STI Policy Note
February 2016

ROUTINE JOBS, EMPLOYMENT AND TECHNOLOGICAL INNOVATION IN GLOBAL VALUE CHAINS

Innovation and new technologies – especially Information and Communication Technologies (ICTs) – and participation in global value chains (GVCs) are key features of 21st century economies. They help shape firm and industry performance and dynamics, and may trigger radical changes in employment patterns and the skills profile of the workforce.

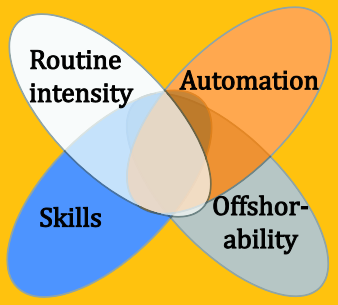
Many factors determine the way firms organise production across borders and, ultimately, countries' specialisation patterns. Among them is the *routine content of occupations*, as routine intensive jobs are thought to be easier to outsource and offshore. Occupations are *routine intensive* when the tasks undertaken follow a set of well-defined rules or sequences (e.g. hand packers), whereas non-routine occupations typically entail performing more complex tasks, such as creative problem solving and decision making (e.g. managers).

While being related, job tasks and workforce skills are not synonymous. Routine-intensive jobs tend to be associated with lower skill levels, but skilled workers carrying out routine jobs (e.g. medical imaging technicians) can be affected by automation and relocation in the same way as low skill routine workers can.

The distribution of occupations according to routine intensity varies across countries and is shaped by differences in industrial structure, technology and innovation capabilities, workforce skills and participation in GVCs. Coordinated industrial, innovation, labour, trade and skills policies are thus needed to boost economic performance and to maximise the value from trade.

The quick read

Contrary to some common perceptions, *offshoring does not necessarily make routine workers redundant*. Especially in manufacturing, offshoring of inputs can have a positive impact on routine-intensive jobs. As manufacturing firms specialise in specific stages of GVCs, they may import more inputs, but then rely on more routine-intensive jobs for further processing.



Technological innovation is found to relate positively to employment in all types of occupations: An increase in industry innovation leads to increased employment in each of the four occupational groups considered. Broad-based innovation policies supporting investment in innovation activities lead to more employment and to productivity gains, thus enhancing growth and well-being.

Boosting the ICT intensity of industries means more employment in most but not all occupations: routine-intensive jobs – i.e. jobs featuring sequential tasks that are easy to codify – get displaced when ICT intensity increases. The extent of such displacement varies according to the sector considered (i.e. manufacturing or services) and the development level of the country (i.e. mature service-based economies or catching up countries).

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While generally positively associated with employment, *the role played by high skills differs in manufacturing and services industries*. Targeted skill policies, also related to ICT capabilities, may thus be needed to boost employment – notably, when certain types of jobs have been affected by offshoring practices.

In manufacturing, the presence of large firms is positively associated with employment in routine occupations. More generally, industry structure matters and so do economies of scale when competing in global markets: small is not always beautiful, and more is not always the merrier. Industrial policy aiming to foster growth and productivity and the competitiveness of firms should account for the structural difference existing across industries and the increasing services content of manufacturing.

Complex dynamics require coordinated policies. Complex interactions exist between the routine content of occupations, the skill profile of the workforce, technology endowment, innovation capabilities, industry structure and trade in value added. Such interactions do not allow clear "winners" and "losers" to be identified easily in a GVC context. Caution is needed when designing and assessing the impact of policies promoting participation in GVCs: trade policy alone cannot change or reverse recent global production trends, as several determinants shape them.

Routine intensity of occupations: distinguishing tasks and skills

Recent OECD work (Marcolin et al., 2016) develops new indicators of the routine intensity of occupations based on information from the OECD Programme for the International Assessment of Adult Competencies (PIAAC). These indicators capture individual workers' degree of independence in planning and organising their activities and time as well as their freedom in deciding what to do on the job and in what sequence. Compared to earlier studies, this report distinguishes between what workers do on their jobs and the skills with which they are endowed and covers 28 countries, thus shedding new light on the role that skills and the routine content of occupations play for industry, labour market and trade dynamics.

Using the routine intensity indicator (RII), it is possible to subdivide occupations into four groups:

1. *Non-routine* (NR) jobs, such as legislators and managers
2. *Low routine-intensive* (LR) jobs, like secondary education teachers and hairdressers
3. *Medium routine-intensive* (MR) jobs, such as machinery mechanics and shop salespersons
4. *High routine-intensive* (HR) jobs, like assembly line workers and food preparation assistants.

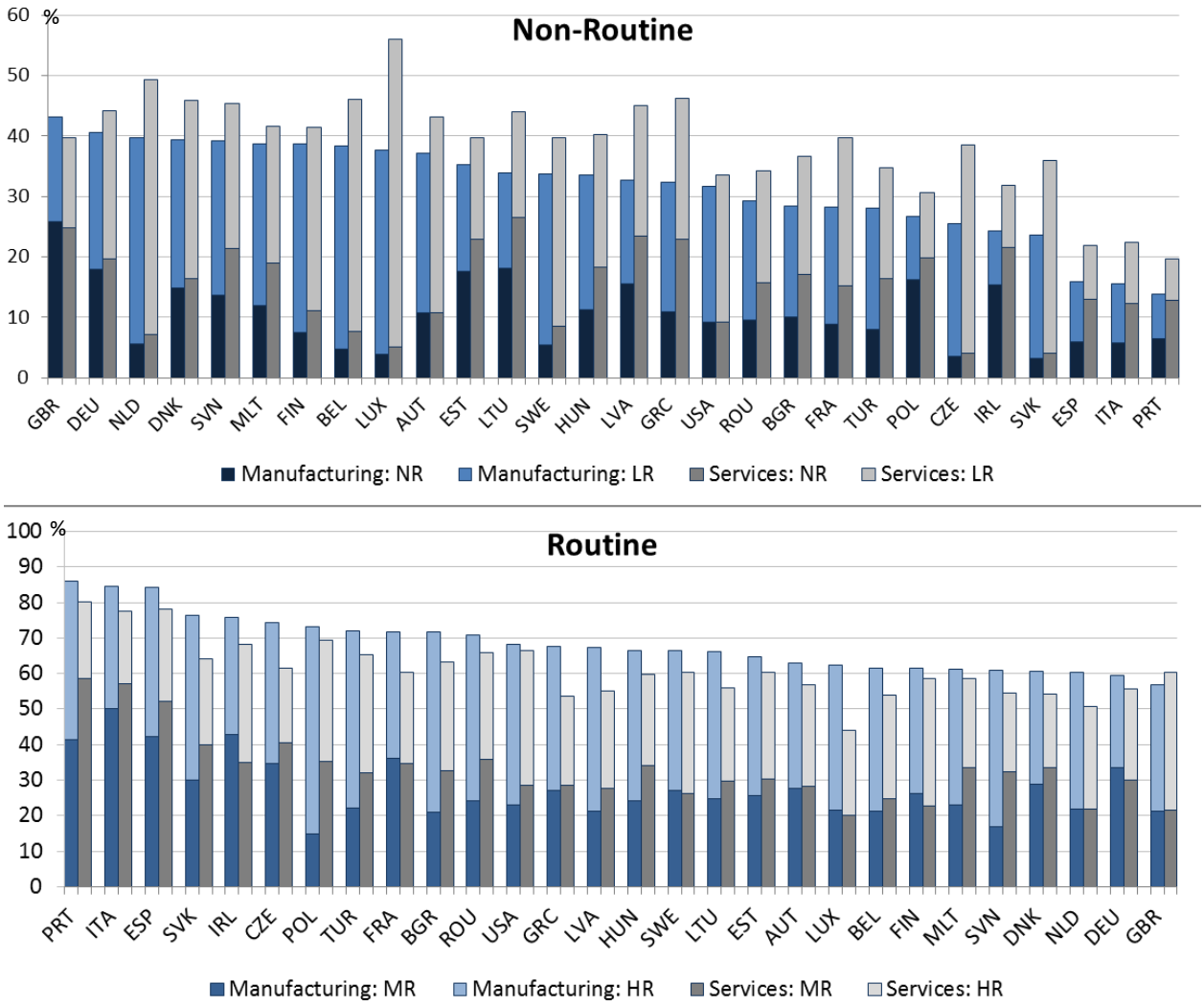
Routine employment varies across countries and industries and over time

Between 2000 and 2011 important cross-country differences emerge in the average share of employment accounted for by the different groups of routine-intensive occupations. At the economy level, the number of non-routine and low-routine-intensive workers ranged between about 22% (Italy) and 56% (Luxembourg). Also, the average share of workers in high routine-intensive occupations ranged from 21% (Greece) to 37% (Poland). Finally, the proportion of workers belonging to occupations in the central groups – i.e. LR and MR – varied between about 70% in relatively smaller economies such as Luxembourg and the Czech Republic and about 35% in larger economies like Poland and the United Kingdom (see Marcolin et al., 2016).

These differences mirror differences in the composition and structure of industries and the skills endowment of the workforce. Generally services enjoy higher shares of employment in non-routine, low-routine and medium-routine jobs (see Figure 1). Conversely, manufacturing accounts for higher shares of workers in high-routine occupations: 41% on average, as compared to an average 28% in services. With the exception of non-routine workers, whose share is generally higher in services than in manufacturing, no clear patterns emerge in the country and sector specific proportions of workers in the different routine intensity groups. This suggests that factors such as countries' industry structure and stage of development matter.

Figure 1. Countries' shares of employment by routine intensity of jobs, in manufacturing and services

Average of years 2000, 2005, 2008-11



Note: Country-specific average values, ranked from lower to higher employment share in manufacturing.

Source: based on Marcolin, Miroudot and Squicciarini (2016).

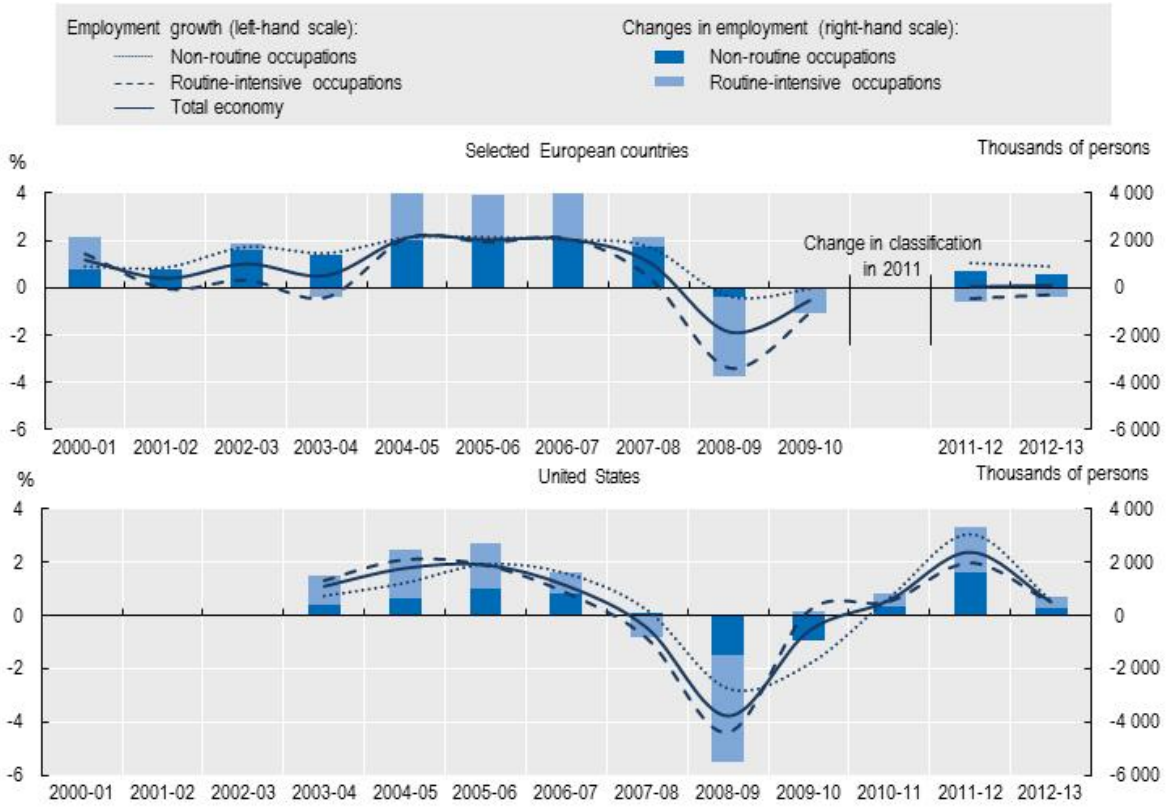
Existing studies suggest that high skilled workers tend to specialise in non-routine tasks, and that some low skill tasks can be complementary to high skill ones (e.g. cleaning services, personal care). OECD work finds that the correlation between skill content and routine intensity is indeed negative, i.e. that more routine-intensive occupations tend to require lower level skills, but that this correlation is not necessarily very strong. As a consequence, provided that technological advancements and the fragmentation of production affect routine employment more than non-routine employment (see e.g. Autor, 2013, 2015), high-skill workers in routine jobs may still be at risk of relocation or automation in the same way as their less skilled counterparts.

… and show a different resilience to crisis

Also economic cycles affect occupational categories to a different extent. Looking at the extent to which workers in different occupations have been affected by the crises (see Figure 2) shows that in Europe, routine intensive occupations have been more affected by layoffs during downturns and have benefitted less from growth spells than their counterparts in the United States. In general, while the United States shows more cyclical responsiveness than the European Union, in both regions routine-intensive occupations appear more cyclical than non-routine ones, which are more resilient. In the depths of the crisis (2008-09), job losses in Europe mainly concerned routine-intensive occupations while in the United States they affected both groups. During the upswing of 2011-12 the United States gained jobs in both routine-intensive and non-routine occupations, while gains in Europe were only in non-routine occupations.

Figure 2. Contribution of routine-intensive and non-routine occupations to employment growth, 2000-13

Yearly growth rates, selected European countries and the United States



Note: Non routine and low-routine intensive occupations are here denoted as "non-routine", whereas medium- and high-routine-intensive occupations are denoted as "routine-intensive". Figures based on data from: Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Iceland, Italy, Lithuania, Luxembourg, Latvia, Malta, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, the United Kingdom and the United States.

Source: based on OECD (2015a), *Science, Technology and Industry Scoreboard 2015*, http://dx.doi.org/10.1787/888933272860.

Routine jobs are shaped by GVCs, innovation and ICT

OECD analysis of the relationship between the routine intensity of occupations and trade in value-added patterns sheds light on the way in which ICT, innovation and industry structure explain the distribution of jobs in GVCs and affect employment at the country and industry levels.

Offshoring does not always mean fewer jobs

Offshoring does not necessarily lower the levels of employment of routine-intensive workers. Especially in manufacturing, offshoring the inputs of production relates positively to employment in routine-intensive occupations. Such a relationship is consistent with the specialisation of manufacturing firms in specific stages of the value chain: as they import more inputs that need to be further processed, they also rely relatively more on routine-intensive jobs. Conversely, offshoring the final assembly of production is associated with a reduction of employment in non-routine jobs. When final assembly is offshored, it is not only production and core assembly that are lost, but also some supervision and support activities carried out by the least routine-intensive workers.

Countries' industrial specialisation matters

Offshoring and employment relate to the specialisation of countries: different patterns emerge for large and more mature "service-based" economies on the one hand and for European catching-up and transition economies, on the other hand. The latter have been gaining employment in medium and high routine-

intensive occupations, while the former have been experiencing more labour demand in non-routine occupations. While more open trade regimes might have facilitated such specialisation, this does not imply that trade policy may be able to reverse (some of) these trends, as they appear to be explained by other determinants, including the skill distribution of the workforce, technology endowments, innovation capabilities and industry structure.

Also, policy needs to take into account the ever-greater integration of manufacturing and services industries of recent years. The progressive "servitisation" of economies, i.e. the growing propensity of manufacturing firms to bundle services together with their core products, may lead to important productivity gains through the reallocation of resources to their best use (e.g. Arnold et al., 2016), but may also represent a challenge, as it may entail dealing with higher levels of complexity linked to switching from production in-house to outsourcing (e.g. Grossman and Helpman, 2005), at least in the short term.

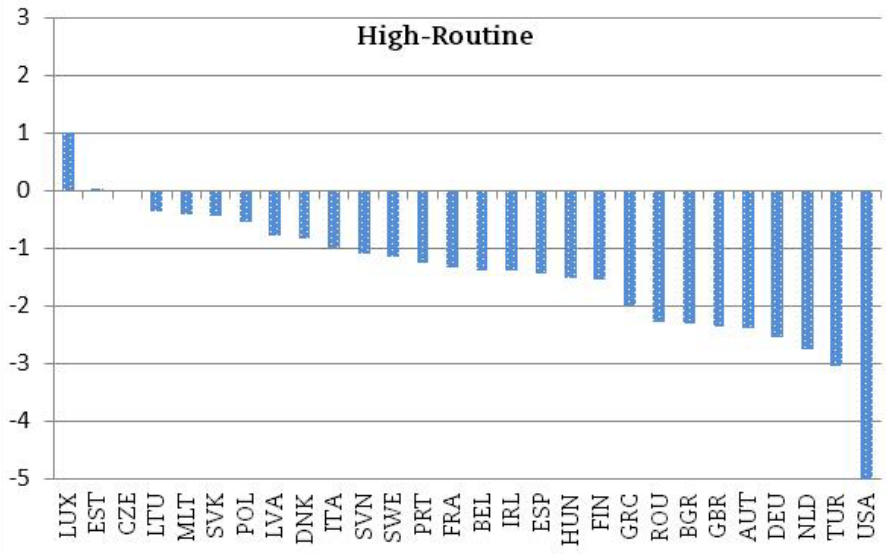
Technological innovation helps employment…

Technological innovation (using patenting as a proxy) does matter and positively so for employment in all groups of occupations. The stronger competitiveness that technological innovation may confer, especially in manufacturing, translates into-higher employment levels, and generally more so in the case of non-routine and low routine intensive occupations. This argues in favour of policies supporting investment in innovation-related activities, and calls for the need to design broad-based innovation policies able to foster productivity, growth and well-being (OECD, 2015b).

… as do Information and Communication Technologies, but not everywhere

A clear relationship emerges between the skill level of the workforce, ICT-related capabilities and innovation on the one hand, and labour demand across different groups of occupations on the other hand. ICT-related capabilities appear to be positively correlated with employment levels in all groups but for the high-routine one (see Figure 3) in basically all economies considered. Also, while comparatively higher skills are generally associated with higher employment especially in non-routine (NR) and low routine-intensive (LR) occupations, differences emerge between manufacturing and services industries.

Figure 3. Employment levels and ICT intensity in high-routine occupations



Note: The y axis displays the percentage change in employment levels in the considered routine quartile due to a 1% change in ICT intensity, all other factors held constant.

Source: based on Marcolin, Miroudot and Squicciarini (2016).

The role played by ICTs and skills confirms the relevance of policies targeting skills and education, especially ICT skills. While it is unlikely that any policy may influence the routine-intensity of occupations, targeted skill policies, especially those related to ICT capabilities, can indeed play a role for employment distribution and reallocation within and across countries, mitigating the losses associated with offshoring that leads to a workforce re-allocation.

Industries differ, and policies should keep these differences in mind

The results point to the possible existence of economies of scale and competition-related effects, whereby the number of firms and the proportion of big firms in an industry relate to employment levels. The number of firms correlates negatively with employment levels in the overall sample, whereas the proportion of big firms is correlated with higher employment, especially in manufacturing.

These complex relationships point to the need of tailoring policies depending on whether manufacturing or services industries are being considered, as the routine content of occupations differs importantly across industries (especially in high-routine occupations). Also, policies affecting firm creation and scaling up processes would need to be carefully designed, as they may shape employment in opposite directions, depending on the occupation(s) and industry(ies) involved. For instance, in manufacturing the presence of big firms correlates positively with higher employment of routine workers, whereas this is not the case in services. Hence, scaling up policies might have differential effects on aggregate employment levels depending on the structure of the economy and on whether the focus is on manufacturing or services.

Complex dynamics need coordinated policies

The analysis emphasises the need for tailoring policies targeting industries, skill levels or regions, as results may differ depending on the routine content of occupations. This poses new challenges to actions aimed at addressing the displacement of workers within and across industries. More generally, the increased level of competition and re-allocation of resources between firms within each industry and across industries and countries might have non-neutral consequences for employment. This underscores the need for well-functioning labour markets and appropriate labour market policies, able to strike the right balance between employment flexibility and aggregate welfare and to smooth the reallocation of the labour force according to the patterns of production and of trade in value added. Moreover, labour market policies need to be coupled with trade, industry and innovation and competition policies, creating the right business environment in a GVCs context.

New and sound evidence needs better data

Better policies need better evidence, and better evidence needs better data: this study is made possible by the OECD Survey of Adult Skills (PIAAC) and the OECD-WTO Trade in Value Added (TiVA) dataset.

The *OECD Survey of Adult Skills* (2012) contains information on workers' skills, the tasks they perform on the job, the workers themselves (e.g. gender, age, and occupation) and their workplace (including size, public or private nature of the institution, and industry). Comparability across more than 20 countries is ensured through the use of international classifications of educational attainment, occupation and economic activity.

The *TiVA database* and its underlying Inter-Country Input Output (ICIO) infrastructure yield a wealth of indicators tracking the origins of the value added content of international trade flows and final demand. The indicators relate to both direct and indirect inter-country, inter-industry flows of intermediate inputs and final goods and services, and thus can reveal inter-country relationships both in gross trade and value added terms. The 2015 release of TiVA contains information for 61 countries, 34 industries and 7 years (1995, 2000, 2005, and all years between 2008 and 2011).

PIAAC allows distinguishing workers' skills from the tasks performed on the job and enables the construction of detailed cross-country comparable measures of the routine content of occupations. TiVA indicators shed light on the generation of value added along global production chains which can be linked to employment patterns.

Further reading

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OECD, WTO and World Bank Group (2014), *Global Value Chains: challenges, opportunities and implications for policy*. Report prepared for submission to the G20 Trade Ministers Meeting Sydney, Australia, 19 July 2014. http://www.oecd.org/tad/gvc_report_g20_july_2014.pdf

www.oecd.org/site/piaac/

www.oecd.org/trade/valueadded

Directorate for Science, Technology and Innovation Policy Note

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