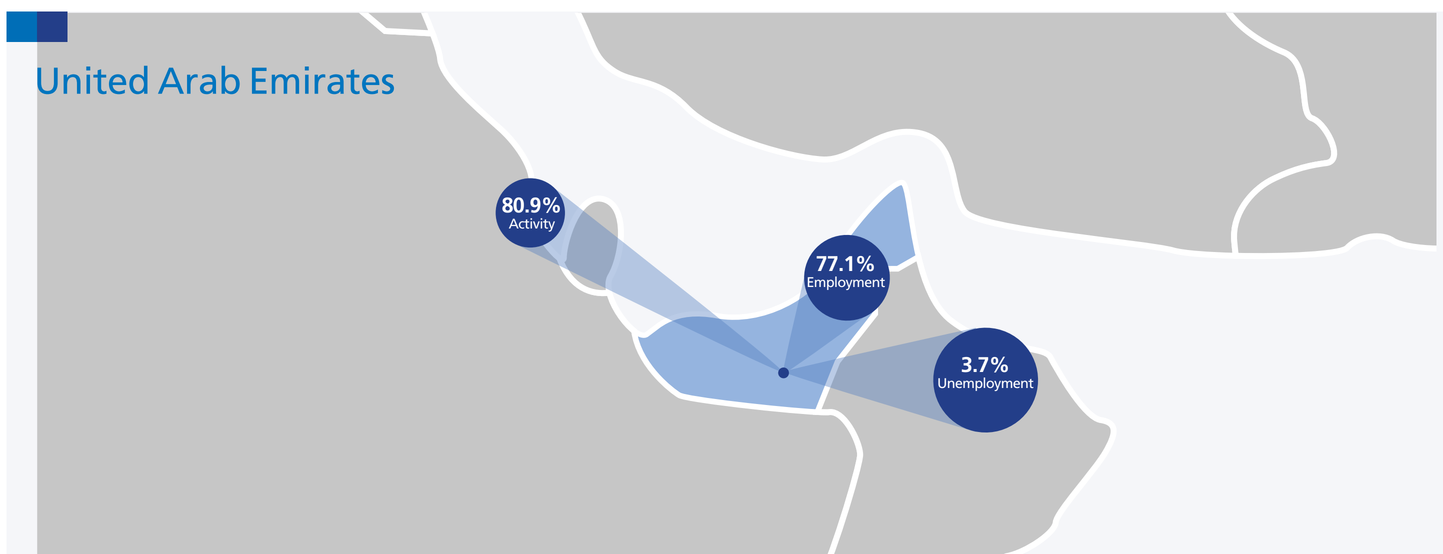
	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	56.5%	51.1%	9.3%	10.6%	20.1%	15.7%	9.5%	1.4%
Men	77.2%	70.7%	8.4%	6.4%	24.6%	18.8%	10.3%	
Women	35.6%	31.5%	11.5%	20.6%	9.9%	8.7%	7.5%	
Age 15 to 24	41.3%	34.4%	33.3%	12.9%	4.5%	3.7%	17.8%	
Age 25 to 54	66.0%	60.6%	8.2%	8.5%	20.2%	15.3%	8.1%	
Age 55 to 64	35.4%	33.2%	6.1%	19.7%	48.1%	41.5%	6.8%	
Education: basic	49.6%	45.1%	8.7%		24.8%	21.2%	12.9%	
Education: intermediate	61.3%	54.9%	10.5%		17.3%	11.4%	5.9%	
Education: advanced	82.2%	74.0%	10.0%		9.5%	4.2%	3.1%	

United Kingdom



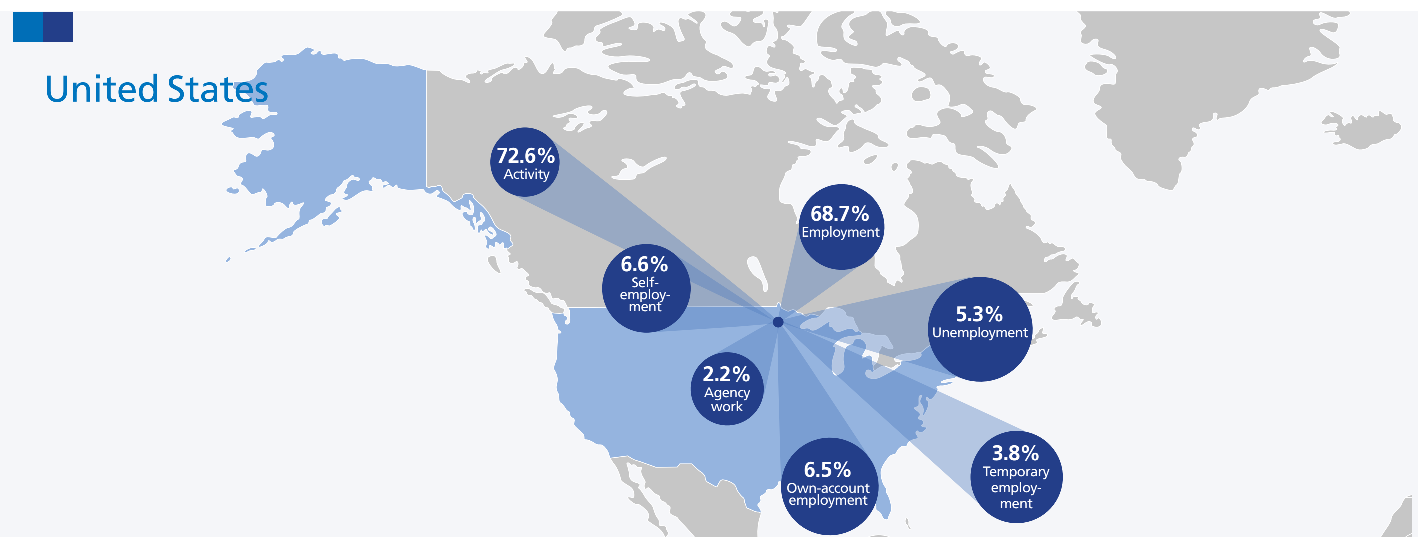
	Activity	Employment	Unemployment	Parttime employment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	76.6%	72.3%	5.5%	24.1%	13.6%	11.3%	5.2%	3.9%
Men	81.7%	77.0%	5.6%	11.7%	17.5%	14.2%	4.5%	
Women	71.5%	67.7%	5.2%	38.1%	9.2%	8.0%	5.9%	
Age 15 to 24	57.4%	48.8%	15.0%	35.4%	5.0%	4.8%	13.5%	
Age 25 to 54	85.8%	82.2%	4.2%	19.5%	13.8%	11.4%	4.0%	
Age 55 to 64	64.0%	61.8%	3.5%	28.4%	19.7%	16.1%	3.8%	
Education: basic	61.0%	54.5%	10.2%		14.1%	11.6%	4.3%	
Education: intermediate	78.1%	73.2%	6.1%		13.6%	11.6%	5.1%	
Education: advanced	87.4%	84.8%	2.9%		13.4%	10.9%	5.6%	

United Arab Emirates



	Activity	Employment	Unemployment
Total	80.9%	77.1%	3.7%
Men	92.4%	88.9%	2.9%
Women	42.5%	38.1%	9.1%
Age 15 to 24	48.0%	42.7%	11.1%
Age 25 to 54	87.6%	83.1%	
Age 55 to 64	70.6%		

United States



	Activity	Employment	Unemployment	Self-employment	Own-account employment	Temporary employment	Agency work
Total	72.6%	68.7%	5.3%	6.6%	6.5%	3.8%	2.2%
Men	78.5%	74.2%	5.4%	7.5%	7.4%	3.7%	
Women	66.9%	63.4%	5.2%	5.6%	5.5%	3.9%	
Age 15 to 24	55.0%	48.6%	11.6%			7.4%	
Age 25 to 54	80.9%	77.2%	4.5%			3.1%	
Age 55 to 64	63.9%	61.5%	3.8%			2.7%	

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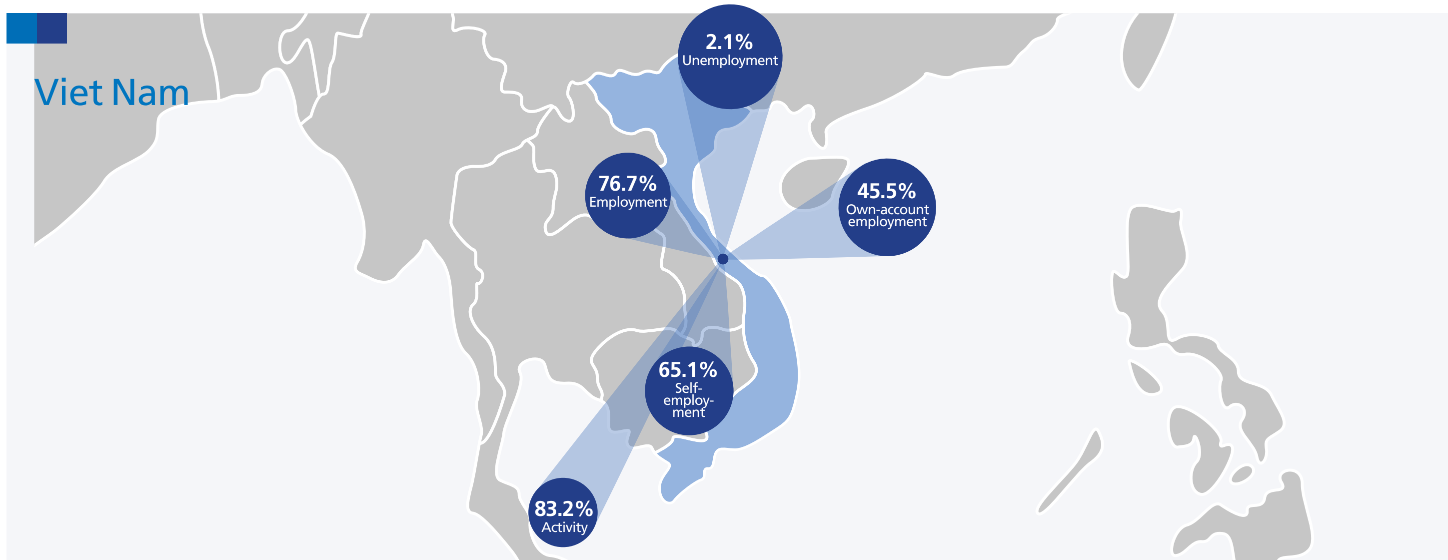
Viet Nam



	Activity	Employment	Unemployment	Self-employment	Own-account employment
Total	83.2%	76.7%	2.1%	65.1%	45.5%
Men	86.7%	81.5%	2.0%	60.0%	44.6%
Women	79.7%	72.2%	2.1%	70.5%	46.4%
Age 15 to 24	60.4%	57.2%	5.3%		
Age 25 to 54	93.5%	82.2%			
Age 55 to 64	74.2%				

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PART II. FLEXIBLE LABOR AND EMPLOYMENT

Sources:

- Employment Outlook 2015 (OECD)
- Skills Outlook 2015 (OECD)
- The future of work centenary initiative (ILO 2015)
- World Employment and Social Outlook – Trends 2016 (ILO)
- The changing nature of jobs - World Employment and Social Outlook 2015 (ILO)
- The Future of Jobs (WEF 2016)
- Global talent risk report (WEF 2012)
- World Economic report 2016 (Ciett)
- World population prospect 2015 (United Nations)
- Flexibility@work 2013 (Randstad. SEO)
- Flexibility@work 2014 (Randstad. Regioplan. Sheffield University)
- Flexibility@work 2015 (Randstad. Dartmouth college)

Data: Eurostat. OECD. ILOSTAT. BLS. Pew. UN

COUNTRY TABLES:

Definitions and sources

Activity: The activity rate is calculated as the active population (employed plus unemployed) divided by the working age population.
Sources: Eurostat (2015q2): Austria. Belgium. Czech Republic. Denmark. European Union. Finland. France. Germany. Greece. Hungary. Ireland. Italy. Luxembourg. Netherlands. Norway. Poland. Portugal. Slovakia. Spain. Sweden. Switzerland. Turkey. United Kingdom
OECD (2015q2): Australia. Chile. Canada. Israel. Korea. Mexico. New Zealand. United States
ILO (2014): Argentina. Brazil. China. Colombia. Hong Kong. India. Indonesia. Malaysia. Russian Federation. Singapore. South Africa. United Arab Emirates. Viet Nam

Employment: The employment rate is measured as the number of employed people divided by the working age population.
Sources: Eurostat (2015q2): Austria. Belgium. Czech Republic. Denmark. European Union. Finland. France. Germany. Greece. Hungary. Ireland. Italy. Luxembourg. Netherlands. Norway. Poland. Portugal. Slovakia. Spain. Sweden. Switzerland. Turkey. United Kingdom
OECD (2015q2): Australia. Chile. Canada. Israel. Korea. Mexico. New Zealand. United States
ILO (2014): Argentina. Brazil. China. Colombia. Hong Kong. India. Indonesia. Malaysia. Russian Federation. Singapore. South Africa. United Arab Emirates. Viet Nam

Unemployment: The unemployment rate is the ratio of number of persons unemployed and the number of persons in the labor force. The labor force is the sum of the numbers of persons employed and unemployed.
Sources: Eurostat (2015q2): Austria. Belgium. Czech Republic. Denmark. European Union. Finland. France. Germany. Greece. Hungary. Ireland. Italy. Luxembourg. Netherlands. Norway. Poland. Portugal. Slovakia. Spain. Sweden. Switzerland. Turkey. United Kingdom
OECD (2015q2): Australia. Chile. Canada. Israel. Korea. Mexico. New Zealand. United States
ILO (2015q2):. Brazil. China. Colombia. Hong Kong. India. Indonesia. Malaysia. Russian Federation. Singapore. South Africa. United Arab Emirates. Viet Nam

Parttime: The part time rate is the ratio of number of persons employed part time (OECD definition is less than 30 hours a week) and the number of persons in employment.
Source: OECD (2014)

Self-employment: The self-employment rate is the ratio of number of persons in self-employment and the total number of persons in employment.
Sources: Eurostat (2015q2): Austria. Belgium. Czech Republic. Denmark. European Union. Finland. France. Germany. Greece. Hungary. Ireland. Italy. Luxembourg. Netherlands. Norway. Poland. Portugal. Slovakia. Spain. Sweden. Switzerland. Turkey. United Kingdom
ILO (2014): Argentina (2013). Australia (2013). Brazil. Canada. Colombia (2013). Hong Kong (2013). Indonesia. Israel (2013). Japan. Korea (2013). Malaysia. Mexico (2013). New Zealand (2013). Russian Federation (2013). Singapore (2013). South Africa. United Arab Emirates. United States (2013). Viet Nam (2013)

Own-account employment: The own-account employment rate is the ratio of number of persons in own-account employment and the total number of persons in employment.
Eurostat (2015q2): Austria. Belgium. Czech Republic. Denmark. European Union. Finland. France. Germany. Greece. Hungary. Ireland. Italy. Luxembourg. Netherlands. Norway. Poland. Portugal. Slovakia. Spain. Sweden. Switzerland. Turkey. United Kingdom
ILO (2014): Argentina (2013). Australia (2013). Brazil. Canada. China (2013). Colombia (2013). Hong Kong (2013). Indonesia. Israel (2013). Japan. Korea (2013). Malaysia. Mexico (2013). New Zealand (2013). Russian Federation (2013). Singapore (2013). South Africa. United Arab Emirates. United States (2013). Viet Nam (2013)

Temporary employment: The temporary employment rate is the ratio of number of persons in temporary employment and the total number of persons in employment.
Eurostat (2015q2): Austria. Belgium. Czech Republic. Denmark. European Union. Finland. France. Germany. Greece. Hungary. Ireland. Italy. Luxembourg. Netherlands. Norway. Poland. Portugal. Slovakia. Spain. Sweden. Switzerland. Turkey. United Kingdom
OECD (2014): Australia (2013). Chile. Canada. Israel. Korea. Mexico. New Zealand. United States (2005)

Agency work: The Agency work rate is the ratio of number of persons employed in Agency work and the total number of persons in employment.
Source: Ciett (2014)

randstad