OECD Skills Outlook 2017

SKILLS AND GLOBAL VALUE CHAINS

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BETTER POLICIES FOR BETTER LIVES

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Foreword

"Global value chains (GVCs)" have immensely increased the potential for individuals and nations to benefit from globalisation. Workers in different parts of the world can now contribute to the production of a single product, giving even small companies and countries unprecedented opportunities to reach global markets and create new jobs, and generating new gains in productivity that benefit consumers. But they can also leave people behind. While many jobs depend on GVCs, GVCs have meant that some workers have lost their jobs and many of them have not seen their income growing over the past decade.

It is thus important to recognise that at the heart of global value chains are people: from the people who conceive a new product to the consumers who use it, and in between the people who design, produce, assemble and transport the article and its various parts. And the extent to which people can plug into global value chains greatly depends on their skills. This is the topic of this year's edition of the Skills Outlook.

Workers need to have strong literacy, numeracy and problem-solving skills, skills in the use of technologies, social and emotional skills, and the capacity and motivation to learn. When workers have the mix of skills that is well aligned with the needs of the most technologically advanced industries, and when qualifications reliably reflect what workers can do, countries can develop a comparative advantage by specialising in these industries. Having the right skills can also help workers face the potential negative impacts of global value chains: having communication and decision-making skills make workers less vulnerable to the risk of offshoring.

However, many adults lack those skills. The Survey of Adult Skills, a product of the OECD Programme for the International Assessment of Adult Competencies (PIAAC), has revealed that about one in four adults has low skills in either literacy or numeracy. As both production and education are no longer bound by national borders, countries can co-operate on designing education and training programmes that improve the skills of workers and find ways to recognise relevant skills through shared definitions of workers' qualifications.

Above all, governments need to look at the full range of their structural policies to address the challenges of globalisation. This publication focuses on the specific role of skills and skills policies to make the most of global value chains, but these policies need to be aligned with other policies, including those covering trade, innovation, investment, and industry. In other words, a whole-of-government approach is needed. The OECD stands ready to work with governments to face the challenges and reap the benefits of globalisation.

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Executive summary

The world has entered a new phase of globalisation over the past two decades that presents countries and workers with new challenges and opportunities. Helped by the rise of information technology and transportation innovations, production has become globalised and fragmented along so-called global value chains: workers across different countries now contribute to the design, production, marketing and sales of the same product. On average in OECD countries, one-third of jobs in the business sector depend on demand in foreign countries. Thirty percent of the value of exports of OECD countries now originates from abroad.

The impacts of global value chains on economies and societies are more complex, more diffuse and more inter-dependent than those from earlier phases of globalisation. The benefits of globalisation are being questioned. Countries can help ensure that their participation in global markets translates into better economic and social outcomes, through a range of policy actions, where investing in the skills of their populations is paramount.

Skills matter for globalisation

Skills can help countries integrate into global markets and specialise in the most technologically advanced industries

- When skills development accompanies participation in global value chains, countries can achieve stronger productivity growth. Countries with the largest increase in participation in global value chains over the period 1995-2011 have benefited from additional annual growth in industry labour productivity. This extra growth ranges from 0.8 percentage points in industries that offer the smallest potential for fragmentation of production to 2.2 percentage points in those with the highest potential, such as many high-technology manufacturing industries.
- To integrate and grow in global markets, all industries need workers who have not only strong cognitive skills (including literacy, numeracy and problem solving) but also managing and communicating skills, and a readiness to learn. To spread the productivity gains from participation in global value chains across the whole economy, all firms, including small firms, need workers with such skills.
- To specialise in the most technologically advanced industries, countries also need:
  - workers with good social and emotional skills (such as managing, communicating, self-organising skills) that complement cognitive skills. A country with a skills mix that is well aligned with the skills requirements of technologically advanced industries can specialise in these industries on average 8% more than other countries.
  - pools of workers with qualifications that reliably reflect what they can do. Many technologically advanced industries require workers to complete long sequences of

tasks; poor performance at any stage greatly reduces the value of output. Countries with such workers can specialise in these industries on average 2% more than countries whose skills outcomes are less certain.

Skills can help individuals face the potential negative impacts of global value chains

- Countries can reduce workers' exposure to the risk of offshoring – the relocating of production to other countries – by investing in the skills development of their populations. What people do on the job, and thereby the type of skills they develop, also strongly influences the exposure of their jobs to this risk. When workers have the necessary skills, they can evolve in their jobs or adapt more easily to changing needs.
- More educated workers enjoy higher job quality than less educated ones in all countries. However, countries that participate more in global value chains experience a wider gap in job quality between highly educated and less educated workers.
- Too many adults lack the skills needed to face the challenges of globalisation. More than 200 million adults across OECD countries (about one in four) have low literacy or numeracy skills and 60% of them lack both types of skills.

Skills have accompanied global integration of countries differently

Countries need to invest in skills not only to help individuals enter the labour market and protect them against the risks of job losses and poor job quality but also to pursue international competitiveness and economic progress in an interconnected world.

- Over the last 15 years, from different starting positions, Korea and Poland have increased their participation in global value chains and specialisation in technologically advanced industries, while improving the skills of their populations and achieving economic and social gains, thereby seizing the benefits of global value chains.
- Chile and Turkey have significantly increased their participation in global value chains, have developed the skills needed to face the challenges of global value chains, and have enjoyed strong employment outcomes. Their skills are weakly aligned with the requirements of technologically advanced industries, however, which partly explains their low specialisation in these industries.
- Germany and the United States also significantly increased their participation in global value chains. However, the skills of the German population appear to support the country's industry specialisation pattern while this is less the case for the United States.
- Some countries, such as Greece and to some extent Belgium, are weakly integrated into global value chains, have not improved the skills of their populations much, and have not benefited from global value chains as a source of economic growth.

Implications for skills-related policies

To seize the benefits of global value chains, countries need to invest in education and training, make better use of skills, better co-ordinate skills-related policies – from education and migration policies to employment protection legislation – and align these policies with industry and trade policies.

Equip graduates with reliable qualifications and strong mixes of relevant skills

From early childhood through to adult learning, education and training systems need to equip all learners with strong mixes of skills. This requires maintaining a strong focus

on cognitive skills while developing innovative teaching strategies, flexibility in the curriculum choice and well-designed entrepreneurship education.

Countries can better align their skills characteristics with industries' skills requirements through high quality vocational and professional education and training that includes a strong work-based learning component, and specific policies to foster closer collaboration between the private sector, higher education institutions and research institutions.

Remove barriers to further skills development

Adults need to continuously develop and adapt their skills, so countries should dismantle barriers to further skills development, especially for adults with weaker skill sets. Governments, employers, unions, and education and training providers need to work together to develop flexible on-the-job training opportunities, improve access to formal education for adults, and make it easier for workers to combine work and training. Greater recognition of skills acquired informally would help workers gain further qualifications and adapt their careers to changing needs.

Use skills more effectively

Skills can enable countries to perform well within global value chains, but only if people are working in firms and industries that make the best use of their skills. Countries need to ensure that people can move easily into jobs where their skills can be used well, while providing flexibility to firms and security to workers. Countries could foster the development of effective management practices, design employment protection legislation, and regulate non-compete clauses in ways that enable expertise and knowledge to be shared across the whole economy more effectively.

Enhance international co-operation on skills policies

Rather than competing to attract talent, countries could co-operate in the design of education and training programmes. Such collaborative efforts can ensure quality and maintain the knowledge and skills that countries need to thrive in global value chains. They can also improve skills in developing economies and facilitate the recognition of these skills by other countries. Countries could consider financing arrangements that better reflect the distribution of benefits and costs across countries in a world where both education and the production process have been internationalised.

Glossary

Automation of production: The use of machines and automatic devices to perform part of the production process. It is generally used to reduce human intervention and is therefore considered to replace human labour by machines.

Backward participation in global value chains: Import of foreign inputs used in products for export. This is similar to the foreign value added embodied in gross exports (see below).

Cognitive skills: These skills involve the understanding, interpretation, analysis and communication of complex information and the ability to apply this information in situations of everyday life. These skills are general in nature and relevant for all kinds of occupations, considered necessary to provide a foundation for effective and successful participation in social and economic life.

Comparative advantage in trade: One of the most important concepts in international trade theory, which refers to the ability of a country to produce goods and services at a lower opportunity cost than other countries and therefore to specialise in producing this product. This is the case even if the country holds an absolute advantage in all products, or if it can produce more or better goods than other countries. In the case of two countries, two industries, and two factors of production, high-skilled and low-skilled human capital, the country that is more endowed with high-skilled workers is said to have a comparative advantage in the industry that is more intensive in high-skilled tasks.

Complementarity of skills: If efficiency improves when skills of different workers are used together in the production process, those skills are said to be complementary.

Distance to final demand: The number of stages of production that are left before goods or services produced reach final demand. Its measure is based on trade in value added data.

Domestic value added embodied in gross exports: Value added generated domestically by the exporting industry or country during production processes as well as any value added coming from activities earlier in the value chain, such as research and development, and design.

Downstream activities: Activities at the end of a value chain, such as marketing, branding and customer service.

Final demand: Final goods and services consumed or invested by households, government and businesses.

Foreign value added embodied in gross exports: Value from abroad of intermediate goods and services imported and used in a domestic industry's exports. It can be expressed as a share of gross exports or a share of final demand, as an indicator of backward participation in global value chains.

Forward participation in global value chains: Production of inputs used in third countries' exports.

Fragmentation of production: Organisation of production in which different stages are divided among different suppliers or subsidiary companies that can be located in different countries. As a result, products traded between firms in different countries can be intermediate goods and tasks instead of final goods and services.

Global value chains: International production, trade and investments are increasingly organised within global value chains, in which the different stages of the production process are located across different countries. Globalisation motivates companies to restructure their operations internationally through outsourcing and offshoring of activities.

Industry cluster: A group of firms in the same geographic area that share markets, technologies and skills needs, and that are often linked by buyer-seller relationships.

Intermediate goods: Goods used as inputs in the production of other goods.

International co-authorship: Scientific collaboration on research articles between scientists who reside in different countries.

International co-invention: Innovation, often measured as patents, with several inventors who reside in different countries.

Job quality: Various aspects of employment that contribute to the well-being of workers.

Knowledge spillover: Information or ideas emerging from other countries or firms that can be acquired without payment.

Length of global value chain: The number of stages involved in the production process of an industry. It is measured using trade in value added data.

Non-compete clause: A clause under which an employee agrees not to use information acquired during employment in subsequent jobs for a specific period of time.

Offshoring: Relocation of a business activity from one country to another – typically an operational activity, such as assembly, and sometimes a downstream (e.g. marketing) or an upstream (e.g. research and development) activity.

Participation in global value chains: The extent to which countries' exports are integrated in an internationally fragmented production network. Indicators of participation in global value chains are based on trade in value added data.

Relative task intensity of industry: The extent to which an industry involves a more frequent performance of one task than another one. It is measured by the ratio of the frequencies of the performance of two tasks, by industry.

Revealed comparative advantage: A measure of the performance of a country in one industry relative to its performance in all other industries and as compared with the performance of a reference group of countries using export flows. It infers the existence of a comparative advantage (or stronger performance) of this country in an industry relative to other countries and all other industries. The indicator is based on trade in value added data. It captures countries' specialisation in industries within global value chains.

Skills advantage: An individual is said to have a relative skills advantage in one skill if she is more proficient in that skill than in another one. It is measured by the ratio of scores in two skills (e.g. numeracy to literacy scores). This advantage determines which industry a worker is most suited to. An individual is said to have an absolute advantage if she is

highly skilled in both skills. This advantage determines a worker's productivity on the job, depending on the industry's skills requirements.

Skills mix: A combination of various skills, possibly of various types. It is measured by considering two skills (e.g. literacy and numeracy), and looking at the scores in the two skills, the ratio of the scores in the two skills, and the correlation between these two elements. The characteristics of the skills mix of the whole population in an economy determine a country's industry specialisation.

Social and emotional skills: Skills involved in working with others (friendliness, respect, caring), in achieving goals (perseverance, self-control, passion for success) and in managing emotions (calm, optimism, confidence). They are based on recognised taxonomies in personality psychology, particularly the "Big Five" factors (extraversion, agreeableness, conscientiousness, emotional stability, and openness).

Specialisation: A country's ability to produce more in industries where it has a comparative trade advantage. It is measured using trade in value added data.

Task-based skills: Skills related to the performance of business tasks at work. They are measured based on information from the background questionnaire in the Survey of Adult Skills.

Technologically advanced industries: Manufacturing industries using cutting-edge technology, and complex business services industries that use and/or develop sophisticated technologies.

Technology transfer: The transfer of new technology from an inventor to a secondary user.

Trade in gross terms: Gross flows of goods and services reported every time they cross a border.

Trade in value added terms: Net trade flows between countries, which account for the origin of value added embodied in any goods or services crossing a border.

Unobservable skills dispersion: The dispersion of skills of a country's population after accounting for observable skills determinants such as the level of education and training, age, and socio-economic background.

Upstream activities: Activities at the beginning of a value chain, such as the development of a new concept, research and development, manufacturing of key components, and production of raw materials.

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Chapter 1

Overview: Skills to seize the benefits of global value chains*

Over the last two decades, international patterns of production and trade have changed, leading to a new phase of globalisation. Each country's ability to make the most of this new era, socially and economically, depends heavily on how it invests in the skills of its citizens. This chapter develops a scoreboard that measures the extent to which countries have been able to make the most of global value chains through the skills of their populations. It assesses jointly how countries have performed in recent years in terms of skills, global value chain development, and economic and social outcomes. This chapter offers an overview of the whole report. It examines how countries can ensure their performance within global value chains translates into better economic and social outcomes through effective, well-co-ordinated skills policies.

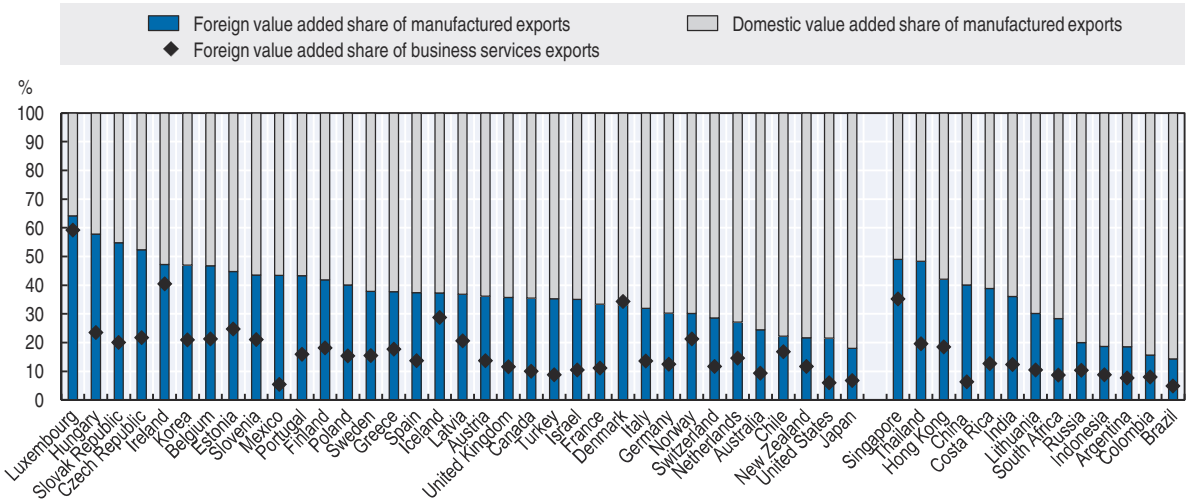
*The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Since the 1990s, the world has entered a new phase of globalisation. Information and communication technology, trade liberalisation and lower transport costs have enabled firms and countries to fragment the production process into global value chains (GVCs): many products are now designed in one country and assembled in another country from parts often manufactured in several countries. To seize the benefits of GVCs, countries have to implement well-designed policies that foster the skills their populations need to thrive in this new era.

The scale of GVC deployment can be gauged by measuring trade in value-added terms instead of in gross terms, thus distinguishing between the value of exports that is added domestically and the value that is added abroad. Such measurement has been made possible through important recent advances by the OECD in co-operation with the WTO (OECD, 2013). On average, in OECD countries, close to 40% of the value of manufactured exports and 20% of the value of business services exports comes from abroad (Figure 1.1).

Figure 1.1. **The incidence of global value chains**

Foreign value added embodied in exports of manufactured goods and exports of services, 2011



Source: OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*.

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Global value chains present both opportunities and challenges for countries

GVCs give workers the opportunity to apply their skills all around the world without moving countries: an idea can be turned into a product more easily and those who are involved in production can all benefit from this idea. GVCs give firms the possibility of entering production processes they might be unable to develop alone. At the same time, the demand for some skills drops as activities are offshored, exposing workers to wage reductions or job losses in the short term. In the long term, however, offshoring enables firms to reorganise and achieve productivity gains that can lead to job creation. Overall, the

costs and benefits of GVCs are complex. GVCs increase the interconnections between countries and thereby the uncertainty surrounding the demand for skills. A country's competitiveness can be affected by skills policy changes occurring in its trading partners.

The impacts of GVCs on economies and societies are more diffuse and less controllable than those from the initial phase of globalisation (Baldwin, 2016). Economies used to be split into a sector exposed to international competition and a sheltered sector. Workers could enjoy higher wages in the exposed sector in return for accepting higher risks (e.g. unemployment risks), while governments could design specific policies for this sector. This distinction has now disappeared. Any job in any sector can be the next to benefit or suffer from globalisation: in many OECD countries, up to one-third of jobs in the business sector depend on foreign demand.

The rise of GVCs has prompted a backlash in public opinion in some countries. This negative reaction has sometimes focused on the leading role of multinationals and foreign direct investment. Multinationals can boost production and job creation in the host country by engaging local companies as suppliers, but they can also quickly relocate parts of the production process from country to country. This increases uncertainty about the demand for jobs and skills in each country, while making unco-ordinated policy response in each country less effective. Multinationals are often seen as responsible for offshoring jobs while contributing to the increase in top incomes.

The belief that rising trade integration can lead to unemployment, income losses and inequalities can lead to polarisation of politics (Autor et al., 2016). Given this risk, the challenge for countries is not only to seize the economic and social benefits of GVCs but also to explain their consequences better so that citizens can have informed views on the issue and vote accordingly.

The development of global value chains is uncertain

The trend towards GVCs, which had been increasing since the 1990s, dipped slightly in 2008 with the global trade slowdown and has since levelled off (Haugh et al., 2016; Timmer et al., 2016; Figure 1.2). Structural factors also seem to have contributed to the slowdown in the fragmentation of production, including greater protection of domestic production and, in some countries such as China, a substitution of imports by domestic goods as local production capabilities increase.

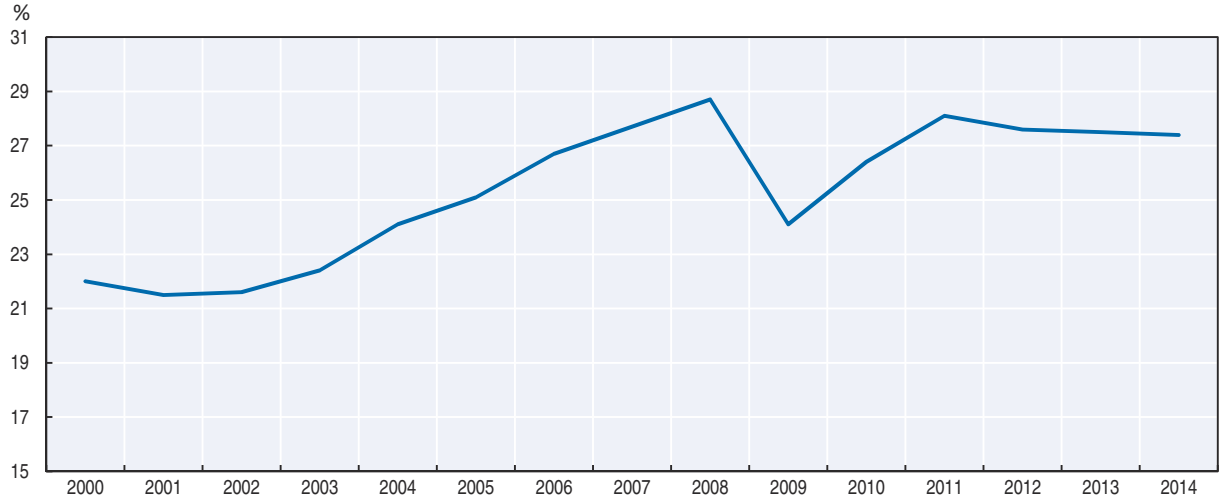
The development of GVCs is uncertain. Digitalisation could enable further fragmentation of production. Services offer a large potential for fragmentation, which could also reinvigorate the development of GVCs (Baldwin, 2016). As some emerging economies, including China, move up GVCs, the internationalisation of production could expand to other countries, especially developing economies. On the other hand, technological innovations such as automation could stimulate renewed localisation of production in advanced countries, especially if policies enable this.

Investing in skills helps countries to seize the benefits of global value chains

This edition of the *OECD Skills Outlook* shows that through their skills and well-designed skills policies, countries can shape their capacity to seize the benefits of GVCs. As these policies are also vital to tackle other challenges, such as youth unemployment, investing in skills is a double-dividend strategy. Governments tend to respond to concerns about GVCs with policies outside the skills area, e.g. trade and industry, including policies

Figure 1.2. **Recent developments of global value chains**

Share of global value chain imports in the value of the final product



Note: Global value chain imports are all imports of goods and services needed in any stage of production of a final product.
Source: Timmer et al. (2016), "An Anatomy of the Global Trade Slowdown based on the WIOD 2016", *GGDC Research Memorandum*, No. 162, University of Groningen.

StatLink http://dx.doi.org/10.1787/888933473990

that aim to stop the offshoring of activities. Such policies can be ineffective and less certain in terms of outcomes, and do not lead to a double dividend.

Skills can help countries to make the most of GVCs through various channels:

- Skills are needed to realise the productivity gains offered by participation in GVCs and ensure these gains transfer to a broad range of firms, including small ones, and thereby benefit the whole economy.
- Skills can protect workers against the potential negative impacts of GVCs in terms of job losses and lower job quality.
- Skills are crucial for countries to specialise in the most technologically advanced manufacturing industries and in complex business services that are expected to lead to innovation, higher productivity and job creation.

More generally, investing in skills can ensure that all individuals understand the challenges and opportunities of globalisation, feel more confident in the future, shape their own careers, and cast informed votes.

OECD countries that appear to have benefited the most economically and/or socially from global value chains include Germany, Korea and Poland

The extent to which countries have been able to make the most of GVCs through the skills of their populations can be summarised in a scoreboard (Table 1.1). The scoreboard gathers three blocks of information on i) countries' skills; ii) countries' participation in GVCs; and iii) countries' economic and social outcomes based on the analysis developed in the whole publication (Box 1.1).

The scoreboard shows that:

- No country has achieved above-average outcomes in all the dimensions of the scoreboard.

Table 1.1. **Scoreboard on skills and global value chains**

	Skills			Development of GVCs			Economic and Social Outcomes		
	A limited share of low-skilled people	Developing skills to face the challenges of GVCs	Skills to specialise in tech. advanced industries	Increasing participation in GVCs	Specialised in tech. advanced industries	Increasing specialisation in tech. advanced industries	Increasing productivity	Increasing employment	Improving social outcomes
Australia	Top 25%	Bottom 25%	Around average	Around average	Bottom 25%	Bottom 25%	Around average	Around average	Around average
Austria	Around average	Around average	Around average	Around average	Around average	Around average	Around average	Top 25%	Around average
Belgium	Around average	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Around average	Bottom 25%	Around average	Top 25%
Canada	Around average	Around average	Around average	Around average	Around average	Around average	Around average	Around average	Around average
Chile	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Bottom 25%	Top 25%	Top 25%	Missing data
Czech Republic	Around average	Around average	Around average	Bottom 25%	Around average	Top 25%	Top 25%	Around average	Around average
Denmark	Around average	Around average	Around average	Around average	Around average	Around average	Bottom 25%	Bottom 25%	Bottom 25%
Estonia	Around average	Top 25%	Around average	Bottom 25%	Around average	Top 25%	Top 25%	Around average	Around average
Finland	Top 25%	Bottom 25%	Top 25%	Around average	Around average	Bottom 25%	Around average	Around average	Around average
France	Around average	Around average	Around average	Around average	Around average	Bottom 25%	Around average	Around average	Around average
Germany	Around average	Around average	Around average	Top 25%	Around average	Around average	Around average	Top 25%	Top 25%
Greece	Bottom 25%	Around average	Bottom 25%	Around average	Bottom 25%	Around average	Bottom 25%	Bottom 25%	Around average
Hungary	Missing data	Around average	Missing data	Around average	Around average	Around average	Top 25%	Top 25%	Around average
Iceland	Missing data	Bottom 25%	Missing data	Top 25%	Bottom 25%	Around average	Around average	Bottom 25%	Top 25%
Ireland	Around average	Around average	Around average	Around average	Top 25%	Around average	Top 25%	Bottom 25%	Bottom 25%
Israel	Bottom 25%	Top 25%	Bottom 25%	Around average	Top 25%	Around average	Around average	Top 25%	Top 25%
Italy	Bottom 25%	Top 25%	Bottom 25%	Around average	Around average	Around average	Bottom 25%	Around average	Around average
Japan	Top 25%	Around average	Top 25%	Top 25%	Around average	Bottom 25%	Around average	Bottom 25%	Around average
Korea	Around average	Around average	Top 25%	Top 25%	Top 25%	Around average	Top 25%	Around average	Top 25%
Luxembourg	Missing data	Around average	Missing data	Bottom 25%	Top 25%	Around average	Bottom 25%	Top 25%	Bottom 25%
Mexico	Missing data	Around average	Missing data	Around average	Bottom 25%	Bottom 25%	Bottom 25%	Around average	Around average
Netherlands	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Around average	Top 25%	Bottom 25%	Around average	Bottom 25%
New Zealand	Top 25%	Bottom 25%	Around average	Bottom 25%	Bottom 25%	Top 25%	Around average	Around average	Around average
Norway	Top 25%	Around average	Top 25%	Bottom 25%	Bottom 25%	Bottom 25%	Bottom 25%	Bottom 25%	Around average
Poland	Around average	Top 25%	Around average	Top 25%	Around average	Top 25%	Top 25%	Around average	Top 25%
Portugal	Missing data	Top 25%	Missing data	Around average	Missing data	Around average	Around average	Bottom 25%	Top 25%
Slovak Rep.	Around average	Bottom 25%	Around average	Bottom 25%	Around average	Top 25%	Top 25%	Top 25%	Around average
Slovenia	Bottom 25%	Top 25%	Bottom 25%	Around average	Around average	Around average	Around average	Around average	Bottom 25%
Spain	Bottom 25%	Around average	Bottom 25%	Around average	Around average	Top 25%	Around average	Around average	Bottom 25%
Sweden	Top 25%	Bottom 25%	Top 25%	Around average	Around average	Around average	Around average	Around average	Bottom 25%
Switzerland	Missing data	Around average	Missing data	Around average	Top 25%	Top 25%	Around average	Around average	Around average
Turkey	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Bottom 25%	Around average	Top 25%	Top 25%
United Kingdom	Around average	Around average	Around average	Around average	Top 25%	Around average	Around average	Around average	Around average
United States	Around average	Around average	Around average	Top 25%	Top 25%	Around average	Around average	Bottom 25%	Bottom 25%

Top 25% Around average Bottom 25% Missing data

Note: Indicators are described in Box 1.1. The scoreboard shows for each sub-category, countries that perform in the top 25%, bottom 25%, and those around the OECD average. For instance, Finland is among the OECD countries that have the lowest share of low-skilled people, have not developed skills much to face the challenges of GVCs but have the skills to specialise in technologically advanced industries, and have not increased much their specialisation in technologically advanced industries. It performs around the average for the other sub-categories.

Source: OECD calculations based on the OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237;* OECD Income Distribution Database, *www.oecd.org/social/income-distribution-database.htm;* OECD Job Quality Database, *https://stats.oecd.org/Index.aspx?DataSetCode=JOBQ;* OECD Productivity Database, *http://stats.oecd.org/;* OECD STAN STructural ANalysis Database, *http://stats.oecd.org/;* PISA database (2012), *www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm;* Survey of Adult Skills (PIAAC) (2012 and 2015), *www.oecd.org/skills/piaac/publicdataandanalysis;* and OECD (2016), *Education at a Glance 2016: OECD Indicators*, *http://dx.doi.org/10.1787/eag-2016-en*.

- Some countries, such as Germany, Korea and Poland, appear to have seized the benefits of GVCs by increasing their participation in GVCs, increasing their specialisation in technologically advanced industries, performing well in terms of the skills of their populations, and achieving good social or economic outcomes.

Box 1.1. **Scoreboard on skills and global value chains: Methodology**

The scoreboard presented in Table 1.1 aims to measure the extent to which countries have been able to make the most of GVCs through the skills of their populations. It assesses jointly how countries have performed in recent years in terms of skills, GVC development, and economic and social outcomes linked to participation in GVCs. It also gives information on the populations' skills at the latest available date and the state of play of countries' specialisation in technologically advanced industries.

Three main dimensions are considered, with sub-dimensions based on a group of indicators. All of them are taken from the analytical work presented in this edition of the *OECD Skills Outlook*.

The **skills dimension** attempts to capture some skills features that affect countries' performance in GVCs and their capacity to make the most of GVCs. The following sub-categories are considered:

- *Do countries have a limited share of low-skilled people?* To participate in GVCs, ensure that participation translates into productivity growth, and limit the risks of employment loss, increased inequality and poor job quality, countries need to minimise their shares of low-skilled adults (Chapter 2). To measure this aspect of skills, the scoreboard uses three indicators of the shares of adult low performers in different cognitive skills domains (literacy, numeracy and problem solving in technology-rich environment) based on the Survey of Adult Skills, a product of the Programme for the International Assessment of Adult Competencies (PIAAC).
- *Have countries developed skills to face the challenges of GVCs?* To perform well in GVCs and ensure that participation in GVCs translates into good economic and social outcomes, countries need to invest in skills (Chapters 2 and 3). To measure how skills have developed, the scoreboard uses three indicators of change in students' scores in the OECD Programme for International Student Assessment (PISA) (2003-15) and the growth rate of tertiary graduates (2000-15).
- *Do countries have the skills to specialise in technologically advanced industries?* Technologically advanced industries require workers who have strong sets of skills and perform at the expected level (Chapter 3). To measure this aspect of skills, the scoreboard uses indicators of the skills (covered in the Survey of Adult Skills) of the adult population scoring in the top 25% of each country's population, and indicators of the skills dispersion of adults with similar characteristics.

The **global value chains dimension** captures the extent to which countries have increased their participation in GVCs between 2000 and 2011, their specialisation in technologically advanced industries, as well as the state of play of this specialisation. It consists of three sub-dimensions:

- *How much have countries extended their participation in GVCs?* An increase in participation in GVCs can lead to productivity growth, especially if countries have the relevant skills. The scoreboard uses several indicators to account for the development of the main two forms of participation (2000-11): i) importing foreign inputs for exports, or *backward participation;* and ii) producing inputs used in third countries' exports, or *forward participation*. Participation in GVCs is assessed by looking at these two forms of participation as a share of countries' exports or, alternatively, of foreign final demand (see Chapter 2).
- *To what extent are countries specialised in technologically advanced industries?* Specialisation in technologically advanced industries is linked to value creation, innovation and productivity gains (Chapters 2 and 3). It is measured by the indicator of revealed comparative advantage in technologically advanced industries in 2011.

Box 1.1. **Scoreboard on skills and global value chains: Methodology** *(cont.)*

- *How much have countries increased specialisation in technologically advanced sectors?* This is measured by the growth rate of the revealed comparative advantage indicator mentioned above (2000-11).

The **economic and social outcomes dimension** captures how well countries have performed over the last 15 years in a variety of economic and social outcomes. It consists of three sub-dimensions:

- *To what extent have countries increased productivity?* Increased participation in GVCs can lead to productivity gains via several channels, including the possibility to specialise in certain tasks, increased competition, and technology diffusion (Chapter 2). This economic outcome is measured by the growth rate of labour productivity (2000-15).
- *To what extent has employment increased?* Participation in GVCs may affect employment, through both job destruction and job creation (Chapter 2). This is measured by looking at employment patterns in the business sector (2000-15), the share of youth who are neither employed nor in education or training (NEET, 2007-15), and the employment rate of workers older than the age of 54 (2000-15).
- *To what extent have social outcomes improved?* Increased integration in GVCs can affect wages and inequalities, labour market security, and the quality of the working environment (Chapter 2). To measure these social outcomes, the scoreboard uses the growth rate of the Gini coefficient (2004-12) and the development of two aspects of job quality: labour market security (2007-13) and job strain (2005-15).

For each of the sub-dimensions of the scoreboard, a summary indicator is calculated and presented in Table 1.1. Each summary indicator aggregates the set of indicators presented above. Before the aggregation, each indicator was normalised in a way that implies a higher value and being among the "top 25%" reflects better performance. For this purpose, the inverse of several variables is considered in the ranking. The summary indicators for the nine sub-dimensions are calculated as a simple average of the indicators they contain.

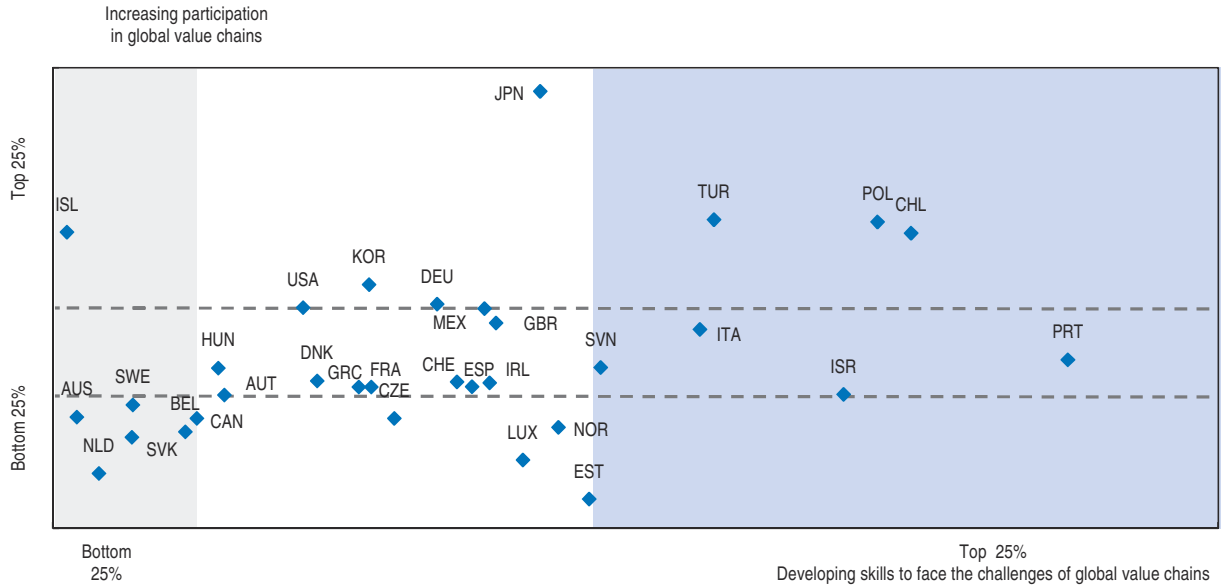
Countries are ranked according to the nine summary indicators. The scoreboard shows countries in the bottom 25%, in the top 25% and those around the OECD average (in the remaining part of the distribution). A sharp threshold has been applied and therefore, some countries can be classified in one group (e.g. the bottom 25%) but be close to the other group (e.g. average).

- In contrast, countries such as the United States and to a lesser extent Denmark and Ireland have also increased their participation in GVCs but have seen weak economic or social development, which may be partly explained by insufficient skills.
- Considering their populations' high skills, Finland and Japan could benefit more from participation in GVCs by deepening their specialisation in technologically advanced industries, and by increasing productivity and employment. Policies outside the skills domain may be preventing them from realising these gains.
- While Chile and Turkey have increased their participation in GVCs a lot and have developed the skills needed to face the challenges of GVCs, they could do more to develop the skills needed in technologically advanced industries and increase their specialisation in this area.

To some extent, countries that have improved the skills of their population the most have also increased their participation in GVCs more than average (Chile, Poland and Turkey, and to some extent Japan) (Figure 1.3). However, in a group of countries, increased

Figure 1.3. **Changes in participation in global value chains and in skills**

OECD countries, 2000-15



Note: The figure shows the scoreboard indicators capturing the development of participation in GVCs over 2000-11 and the evolution of skills (Box 1.1). Countries in the upper part of the figure are among the top 25% that have increased their participation in GVCs the most while those in the lower part of the figure are among the bottom 25% that have increased their participation in GVCs the least. Countries in the right-hand side of the figure are among the top 25% that have increased their skills the most while those in the left-hand side of the figure are among the bottom 25% that have increased their skills the least. Countries in the middle of the figure are around the average.
Source: OECD calculations based on the OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237;* PISA database (2012), *www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm;* and OECD (2016), *Education at a Glance 2016: OECD Indicators*, *http://dx.doi.org/10.1787/eag-2016-en.*

StatLink http://dx.doi.org/10.1787/888933474001

participation in GVCs has not been accompanied by a similar development in skills (Korea and Germany). As these countries have good levels of skills already, it may not represent an issue at present, but it could dampen their capacity to fully realise the benefits of their participation in GVCs in the future.

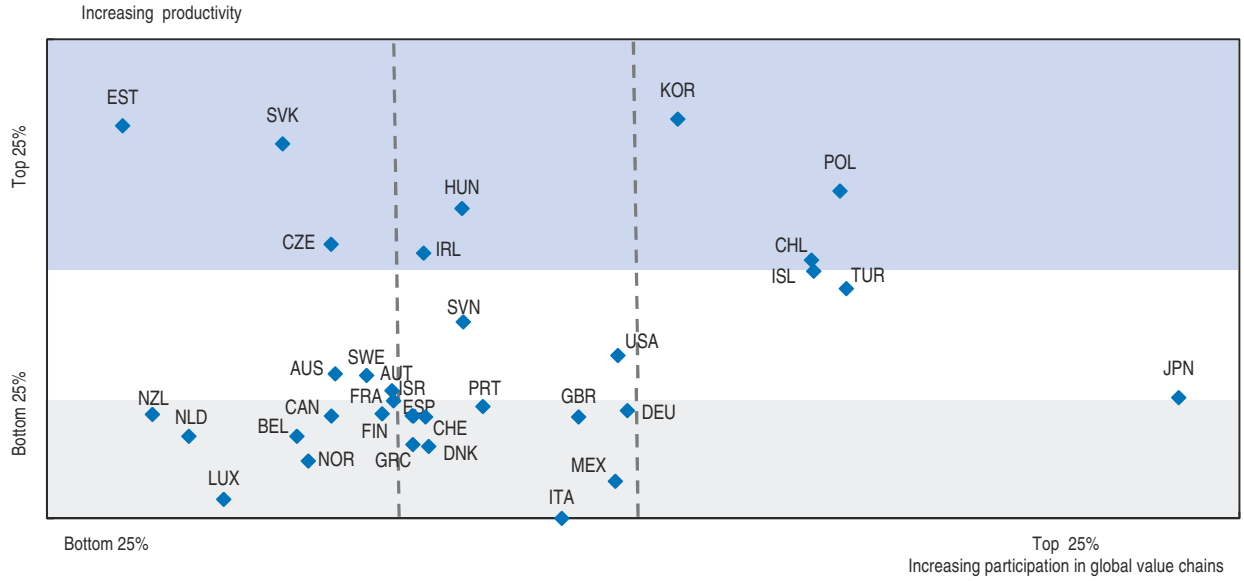
Global value chains improve productivity, especially when participation goes hand in hand with skills

GVCs offer firms and countries opportunities to increase their productivity by specialising in tasks in which they perform better. Participation in GVCs can also increase competition among firms, which can stimulate the adoption of new ways of organising work and production. Finally, the use of more sophisticated imported intermediate products can boost productivity by facilitating the diffusion of new technologies. Over the last 15 years, the OECD countries with the highest increases in participation in GVCs experienced average or above-average productivity gains (Figure 1.4). Some countries increased both their participation in GVCs and their productivity more than others (Chile, Korea and Poland).

According to new OECD estimates, countries with the largest increase in participation in GVCs over the period 1995-2011 have benefited from additional annual industry labour productivity growth ranging from 0.8 percentage points in industries that offer the smallest potential for fragmentation of production to 2.2 percentage points in those with the highest potential (Chapter 2).

Figure 1.4. **Development in participation in global value chains and in productivity**

OECD countries, 2000-15



Note: The figure shows the scoreboard indicators capturing the development of participation in GVCs over 2000-11 and the evolution of productivity, see Box 1.1. Countries in the upper part of the figure are among the top 25% that have increased productivity the most while those in the lower part of the figure are among the bottom 25% that have increased productivity the least. Countries in the right-hand side of the figure are among the top 25% that have increased their participation in GVCs the most while those in the left-hand side of the figure are among the bottom 25% that have increased their participation in GVCs the least. Countries in the middle of the figure are around the average.
Source: OECD calculations based on OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*; and OECD Productivity Database, *http://stats.oecd.org/*.

StatLink http://dx.doi.org/10.1787/888933474012

Investing in skills ensures that participation in GVCs increases productivity, because firms need workers who can learn from new technologies and who benefit from the exposure to more sophisticated goods and new work organisation. However, productivity gains will not spread to the whole economy if small firms do not have the capacity to absorb new technology and production modes, or if they remain disconnected from GVCs. Skills indicators based on the Survey of Adult Skills show that workers in small firms have lower levels of skills than those in larger firms.

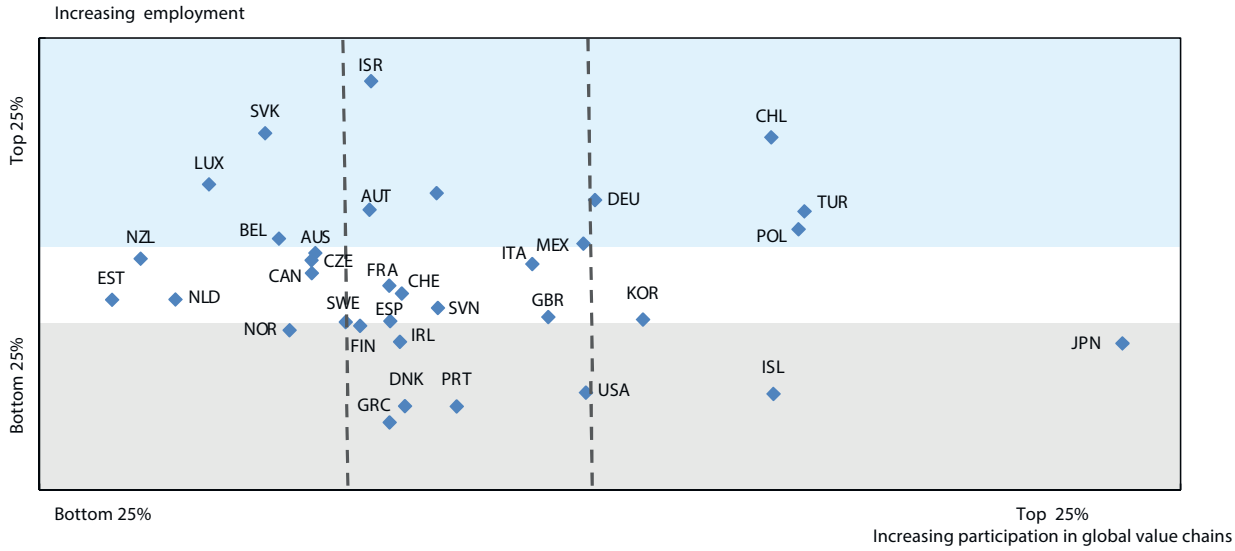
Skills act as a bolster against the potential negative impact of global value chains on social outcomes

Linking more firms to GVCs can help spread productivity gains to the whole economy. It also means that more firms, and therefore more workers, are exposed to the impacts – positive and negative – of GVCs on employment and wages.

The implications of participation in GVCs for employment remain to be fully understood. Recent studies show that import competition from low-cost countries such as China has led to a fall in employment, especially in the manufacturing sector (Autor, Dorn and Hanson, 2015). However, competition from low-cost countries is only one aspect of GVCs. OECD countries import intermediates from high-tech manufacturing industries and business services but also export these products to other countries, which creates new employment opportunities. Among countries that have increased their participation in GVCs the most, some countries had the largest employment growth (Chile, Germany, Turkey and Poland), while others had the lowest (Iceland, Japan and the United States) (Figure 1.5).

Figure 1.5. **Development in participation in global value chains and in employment**

OECD countries, 2000-15



Note: The figure shows the scoreboard indicators capturing changes in participation in GVCs over 2000-11 and the evolution of employment, see Box 1.1. Countries in the upper part of the figure are among the top 25% that have increased employment the most while those in the lower part of the figure are among the bottom 25% that have increased employment the least. Countries in the right-hand side of the figure are among the top 25% that have increased their participation in GVCs the most while those in the left-hand side of the figure are among the bottom 25% that have increased their participation in GVCs the least. Countries in the middle of the figure are around the average.

Source: OECD calculations based on OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237;* OECD Employment database, *www.oecd.org/employment/emp/onlineoecdemploymentdatabase.htm*; and OECD STAN STructural ANalysis Database, *http://stats.oecd.org/*.

StatLink *http://dx.doi.org/10.1787/888933474023*

The impact of participation in GVCs on inequalities within countries also remains debated. Most studies conclude that skill-biased technological change and institutions are the major determinants of inequalities while competition from low-cost countries plays a smaller role. But GVCs create inequalities of opportunity: some high-skilled workers and those with jobs involving non-routine tasks can apply their skills all around the world while those whose jobs can be offshored face a rise in competition.

Countries can reduce workers' exposure to the risk of offshoring by investing in the development of skills. What people do on the job, and thereby the type of skills they develop, strongly influences the exposure of their jobs to the risk of offshoring. Jobs that involve face-to-face interactions, the need to be on-site, and decision making are less easy to offshore. When workers have the necessary skills, they can help their jobs evolve or find it easier to adapt to changing needs.

Participation in GVCs can also affect job quality, by intensifying competition, exposing workers to new standards and work organisation settings, raising the demand for quality and shortening production times. In all countries, more educated workers enjoy higher job quality than low-educated ones. But the gap in job strain between low-educated and high-educated workers is larger in countries that participate more in GVCs (Estonia, Hungary, Poland and Slovenia). Investing in skills along with increasing participation in GVCs is particularly important in developing economies that tend to be at the lower end of value chains, where working conditions are more often poor.

Countries increasingly compete through their skills

A more educated labour force has enabled many OECD countries to specialise in technologically advanced industries, in both the manufacturing and services sectors. Countries' specialisation within GVCs can be gauged via their revealed comparative advantages (RCAs), which indicate the extent to which a country receives a bigger part of its overall GVC income from adding value in the production of an industry than other countries. Over the last 15 years, OECD countries have been increasingly specialising in services and in high-tech manufacturing industries.

However, the comparative advantage that many OECD countries used to derive from the higher education level of their population is shrinking as tertiary education develops in many developing and emerging economies. By 2040, the share of the population with tertiary education in China will approximate the share in European OECD countries but will remain below the share in Japan and the United States (Barro and Lee, 2013). By 2040, around two-thirds of young people with tertiary education will come from non-OECD G20 countries (OECD, 2015).

At the same time, it has become less costly for firms to tap into the international pool of skills. With the fragmentation of production, firms can use workers from abroad without moving the whole production chain. This has increased competition between highly educated individuals.

Countries and individuals increasingly compete through their skills, not only through their level of education. Countries can gain comparative advantages in technologically advanced industries through the characteristics of their skills, how well these skills match industry requirements, and their overall capacity to make the most of these skills pools.

Cognitive skills and readiness to learn are crucial for performance in global value chains…

Skills in all their diversity are a fundamental determinant of economic and social success. While there is no broad agreement on a typology of skills, skills that matter for job performance can be considered as a continuum, with some skills having mostly a cognitive component (e.g. literacy and numeracy), some mostly linked to personality traits (e.g. conscientiousness and emotional stability), and others arising from the interaction and combination of these two components (e.g. communicating, managing and self-organising).

The Survey of Adult Skills provides a broad range of information on the skills composition of the population and the tasks performed on the job, which can be used to measure some of the skills that have been identified as important for workers' and firms' performance. This survey directly assesses three domains of cognitive skills (numeracy, literacy and problem solving in technology-rich environments) through administered tests. In addition, the large set of information on frequency of performance of several tasks at work and on attitudes towards learning sheds light on six other skills domains: information and communications technologies (ICT) skills; management and communication skills; self-organisation skills; marketing and accounting skills; science, technology, engineering and mathematics (STEM) skills; and readiness to learn.

Analysis of this information shows that workers' cognitive skills and readiness to learn play a fundamental role in international integration as workers need them to share and assimilate new knowledge, allowing countries to participate and grow in evolving markets. Literacy, numeracy, problem solving in technology-rich environments and readiness to learn

all tend to be stronger where exports are stronger, even more so when exports are expressed in value added terms, with cognitive skills having the strongest links.

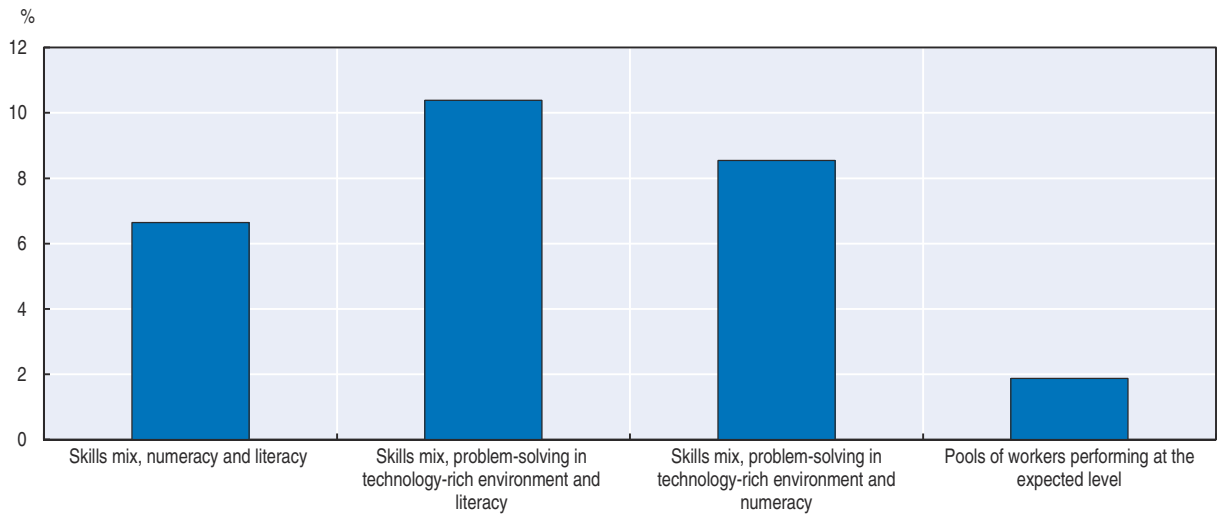
... but countries have to equip their populations with strong skills mixes

Strong cognitive skills are not enough on their own to achieve good performance in GVCs and to specialise in technologically advanced industries. Industries involve the performance of several types of tasks, but all require social and emotional skills as well as cognitive skills. To succeed in an internationally competitive environment, countries and industries need skills in addition to those related to their domain of specialisation.

To perform well in an industry, workers need to have the right mix of skills. According to new OECD estimates, differences in countries' capacity to endow the population with the right skills mix can lead to differences in relative exports of around 8% between two countries with average differences in their skills mixes (Figure 1.6) and of up to 60% between two countries with large differences. In particular, several high-tech manufacturing industries and complex business services are found to require strong skills in problem solving in technology-rich environments, and those with these skills need to also have strong numeracy and literacy skills. The countries with the strongest alignment of the mix of skills with these industries' skills requirements are Canada, Estonia, Israel, Korea and Sweden.

Figure 1.6. **The effect of countries' skills characteristics on specialisation within global value chains**

Change in exports (in value added terms)



Note: Change in exports (in value added terms) in an industry relative to another industry (which has one standard deviation lower industry intensity) resulting from a marginal change (one standard deviation) in each of the four countries' skills characteristics. When countries with large differences in their skills characteristics are considered, these effects reach 60% for the skills mix and 10% for pools of workers performing at the expected level. These effects come from empirical work developed in Chapter 3.

Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis*; OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*; OECD (Annual National Accounts, SNA93, *http://stats.oecd.org/*; OECD STAN STructural ANalysis Database, *http://stats.oecd.org/*; Mayer and Zignago (2011), "Notes on CEPII's distances measures: the GeoDist Database", *CEPII Working Paper 2011-25*; World Input-Output Database (WIOD), *www.wiod.org/home*.

StatLink *http://dx.doi.org/10.1787/888933474032*

Equipping individuals with strong skills mixes is not the same as having groups of individuals who are strong in just one type of skill. Even those who are specialised in one area, for instance in STEM skills, need to have complementary skills.

Specialisation in technologically advanced industries requires pools of workers who perform at the expected level

High-tech manufacturing and complex business service industries require all workers to perform at the expected level, because they involve long sequences of tasks and poor performance in any task can greatly reduce the value of output (Chapter 3). In contrast, industries that are less technologically sophisticated generally involve shorter sequences of tasks. Poor performance in some tasks can be mitigated by superior performance in others.

Pools of workers performing at the expected level (or reliable workers) emerge in countries in which individuals with similar characteristics – including educational attainment – have similar skills. In such cases, employers who have selected applicants on the basis of observable characteristics do not receive any unwelcome surprises from workers' actual skills. According to new OECD estimates, for instance, Japan – which has a small skills dispersion of individuals with similar characteristics – can export in value-added terms around 20% more than Chile and 10% more than Spain in high-tech manufacturing and complex business service industries relative to other industries. Differences in relative exports between two countries with average differences in their skills dispersion reach 2% (Figure 1.6).

As OECD countries progressively lose the comparative advantage that they receive from the higher level of education of their populations, they can seek to gain comparative advantages from their capacity to provide pools of reliable workers:

- The Czech Republic, Japan, the Netherlands and the Slovak Republic show a small dispersion of the skills of individuals with similar characteristics, helping them to provide pools of workers performing at the expected level.
- Canada, Chile, Poland, Slovenia and Turkey show a large dispersion of the skills of individuals with similar characteristics. To maintain or increase their comparative advantages, these countries need to lower the skills dispersion of individuals with similar characteristics. They could achieve this goal through policies fostering equal quality across similar educational programmes, training workers who do not perform at the expected level and better signalling workers' skills.

Countries whose skills characteristics appear to be best aligned with technologically advanced industries' requirements include the Czech Republic, Estonia, Japan, Korea and New Zealand

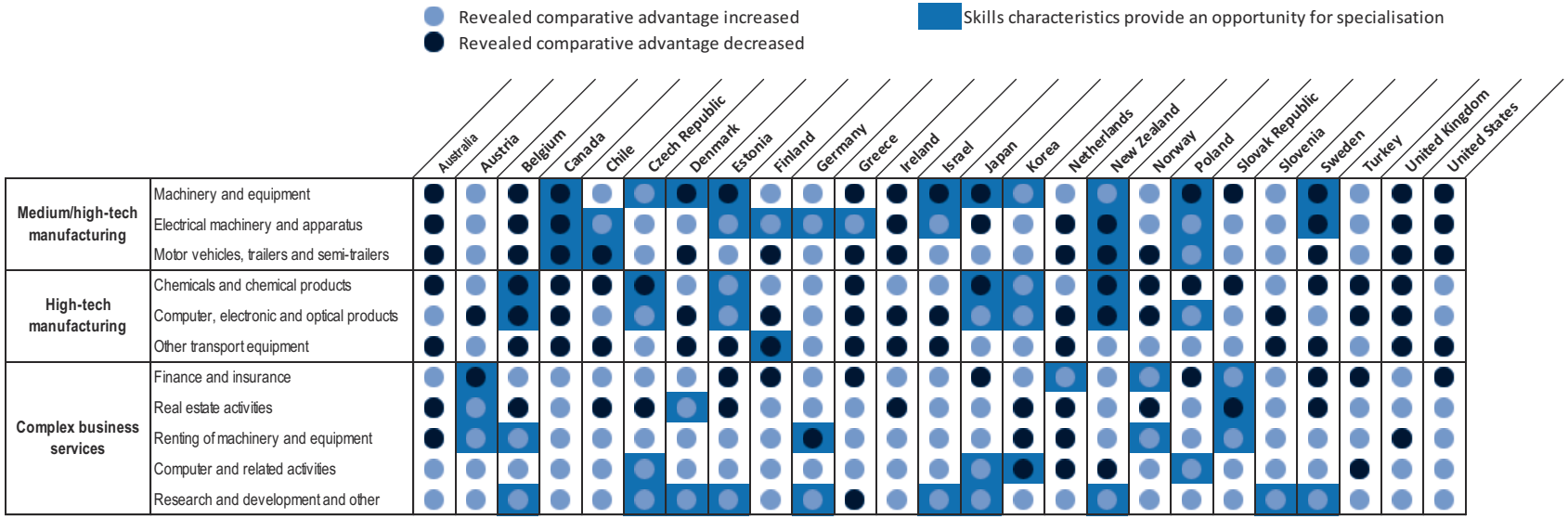
Countries can shape their specialisation in GVCs through their skills characteristics, by aligning these characteristics with industries' skills requirements. Policies to support a specific industry can be inefficient if countries' skills do not match the skills requirements of the industry, and by misallocating skills they can lower the comparative advantage countries have in other industries.

Many OECD countries strive to excel in technologically advanced sectors, but the specialisation pathways for some countries would require more effort and take longer depending on their current production structure, skills characteristics and other countries' comparative advantages in these industries. Table 1.2 shows whether countries have increased or decreased their specialisation in technologically advanced industries and whether their skills characteristics offer them opportunities to specialise in these industries:

- Some countries (the Czech Republic, Estonia, Japan, Korea and New Zealand) have increased their specialisation in technologically advanced industries, and in most cases, this is

Table 1.2. **Specialisation opportunities in technologically advanced industries**

Coming from the alignment of countries' skills characteristics with industries' skills requirements



Note: Revealed comparative advantages show the extent to which a country is specialised in a certain industry within GVCs (or receives more income from its exports in this industry than other countries). The dots in the table show whether countries have increased or decreased their revealed comparative advantages over the period 2000-11. Opportunities for specialisation are the results of empirical work developed in Chapter 3. Countries have an opportunity to specialise in an industry if there is a good alignment of countries' skills characteristics with the skills requirements of this industry. Several characteristics of skills shape countries' specialisation in GVCs. The extent to which these characteristics are aligned with each industry's skills requirement can be consolidated into one measure showing the specialisation opportunities of each country in each industry.

Source: OECD calculations based on OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237;* and the Survey of Adult Skills (PIAAC) (2012 and 2015), *www.oecd.org/skills/piaac/publicdataandanalysis.*

supported by their skills characteristics (e.g. Poland in some medium high-tech manufacturing industries and Korea in high-tech manufacturing industries).

- Some other countries' specialisation is not supported by their skills characteristics (e.g. the United Kingdom and the United States). To maintain their comparative advantages, these countries need to improve the skills mixes of their populations to better align them with the skills requirements of technologically advanced industries.
- Finally, some countries need to improve the alignment of their skills characteristics with technologically advanced industries' requirements if they want to increase their specialisation in these industries. Canada, Chile, Greece, Israel, Poland, Slovenia and Turkey need to achieve a stronger homogeneity in the skills of workers with similar characteristics. Australia and Ireland need to better align the skills mix of their workers with the skills requirements of these industries.

Countries need to improve the quality of their education and training systems

Countries can gain comparative advantages from their populations' skills, and thereby from the quality of their education systems. They can improve their competitiveness in GVCs by teaching all students strong cognitive and soft skills at the same time, and by developing multidisciplinarity. This requires innovative teaching strategies and flexibility in the curriculum choice in tertiary education while maintaining a strong focus on developing cognitive skills.

Countries can also do more to achieve uniform quality of education across schools and programmes. In many countries (including Chile and France), learning outcomes are strongly tied to social background. Countries in which social background influences education outcomes at the age of 15 the least (Estonia, Finland, Japan, Korea and Norway) are also those in which adults with similar characteristics have similar skills, leading to good signals to employers about workers' actual skills. The education funding system, including the way education resources are allocated, plays a vital role for achieving homogeneity in quality of otherwise similar education programmes. This is an area where many countries have to make progress.

Strong co-operation between education and training institutions and the private sector is crucial

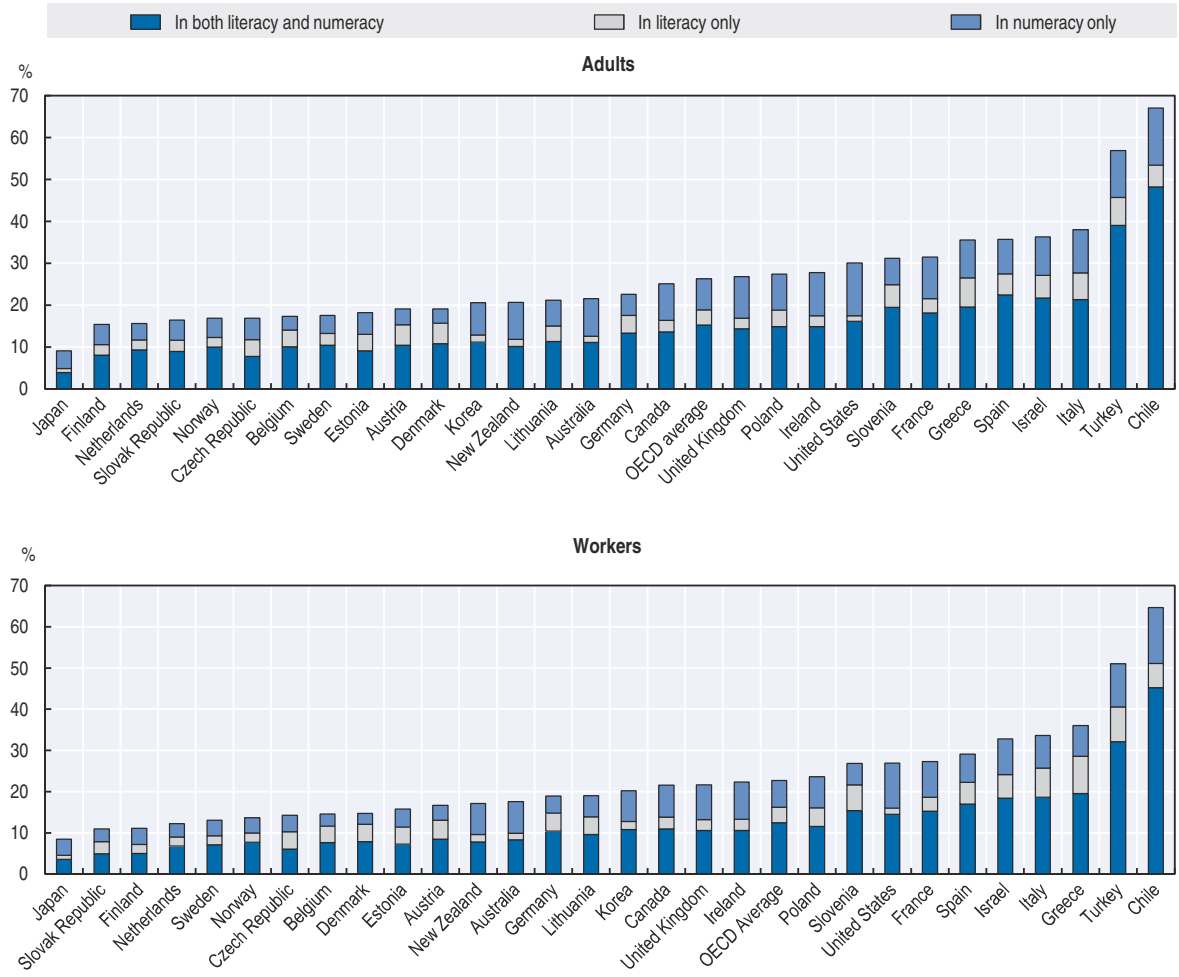
Countries can gain comparative advantages in industries if countries' skills characteristics are closely aligned with industries' skills requirements. To improve this alignment, education and training systems need to co-operate with the private sector, for example through vocational education and training with a strong work-based learning component; local initiatives to link education institutions to the private sector; and policies to foster interaction between the private sector, universities and research institutions. Such co-operation would also make young people feel better prepared and more confident of their capacity to manage their careers in an uncertain environment if they are more exposed to the world of work during their study.

As large parts of global trade are organised around supply chains of multinationals (UNCTAD, 2013), it is important for education and training systems to work with these companies to understand their skills needs. Such links can be developed by encouraging internship and work-based learning, and enabling representatives from firms involved in GVCs to share their experiences with tertiary students. Developing courses in English can also facilitate the recruitment of young graduates by firms involved in GVCs.

Countries need to work on various fronts to encourage adult education and training

Countries with a low share of low-skilled workers are not necessarily less at risk of offshoring, which depends on a country's position in GVCs: some countries might offshore mainly low-skilled activities while countries higher on the value chain might offshore activities performed by skilled workers. In either case, however, workers find it easier to make the transition to a new job if they have the ability to manage this transition and to learn the necessary new skills. Countries differ in their share of low-skilled adults (Figure 1.7). Those with a high share of low-skilled workers (Chile, Greece and Turkey) will have to make significant efforts to implement appropriate education and training policies if they want to specialise in more technologically advanced activities without unemployment expanding.

Figure 1.7. **The proportion of low performers in literacy and/or numeracy**



Note: Low performers are defined as those who score at or below Level 1 in either literacy or numeracy according to the Survey of Adult Skills. Chile, Greece, Israel, New Zealand, Slovenia and Turkey: Year of reference 2015. All other countries: Year of reference 2012. Data for Belgium refer only to Flanders and data for the United Kingdom refer to England and Northern Ireland jointly.
Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012 and 2015), *www.oecd.org/skills/piaac/publicdataandanalysis*.
StatLink *http://dx.doi.org/10.1787/888933474044*

For workers at risk of displacement, labour market programmes and effective, modern public employment services can ease the transition to new jobs. In the long term, however, policies are needed that prepare workers for a world in which skills requirements are evolving fast, by facilitating the development of skills at various phases of life.

Retraining low-skilled workers is one of the biggest challenges that many countries face. Countries have to find efficient ways to develop skills but also to break the vicious cycle between being low-skilled and not participating in adult learning. In all countries, those who are the most skilled or who are making the most intensive use of their skills are those who benefit the most from adult training programmes.

The obstacles to adult education need to be removed, by better designing the tax system to provide stronger learning incentives, easing access to formal education for adults, improving the recognition of skills acquired after initial education, and working with trade partners to develop on-the-job training opportunities and enhance flexibility in the sharing of time between work and training.

Countries can co-operate better on the design and funding of education and training programmes…

GVCs benefit from the internationalisation of tertiary education. Students from abroad with a domestic diploma might be well placed, for instance, to work in multinationals and develop activities in their countries of origin. GVCs can also stimulate the internationalisation of education by giving students opportunities to apply their skills in many countries, not only in the country where they graduated.

As GVCs spread, it becomes more complex to allocate the costs and benefits of the internationalisation of tertiary education. Developing and emerging economies see a large share of their most talented youth leave to study abroad. If they do not return, part of the initial education investment is lost. Developed economies, for their part, lose some investment in education – typically in specific vocational skills – when activities are offshored. In terms of benefits, the opportunity to study abroad may increase the incentive to invest in education at home in developing economies and those who have left may develop activities with their countries of origin through GVCs. Developed economies can enlarge the domestic pool by attracting international students.

Co-operation in the design of education programmes is a way to ensure quality, maintain knowledge in the development of skills that have been offshored but could be brought back to the domestic market tomorrow, and raise the skills in developing economies. Countries could seek agreements to co-design some education and training and consider new financing arrangements that better reflect the distribution of benefits and costs coming from the internationalisation of tertiary education and of the production process. An agreement can take various forms, from consultation on the skills needs implied by offshoring and on how they can be met, to a more formal agreement in which the costs of some education programmes can be shared and offshoring countries can help design education programmes in countries to which activities are offshored.

… and improve recognition of skills acquired informally or abroad

Improving the recognition of skills acquired abroad would help attract foreign students and foreign workers who can contribute to research, innovation and performance in an international context. And expanding recognition of skills acquired informally would help workers exposed to the risks of offshoring gain further qualifications and adapt to changing needs. In addition, it would give employers clearer signals about workers' actual skills. This can contribute to strong performance in GVCs as workers have to perform at the expected level in order not to weaken the production chain.

Policies can ensure better use of the skills pool

Developing the right skills is crucial for countries to seize the benefits of GVCs, but for these skills to materialise into good performance within GVCs, they need to be used effectively. This means ensuring that skills are allocated to the right firms and industries, and using skills effectively within firms.

Within firms, management policies can ensure good use of skills and enhance productivity. The level of education of both managers and non-managers is strongly linked to better management practices, so it is important to ensure that education and training systems develop strong mixes of skills, including entrepreneurship and management skills. Entrepreneurship education can foster awareness and knowledge of best practices for both employers and workers.

Non-compete clauses influence workers' capacities to apply their skills elsewhere. Under these clauses, employees agree not to use information learned on the job for a limited period of time. While protecting employers' intangible investments, these clauses restrict workers' mobility, can be an obstacle to structural adjustments, and limit the spread of knowledge. The use of non-compete clauses in OECD countries needs to be better understood, and it is vital to ensure they are not abused.

The allocation of skills to firms also depends on employment protection legislation. It needs to provide flexibility to firms but also security to workers, so that they have incentives to develop firm-specific skills as well as income security. Non-standard forms of employment have not yet developed much in industries exposed to GVCs but their progress needs to be monitored. While providing flexibility to firms and opportunities to workers, they may lead to underinvestment in skills development, which is crucial for maintaining international competitiveness.

A whole-of-government approach is needed

Within governments, the risks of misalignment between policies and international competitiveness objectives are large. GVCs and trade pertain to ministries with their own sets of policies outside the skills area, while the ministries in charge of most skills policies – education, research and labour – generally focus on national employment and innovation. To make the most of GVCs, a whole-of-government approach is needed.

There are two main types of misalignments of policies. Trade, tax or competition policies aimed at fostering performance in some industries may not be supported by policies ensuring that these industries have the skills they need. Or skills policies may be undermined by employment protection legislation, non-compete clauses or migration policies. For instance, education and training policies may not be able to boost performance in GVCs if migration policies prevent countries from building links with other countries in innovation networks, or if strict employment protection legislation and non-compete clause regulations hinder the needed structural changes.

To make sure that policies across government are aligned in favour of improving performance in GVCs, all of those involved should consult with the aim of reaching a holistic understanding of: i) their country's current positioning in GVCs; ii) the strengths and weaknesses of skills policies, and of other types of policies affecting countries' performance in GVCs; and iii) the potential opportunities for further specialisation. This kind of whole-of-government approach requires moving beyond a short-term policy

response to the challenges posed by this new phase of globalisation. In a world that faces major transformations such as globalisation and digitalisation, it is crucial to adopt long-term responses.

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Chapter 2

Skills and global value chains: What are the stakes?

This chapter explores how investing in skills and knowledge can increase country's ability to make the most of global value chains (GVCs), socially and economically. It shows how GVCs have developed and the extent to which countries vary in their participation in these chains; examines the benefits that participation in GVCs can have for productivity growth, especially when it goes hand in hand with investment in skills; shows how participation in GVCs can affect employment and inequalities; outlines the characteristics that expose jobs to the risk of offshoring and the implications for workers' skills; and investigates how participation in GVCs affects job quality and how stronger skills and better education can translate participation in GVCs into better jobs.

Over the last two decades, international patterns of production and trade have changed, leading to a new phase of globalisation. Each country's ability to make the most of this new era, socially and economically, depends heavily on how it invests in the skills of its citizens.

In this new phase of globalisation, production is increasingly fragmented, with different stages of production dispersed among different suppliers in different countries, to form global value chains (GVCs). This fragmentation has increased trade in intermediate goods and services – semi-finished inputs, or components, of the final product or service. Countries now specialise in tasks rather than in specific products.

This growing interconnectedness of economies presents countries with opportunities and challenges, many of which affect or are affected by the skills of the population. GVCs intensify competition worldwide, forcing firms to become more productive. Trade in intermediate goods and services that incorporate technology fosters the spread of knowledge, as it requires workers who are skilled in learning from new technologies. GVCs lead to reallocation of tasks and jobs as companies relocate or outsource processes, making some skills less or more needed. They also reshape international investment, as multinationals account for an increasing share of global trade.

Globalisation is generally thought to strengthen economic growth and welfare, especially when accompanied by rising educational attainment, as has been the case over the past few decades. However, today it is facing strong headwinds – productivity has slowed, inequalities have risen and high unemployment rates have persisted in many countries (OECD, 2015a; OECD, 2016a). More and more people are concerned about the consequences of the intensification of globalisation. One of the major challenges for governments is to understand how investing in skills and knowledge can increase countries' competitiveness in GVCs with the objective of moving to higher value-added activities and improving job quality.

This chapter aims at shedding light on this challenge by investigating the links between GVCs, productivity, inequality and job quality. It investigates how skills can shield individuals and firms from harm that globalisation might cause and help countries derive the greatest advantage from GVCs. In particular, this chapter:

- Shows how GVCs have developed and the extent to which countries vary in their participation in these chains.
- Examines the benefits that participation in GVCs can have for productivity growth, especially when it goes hand in hand with investment in skills.
- Shows how global value chains have increased the share of employment exposed to global trade and how participation in GVCs can affect jobs and inequalities.
- Outlines the characteristics that expose jobs to the risk of being relocated to other countries (offshoring) and the implications for workers' skills.
- Investigates how participation in GVCs affects job quality and how stronger skills and better education can translate participation in GVCs into better jobs.

The main findings in this chapter include:

- Participation in GVCs has increased significantly in many countries over the last two decades. On average, 30% of the value of exports of OECD countries now comes from abroad. In many OECD countries, up to one-third of jobs in the business sector depend on foreign demand.
- GVCs can improve productivity. Countries with the largest increase in participation in GVCs over the period 1995-2011 have benefited from additional annual industry labour productivity growth ranging from 0.8 percentage points in industries that offer the smallest potential for fragmentation of the production process to 2.2 percentage points in those with the highest potential.
- Investing in skills ensures that participation in GVCs increases productivity, because firms need workers who can learn from new technologies. This is particularly important for small and medium-sized firms that are lagging behind in terms of productivity growth.
- The effects of global value chains on employment and inequalities are difficult to assess:
  - Import competition from low-cost countries such as China has led to a fall in employment, especially in the manufacturing sector. However, competition from low-cost countries, which mainly affects low-skilled jobs, is only one aspect of GVCs. OECD countries import business services and intermediates from high-tech manufacturing industries but also export these products, making it difficult to gauge the overall employment effect.
  - There is no clear relationship between participation in GVCs and inequalities within countries. Skill-biased technological change – which favours skilled over unskilled workers – and institutions are important determinants of inequalities while competition from low-cost countries seems to play a smaller role.
- While GVCs do not appear to be the main driver of employment and inequality, some characteristics of jobs make them more likely to be relocated offshore, such as routine task content and lack of face-to-face contact. Investing in skills makes workers less exposed to the risk of losing their jobs because of offshoring.
- Investing in skills can also limit the risks that participation in GVCs leads to lower job quality, especially in the form of higher job strain for low-skilled workers. In both emerging economies and developed countries, job quality increases substantially as educational attainment improves.

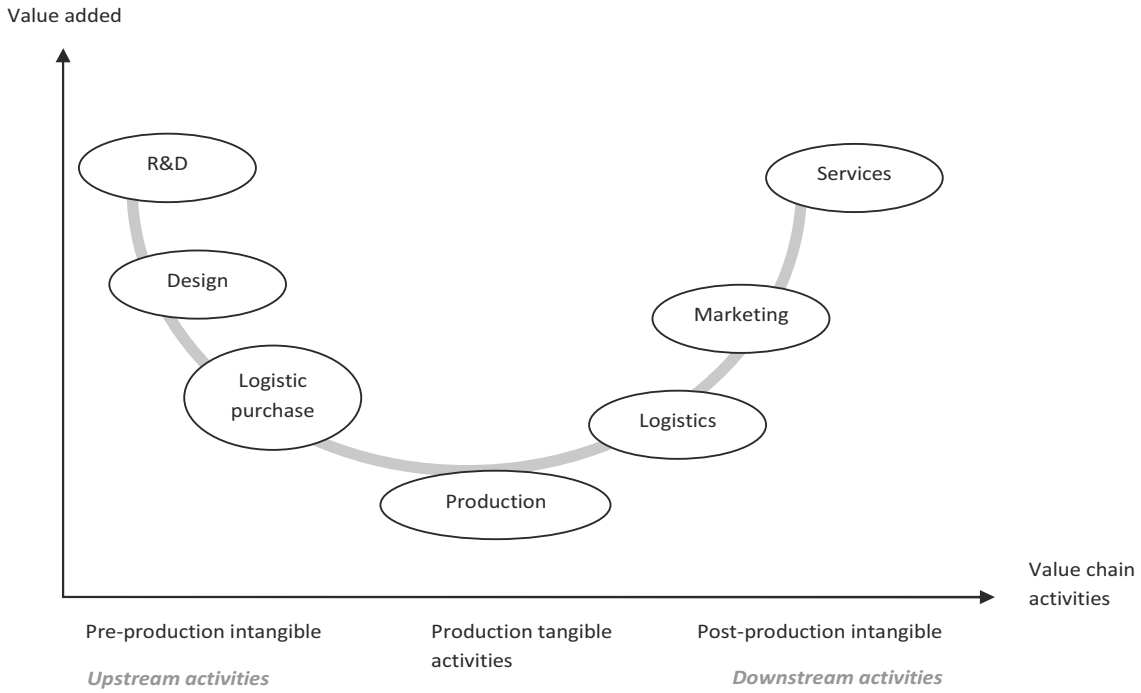
Countries' involvement in global value chains: facts and trends

Measuring the development of global value chains

Over the last two decades, digitalisation, decreasing trade barriers, and the search for efficiency gains have led countries to specialise in activities that create as much value as possible and to offshore other activities. The production process has become increasingly fragmented among different countries, while trade in intermediate goods and services has expanded, leading to the development of GVCs.

Each stage in the production process has a different potential to add value. This difference is often presented as a "smiling curve" (Figure 2.1). While this curve does not capture the complexity of the organisation of the production process in GVCs, it can help illustrate what is meant by GVCs. The smiling curve was originally proposed by Stan Shih,

Figure 2.1. **The smiling curve: Value added along the global value chain**



Source: OECD (2013), *Interconnected Economies: Benefiting From Global Value Chains*, *http://dx.doi.org/10.1787/9789264189560-en*.

the founder of Acer, an information technology (IT) company, to illustrate the problems of IT manufacturers in Chinese Taipei, which found itself locked along the bottom of the curve (Shih, 1996).

According to the smiling curve, in many activities the most value is typically added in either upstream activities, such as the development of a new concept, research and development (R&D) and the manufacturing of key components, or downstream activities, such as marketing, branding and customer service. In-between activities, such as product assembly, add the lowest share of value along the supply chain. These activities tend to be offshored to emerging and developing economies.

The emergence of GVCs has pushed forward the development of value-added measures of trade. As inputs pass through value chains, they cross borders many times, which means that exports in gross terms overstate the amount of domestic value added in exports. In addition, gross trade statistics give a distorted picture of the importance of trade for economic growth and income, as countries with final producers appear to be capturing most of the value of goods and services traded, even though these exports may depend on significant imports (Johnson, 2014). The OECD Trade in Value Added (TiVA) database measures the origin of value added embodied in exports, making it possible to distinguish between foreign and domestic value added content of exports (Box 2.1).

The value added of gross exports can be separated into: i) the domestic value added of gross exports and ii) the foreign value added coming from the use of foreign intermediates in a country's exports. The use of foreign intermediates in exports includes the offshoring of activities to other countries but is a broader concept than offshoring, as some activities may have always been done in another country and not just recently relocated. In recent decades, the share of domestic value added in exports in the manufacturing sector has

Box 2.1. **The OECD Trade in Value Added database**

The OECD Trade in Value Added (TiVA) database measures the origin of value added embodied in any goods or services exported. In doing so, it addresses the issue of double counting of value added that is implicit in reported gross trade flows. The TiVA framework can reveal the global origins of the cumulative value added present in final goods and services consumed by households, government and businesses. Accounting for trade in value added (especially trade in intermediate parts and components) redistributes surpluses and deficits across partner countries while leaving the overall trade balances of countries with the rest of the world unchanged

The TiVA database based on the October 2015 update of the OECD Inter-Country Input-Output (ICIO) tables covers 61 countries, 34 industries and 7 years (1995, 2000, 2005 and all years between 2008 and 2011). Constructing a global input-output table presents many challenges, and entails making several assumptions, as well as reconciling and balancing data. This means that some care is needed in interpreting results, especially given the aggregate nature of the underlying input-output table. All indicators presented in this chapter are estimates of some aspects of GVCs and thereby should be interpreted with care.

The TiVA database reveals new insights into global interconnectedness and bilateral relationships. It captures the degree of fragmentation of trade, the value added exported by countries and industries, and the interconnections between countries arising from trade. The database is a rich source of information on the development of GVCs and the extent to which countries and industries are integrated into GVCs.

Source: OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*.

declined in many economies while trade in intermediates has increased (Johnson and Noguera, 2012). This trend reflects the growing role of GVCs in trade flows. Now, more than half of world trade in manufacturing goods consists of intermediate goods and more than 70% of trade in services involves intermediate services.

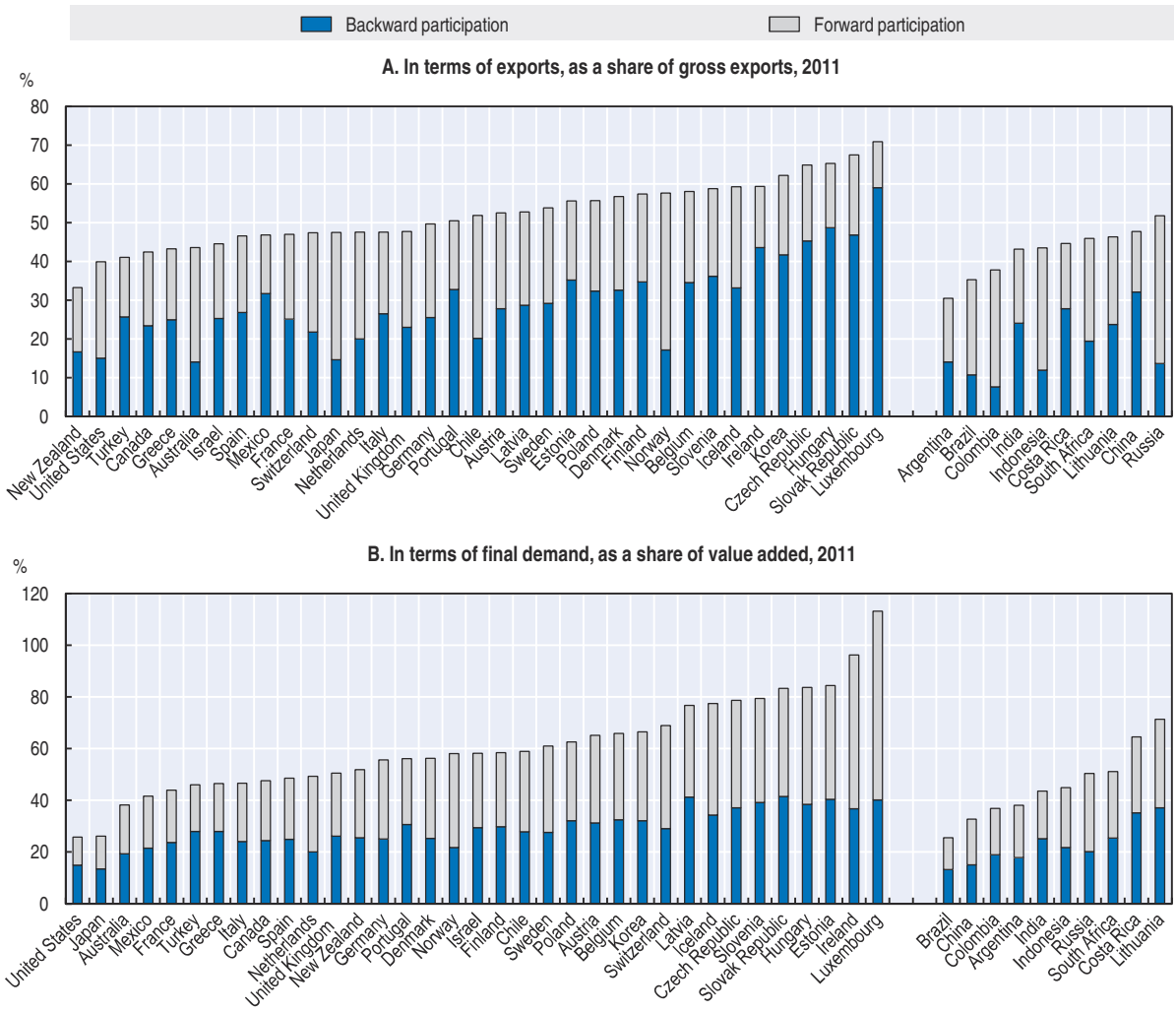
How countries participate in global value chains

Participation in GVCs takes two main forms: i) importing foreign inputs for exports or *backward participation;* and ii) producing inputs used in third countries' exports, or *forward participation*. Participation in GVCs is generally assessed through a participation index by looking at its two forms as a share of countries' exports or of foreign final demand.

Countries vary greatly in terms of their participation in GVCs (Figure 2.2, Panel A) because of their economic structure and other characteristics (De Backer and Miroudot, 2013; Johnson and Noguera, 2012; UNCTAD, 2013). Such characteristics include:

- **Size of the economy.** Large economies such as Japan and the United States have larger internal value chains and rely less on foreign inputs than smaller economies, such as Luxembourg. However, much depends on the ability of the domestic market to provide the required intermediate inputs, as well as the nature of the country's engagement in GVCs. China, for example, has large backward linkages reflecting its significant (albeit declining) share of processing activities.
- **Composition of exports.** Countries with a high share of natural resources in their exports have a higher share of domestic value added in their exports. Also, countries that have a high share of both upstream and downstream services in their exports tend to add more

Figure 2.2. **Participation in global value chains across countries**



Note: Forward and backward participation in terms of final demand are respectively the domestic value added embodied in foreign final demand and the foreign value added embodied in domestic final demand divided by countries' value added.

Source: OECD calculations based on OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*.

StatLink *http://dx.doi.org/10.1787/888933474056*

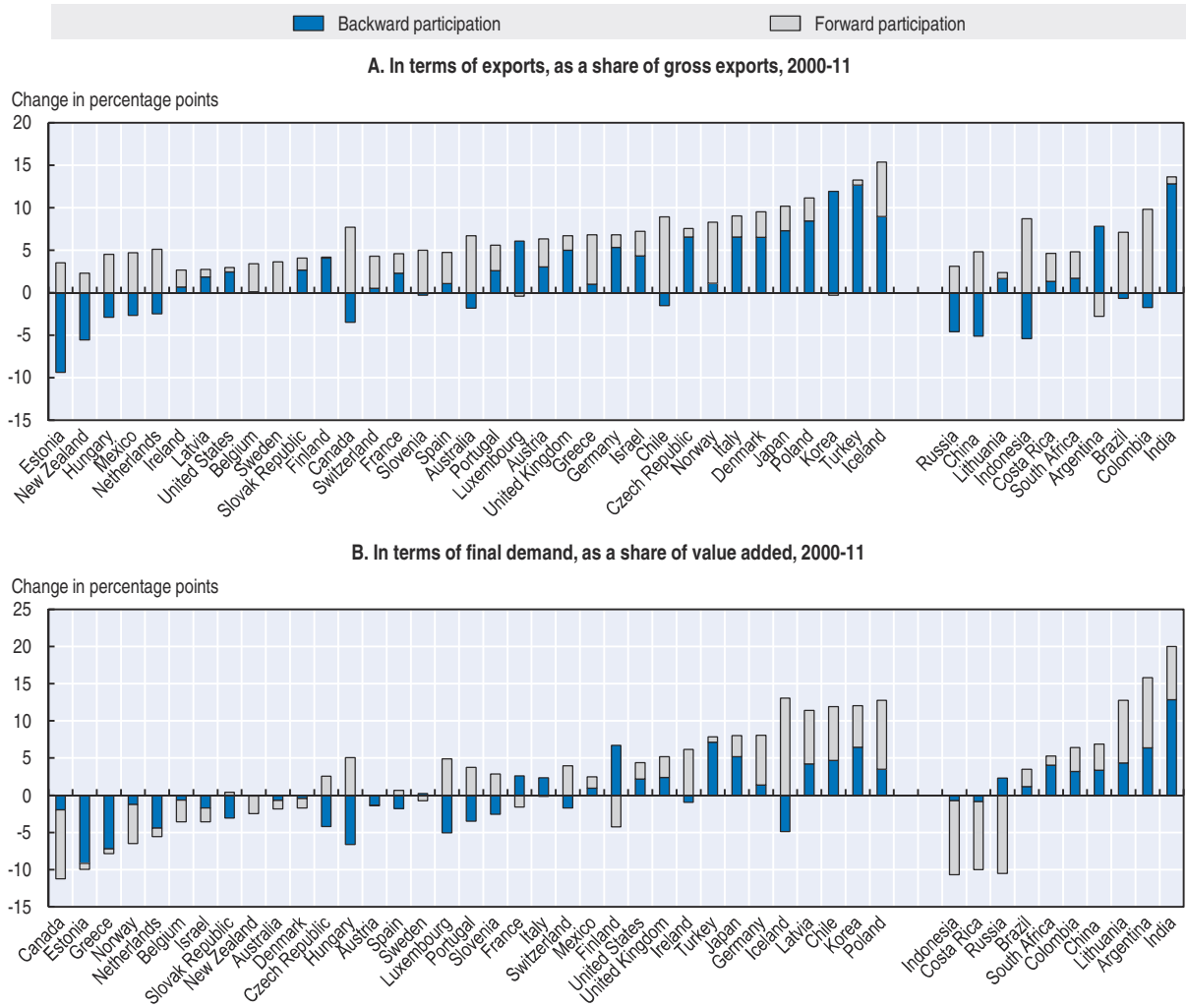
value. Overall, positioning in GVCs (Figure 2.1) influences the share of domestic value added in exports. Countries at the beginning of the value chain (exports of raw materials and R&D services) and at the end of the chain (exports of logistics and after-sales services, like the United States) tend to have a higher share of domestic value added in their exports. Countries that export value added in highly fragmented industries, such as Germany, have a higher share of foreign intermediates in their exports. Countries such as Australia, Japan, and Norway have strong forward participation as they export intermediate products that are used in the exports of third countries.

- **Economic structure and export model.** Countries with a higher share of foreign value added include those specialised in the assembly of intermediate inputs from various countries for consumption in third markets and those with significant shares of entrepôt trade. An entrepôt is a transhipment port where merchandise may be imported, stored or traded, usually to be exported again.

Participation in GVCs can also be assessed in terms of final demand (Figure 2.2, Panel B), or the extent to which countries are connected to final consumers in other countries where no direct trade relationship exists. A country can export products that reach final consumers through the export of third countries (forward participation). A country can also be connected to other countries through the use of foreign inputs that end up in domestic final demand (backward participation). Forward participation tends to be higher in terms of final demand than in terms of exports in OECD countries, reflecting their leading role in exporting value added that reaches final demand. The opposite holds for non-OECD countries.

In the last two decades, most countries have increased their participation in GVCs (Figure 2.3). Many countries have offshored activities in certain industries to increase their specialisation in other activities (Johnson and Noguera, 2012; Timmer et al., 2014; Chapter 3). A group of countries, including Japan, Ireland, Poland, Latvia and Lithuania, have increased their outreach to final consumers through forward participation.

Figure 2.3. **Change in participation in global value chains across countries**



Source: OECD calculations based on OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*.

StatLink *http://dx.doi.org/10.1787/888933474067*

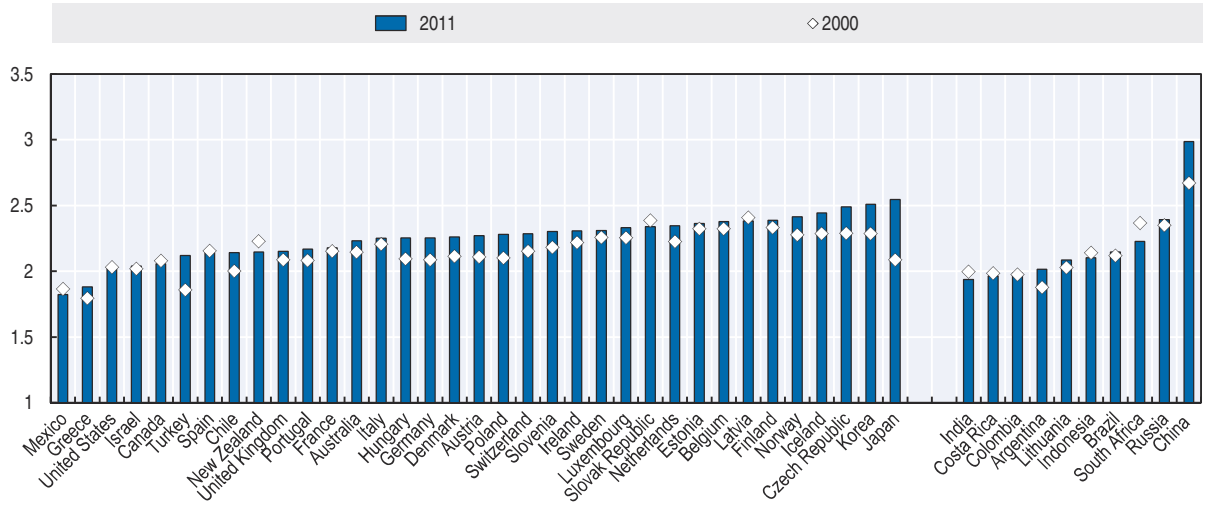
Several misguided ideas exist about what countries should aim to achieve in relation to GVCs. One is that raising participation in GVCs could be an objective per se. The participation index reflects the nature of participation in GVCs, the influence of several inherited factors and, in the end, simply the extent to which countries' exports are integrated in an internationally fragmented production network. Another is that countries should aim to increase the domestic value added share in their exports (or limit backward participation), as the foreign value added part measures the extent to which the contribution of exports to gross domestic product (GDP) is absorbed by other countries in the value chain. However, this accounting does not capture the indirect gains of participation. Backward participation enables countries to specialise in the most productive activities, to achieve gains from declining costs of intermediate goods and services, and to benefit from technology transfer through the use of inputs with high technology content (see next section).

Countries' positioning in global value chains

Several indicators measure the positioning and specialisation of countries within GVCs. Countries can be located upstream at the beginning of the value chain, in activities such as producing raw materials or intangibles (research and design), or downstream at the end of the value chain in activities such as assembling processed products, logistics and customer services. The "distance to final demand" indicator measures how many stages of production are left before goods or services reach final demand (De Backer and Miroudot, 2013; Figure 2.4). Some economies, such as the United States, are generally located downstream, as they specialise in activities close to final consumption such as marketing and sales. By contrast, Japan and Korea are located upstream, as they provide other countries with high-tech components before the assembly phase.

In many countries, the average distance to final demand has increased because chains have lengthened as production has become more fragmented. Countries in which the distance has increased the most may have moved downstream.

Figure 2.4. **Average distance to final demand across industries**



Note: The distance to final demand indicator measures how many stages of production are left before the goods or services produced reach final demand. Average distance across industries to final demand in industries excluding agriculture, hunting, forestry and fishing; mining and quarrying; private households with employed persons.

Source: OECD calculations based on OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*.

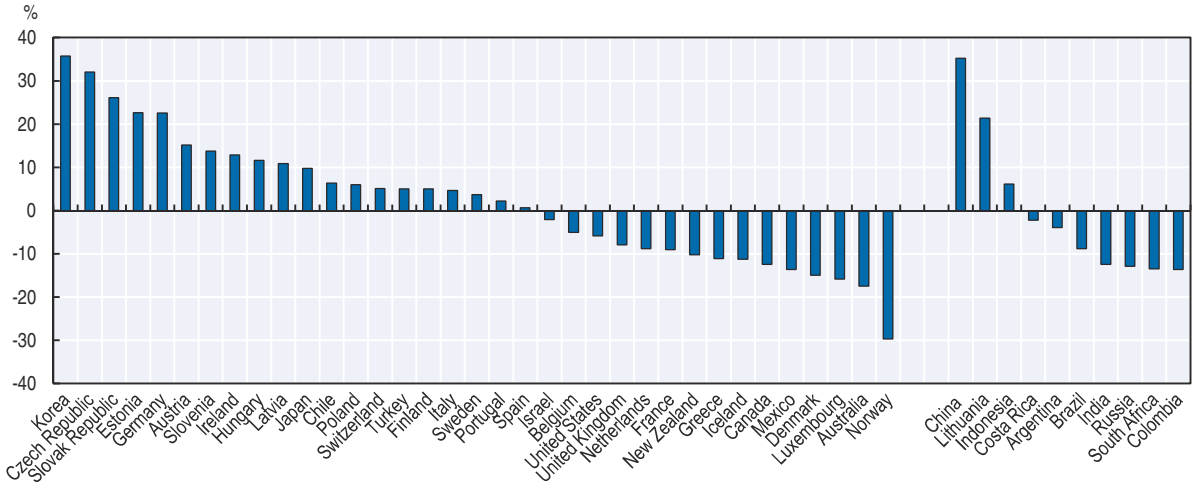
StatLink *http://dx.doi.org/10.1787/888933474072*

The distance to final demand indicator does not fully describe how countries are positioned in GVCs and how this positioning has evolved. For instance, the United States tends to control upstream activities such as design as well as downstream activities such as sales, but only the downstream aspect is reflected by the distance to final demand. "Factory-less" goods producers, which design and co-ordinate the production process of manufacturing goods, are engaged in both upstream and downstream activities, but input-output tables typically bundle these into one downstream activity (Bernard and Fort, 2013).

The income generated by GVCs is unevenly distributed among countries. One way of estimating how well countries perform in GVCs is to look at their income generation within GVCs as related to their size (Figure 2.5). Half of the OECD countries generate larger shares of income within GVCs than their relative size. The leading emerging economies, except China and Indonesia, contribute to a smaller share of income within GVCs than their relative size.

Figure 2.5. **The distribution of income generated by global value chains across countries**

Average global value chains income share across industries relative to the size of the economy, 2011



Note: Average GVC income share in industries (country GVC income divided by world's GVC income per industry) excluding Agriculture, hunting, forestry and fishing; Mining and quarrying; and Private households with employed persons. Income shares are divided by countries' value added share in total value added. Countries above (below) the horizontal axis have on average a larger (smaller) share of GVC income than their average value added share.

Source: OECD calculations based on OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*.

StatLink *http://dx.doi.org/10.1787/888933474084*

Global value chains, productivity, employment and inequality

How can global value chains increase productivity?

By specialising in tasks in which they have a comparative advantage, companies and countries can increase their productivity. If firms can relocate the less efficient parts of their production process to countries that can carry out these tasks more cheaply, they can expand their output in more efficient production stages (Antras and Rossi-Hansberg, 2009). This so-called "unbundling" of production, or the offshoring of both manufactured and service-based inputs, has been shown to be equivalent to a technological improvement.

In the United States, for instance, service offshoring in the manufacturing sector has accounted for around 10% of labour productivity growth between 1992 and 2000 (Amiti and Wei, 2006). By trading tasks or unbundling production, firms can enjoy the productivity

benefits of worker specialisation without sacrificing the gains from locating production in the most cost-effective location (Grossman and Rossi-Hansberg, 2008).

Participation in GVCs increases competition among firms, leading to the reallocation of workers and capital towards the most productive firms. Trade increases the minimum productivity level that is required for firms to survive in the market (Melitz, 2003). As a result, only the most productive firms enter the export market. Less productive firms continue to produce only for the domestic market, while the least productive firms are forced to exit. The reallocation of resources towards the most productive firms contributes to an aggregate productivity gain. The increased competition arising from trade is expected to be exacerbated by GVCs, as firms and countries now compete in terms of tasks as well as in terms of products. The possibility of offshoring activities can also increase competition.

International trade and foreign direct investment (FDI) are major channels of technology diffusion among countries (Keller, 2004). Imports are a significant channel of technology diffusion, but the evidence is weaker that firms learn about foreign technology through exporting – for example, through foreign customers imposing higher standards on exporting firms.

In theory, FDI is a channel for technology diffusion, as technology is supposed to be shared among the multinational parent and its subsidiaries. Most recent studies do tend to find that FDI aids the diffusion of technology (Keller, 2004; Javorcik, 2014), but the empirical evidence for such FDI spillovers is mixed. In addition, the diffusion of technology is only one of the spillover effects of FDI, which also include the transfer of tacit knowledge, know-how, management techniques and marketing strategies within multinationals.

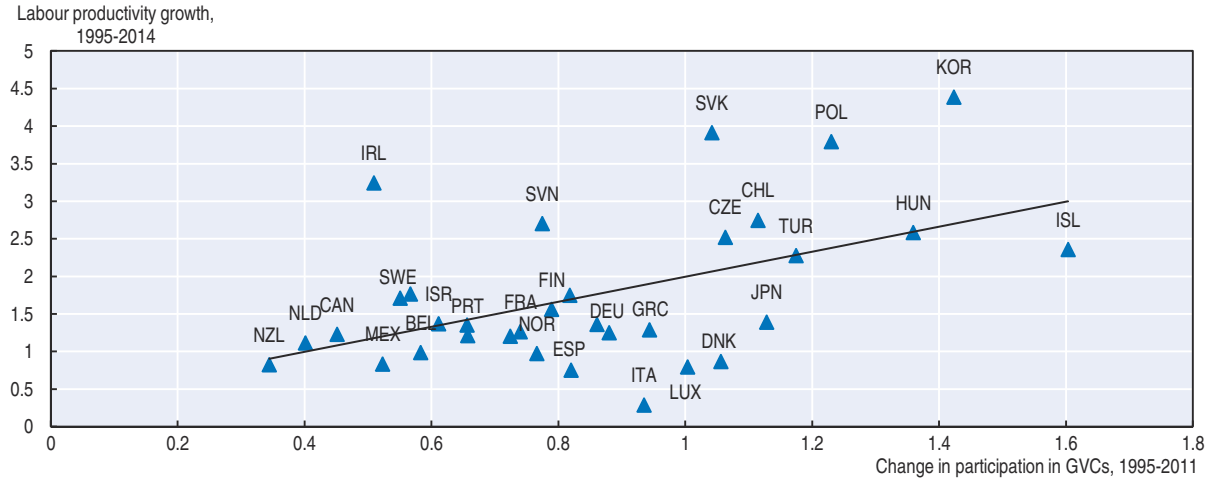
Assessing the impact of participation in global value chains on productivity growth

In recent decades, countries' integration into GVCs has increased substantially overall, but productivity has slowed down in most OECD countries (OECD, 2016a). Simple correlations suggest that countries that have increased their participation in GVCs a lot over the period 1995-2011 also had stronger labour productivity growth (Figure 2.6). These correlations have to be interpreted carefully, however, as the links between productivity and GVCs run in both directions. Firms with high productivity that face low international transport costs tend to choose exporting and importing (Baldwin and Yan, 2014; Kasahara and Lapham, 2013; Melitz, 2003). In return, participation in GVCs can lead to some productivity gains arising from both the use of foreign intermediates (backward linkages) and the export of products used in third countries' exports (forward linkages).

As the relationship between participation in GVCs and productivity runs in both directions, it is difficult to show that participation in GVCs increases productivity. One option to remedy this issue is to assess whether countries with strong participation in GVCs have stronger productivity growth in industries that have a higher potential for fragmentation of the production process (Formai and Vergara Caffarelli, 2015). Industries differ by how much they are fragmentable, as reflected by the average length of GVCs in OECD countries by industry, measured by the number of stages involved in the production process (Figure 2.7). Manufacturing industries show the highest level of fragmentation and services industries the lowest.

Empirical estimates suggest that increasing participation in GVCs can lead to labour productivity growth (Box 2.2): countries with stronger GVC participation in the beginning of

Figure 2.6. **Labour productivity and participation in global value chains**



Source: OECD Productivity Database, *http://stats.oecd.org/*; OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*.

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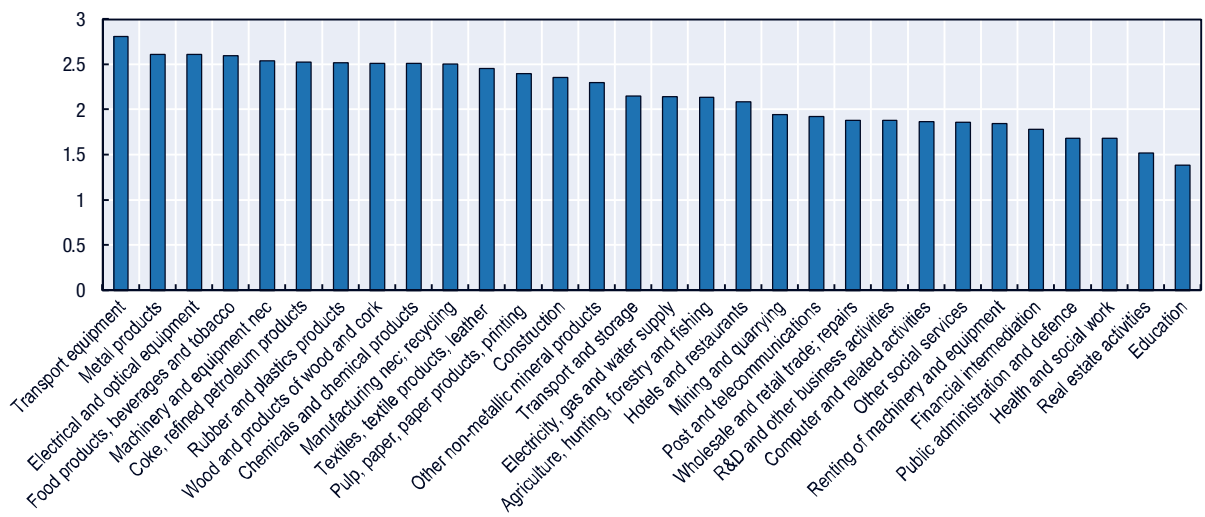
Figure 2.7. **Industries' potential for fragmentation**

Average length of GVCs in OECD countries over the period 1995-2009, by industry



Source: OECD calculations based on OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*.

StatLink *http://dx.doi.org/10.1787/888933474106*

the period have had stronger productivity growth in industries that offer higher potential for fragmentation. The annual gains in industry labour productivity growth range from 0.8 percentage points in the least fragmented industry to 2.2 percentage points in the most fragmented industry (Figure 2.8). Such an increase in labour productivity could be achieved by raising backward participation by 15 percentage points, which is what countries with the biggest change in participation in GVCs over the period 1995-2011 have experienced. Hence, these estimates tend to show the maximum gains countries may have experienced over the period.

Box 2.2. **Participation in global value chains and labour productivity growth: A new assessment**

While global value chains are generally considered to offer potential for productivity gains, the links between the two have seldom been tested empirically. Exceptions include a study that shows that multi-factor productivity grew faster in industries that experienced larger increases in GVC participation (Saia, Andrews and Albrizio, 2015). However, as more productive firms tend to choose GVC participation, this relationship cannot be interpreted in a causal way.

In an attempt to address this issue, a different approach is proposed here following another recent study (Formai and Vergara Caffarelli, 2015). This new assessment investigates whether countries with the highest participation in GVCs in the beginning of the period experienced higher productivity growth rates over the time periods 1995-2009 (or 2000-09) in industries that offer the highest potential for fragmentation of the production process. This methodology, which explains industries' productivity growth by the interaction between a country-specific measure of participation in GVCs and an industry-specific characteristic of potential for international fragmentation, can address some of the causality issues (Rajan and Zingales, 1998). It is however unlikely that this approach solves all the causality issues and therefore, should be considered as tentative and its results should be interpreted with caution.

The analysis uses data from the OECD-WTO TiVA database, the World Input-Output Database (WIOD) and the OECD Inter-Country Input-Output (ICIO) tables to test the relationship between countries' participation in GVCs and industries' productivity growth in a sample of 35 countries and 30 industries over the 1995-2009 period. The potential of industries for fragmentation of the production process is approximated by the average length of the global value chain of industries in OECD countries over all years (Figure 2.7). Two measures of labour productivity are considered, by employer and by hour. Other variables include the industry's share of a country's value added, the country-industry's capital stock, the country-industry's shares of high-skilled and medium-skilled workers, all taken in the beginning of the period, and industry and country fixed effects.

The results of this analysis are shown in two sections of this chapter. Figure 2.8 shows the impact of an increase in participation in GVCs at a country level on industry productivity growth depending on their potential for fragmentation. Figure 2.15 proposes a tentative estimate of the share of productivity gains that stems from the fact that some industries had a higher proportion of high- and medium-skilled workers at the beginning of the assessment period. This is achieved by comparing the estimated impact of countries' participation in GVCs on industries' productivity growth when the skills intensity of industries is accounted for versus when skills intensity is not accounted for.

Source: Formai, S. and F. Vergara Caffarelli (2015), "Quantifying the productivity effects of global value chains", *Cambridge Working Paper in Economics*, No. 1564.
Rajan, R.G. and L. Zingales (1998), "Financial dependence and growth", *The American Economic Review*, Vol. 88, No. 3.
Saia, A., D. Andrews and S. Albrizio (2015), "Public policy and spillovers from the global productivity frontier: Industry level evidence", *OECD Economics Department Working Papers*, No. 1238.

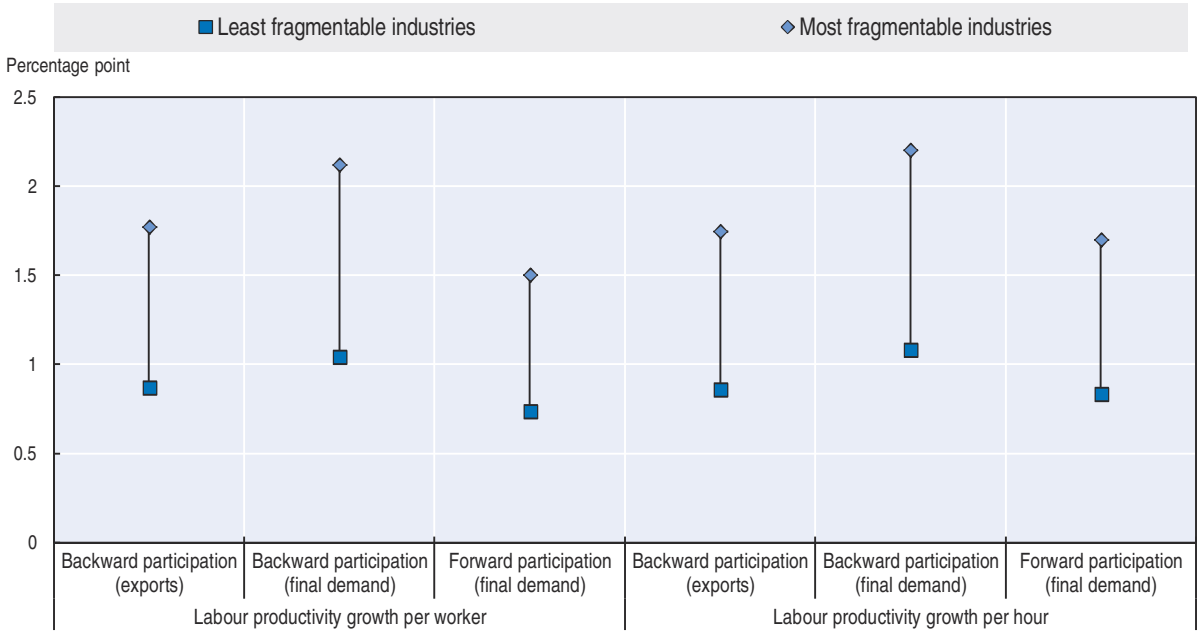
Global value chains and jobs

Many jobs are connected to GVCs and therefore depend on consumers in other countries. The development of GVCs has deepened dependencies between economies (OECD/World Bank, 2015). Estimates of how many jobs are sustained by foreign final demand reveal the extent of a country's integration into the global economy and therefore, the exposure of its labour market to external shocks (Figure 2.9).

In 2011, more than 30% of jobs in the business sector in most OECD countries were sustained by consumers in foreign markets. In some small European countries, this share reached over 50%. In Japan and the United States, shares are lower, reflecting their larger economies and lower dependency on exports/imports. Overall, a large share of jobs

Figure 2.8. **Estimated gains in labour productivity growth coming from an increase in participation in global value chains by degree of fragmentability of industries**

Average annual increase in labour productivity growth over the period 1995-2009



Note: Gains in productivity growth coming from an increase from the 25th percentile of the distribution of integration to the 75th percentile. This corresponds to an increase by 15 percentage points for backward participation in terms of exports, 13 percentage points for backward participation in terms of final demand, and 12 percentage points for forward participation in terms of final demand. See Box 2.2.

Source: OECD calculations based on OECD Trade in Value Added Database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*; and World Input-Output Database (WIOD), *www.wiod.org/home*.

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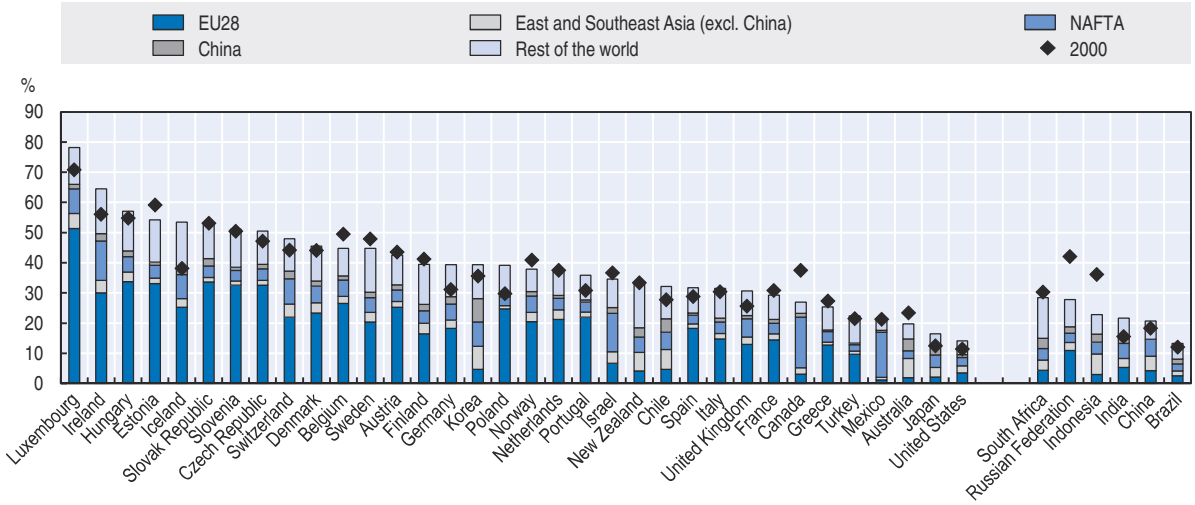
Figure 2.9. **Jobs in the business sector sustained by foreign final demand, by region of demand**

As a percentage of total business sector employment, 2011



Note: The business sector is defined according to ISIC Rev.3 Divisions 10 to 74 i.e. total economy excluding agriculture, forestry and fishing (Divisions 01 to 05), public administration (75), education (80), health (85) and other community, social and personal services (90 to 95). East and Southeast Asia (excluding China) comprises Brunei Darussalam, Cambodia, Indonesia, Hong Kong (China), Japan, Korea, Malaysia, Philippines, Singapore, Chinese Taipei, Thailand and Viet Nam.

Source: OECD (2015b), *OECD Science, Technology and Industry Scoreboard 2015: Innovation for Growth and Society*, *http://dx.doi.org/10.1787/sti_scoreboard-2015-en*.

StatLink http://dx.doi.org/10.1787/888933474123

depends on foreign demand, because of direct links with trade partners or indirect ones when products reach final consumers through the exports of third countries.

By increasing specialisation in tasks, participation in GVCs affects the level of employment, but this impact has not been studied much. There is no simple relationship between employment growth and change in the use of goods or services that come from other countries. GVCs are expected to lead to job destruction and job creation. Several studies have shown that competition from Chinese imports led to a sharp decline in employment in the United States in the manufacturing sector in the early 2000s (Autor, Dorn and Hanson, 2015). However, competition from low-wage countries is only one aspect of participation in GVCs. The use of foreign inputs can also enable firms to develop new activities and therefore create jobs.

The development of GVCs affects the types of jobs in the economy. In most GVCs, there is a strong shift towards value being added by capital and high-skilled labour and away from low-skilled labour, even though the overall employment impact of GVCs remains disputed (Timmer et al., 2014).[1] Developed countries have increasingly specialised in activities carried out by high-skilled workers. Emerging economies have specialised in capital and low-skilled activities.

Global value chains and inequalities within countries

The reference trade model (Hecksher-Ohlin model) predicts that in developed countries, wages of skilled workers should increase compared with wages of unskilled workers as demand for skilled labour increases and demand for low-skilled labour falls, and wage inequality should rise with trade. In developing countries that are well endowed with unskilled labour, on the other hand, wages of low-skilled workers should increase and wage inequality should decline.

However, there is little empirical evidence that trade is a major cause of increasing wage inequalities (OECD, 2011). Skills-biased technological change – change that favours skilled over unskilled workers – and other factors such as institutions may play a bigger role in explaining inequalities within countries.

The development of offshoring and increased import competition from low-wage countries has reawakened the debate on trade and inequality. Fragmentation of production has increased demand for skilled labour in both the North and the South: as the North sheds an activity that requires unskilled labour from its point of view, the South gains an activity that is skills-intensive from its point of view (Markusen, 2005; Feenstra and Hanson, 1996). By making some low-skilled workers redundant, offshoring lowers the wages of low-skilled workers or leads to their dismissal. This could explain the increase in inequalities in both developed and developing countries.

While offshoring can exacerbate inequalities by increasing the vulnerability of low-skilled workers, it can also enable low-skilled workers to abandon unproductive tasks and firms to increase specialisation in tasks. This can lead to productivity gains that at least partly accrue to low-skilled workers in terms of higher wages (Grossman and Rossi-Hansberg, 2008). This productivity effect explains why countries with a higher degree of backward participation in GVCs tend to have lower levels of wage inequality among their working population (Lopez Gonzalez, Kowalski and Achard, 2015).

Skill-biased technological change seems to affect inequalities more than offshoring. In the United States, import competition from low-wage countries appears to reduce

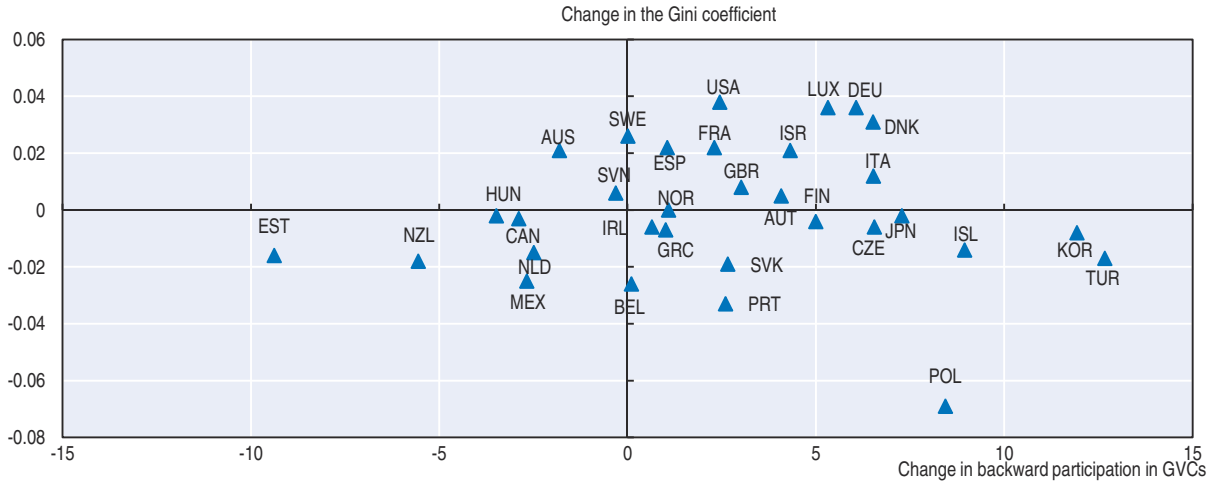
employment of all occupation groups while technology has the largest negative effect on the middle category of routine, task-intensive occupations (Autor, Dorn and Hanson, 2015). In Europe, there is also evidence of a polarisation of employment: the share of low-paid and high-paid occupations has increased while the share of middle-paid occupations has decreased (Breemersch, Damijan and Konings, forthcoming). Technological change and to a lesser extent Chinese imports have contributed to this polarisation, with the increase in backward participation playing a lesser role. Another study finds that technological change and de-unionisation played a central role in explaining the wage distribution in the 1980s and 1990s, while offshoring became an important factor from the 1990s onwards (Firpo, Fortin, and Lemieux, 2012).

In developing and emerging economies, there is evidence that inequality has risen at the same time as globalisation (Pavcnik, 2011). However, very few studies have tried to assess the impact of offshoring or participation in GVCs on inequalities in these countries. These countries are exposed to offshoring both as purchasers of foreign intermediates and hosts of offshored activities.

Simple correlations do not show any clear link between backward participation and inequalities. Since 2000, most OECD countries have developed offshoring, as measured by the foreign value added content of exports, with some of them experiencing a simultaneous rise in income inequalities and others a decline in inequalities (Figure 2.10).

Figure 2.10. **Trends in income inequalities and participation in global value chains**

2000-12



Note: Gini coefficient for disposable income and for the working age population. Backward participation is measured by the foreign value added content of exports as a share of gross exports.

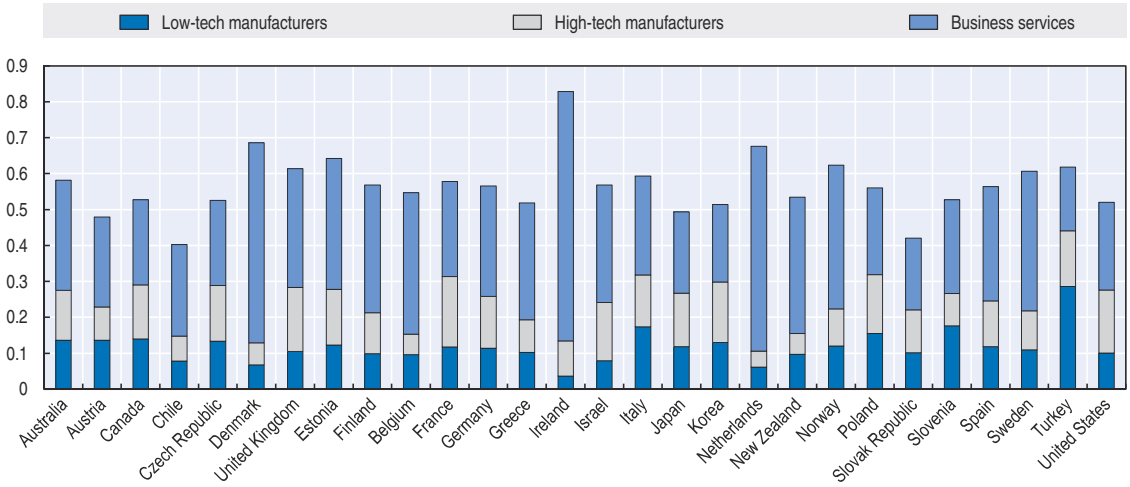
Source: OECD Trade in Value Added Database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*; OECD Income Distribution Database, *www.oecd.org/social/income-distribution-database.htm*.

StatLink *http://dx.doi.org/10.1787/888933474132*

The use of foreign intermediate inputs is not more prevalent in low-tech manufacturing than in high-tech manufacturing and business services (Figure 2.11). This is also an indication that both low-skilled and high-skilled jobs can be concerned by offshoring, explaining why the increase in backward participation is weakly linked to changes in inequalities.

Figure 2.11. **Use of foreign intermediate inputs, by groups of industries**

As a proportion of total imports of intermediate products, 2011



Note: Low technology manufactures are defined as sectors covering ISIC Rev.3 codes 15-22 and 36-37; business services include ISIC Rev.3 codes 50-74; and high technology manufactures include ISIC Rev.3 codes 24, 30, 32-33, 35.

Source: OECD (2016b), *OECD Employment Outlook 2016*, *http://dx.doi.org/10.1787/empl_outlook-2016-en*.

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Skills as a condition to make the most of global value chains

Skills help determine countries' comparative advantages in global value chains

A workforce that is more skilled than in other countries is a source of comparative advantage that enables a country to specialise in high-skilled activities, according to the Heckscher-Ohlin model of international trade and empirical studies (Chor, 2010).

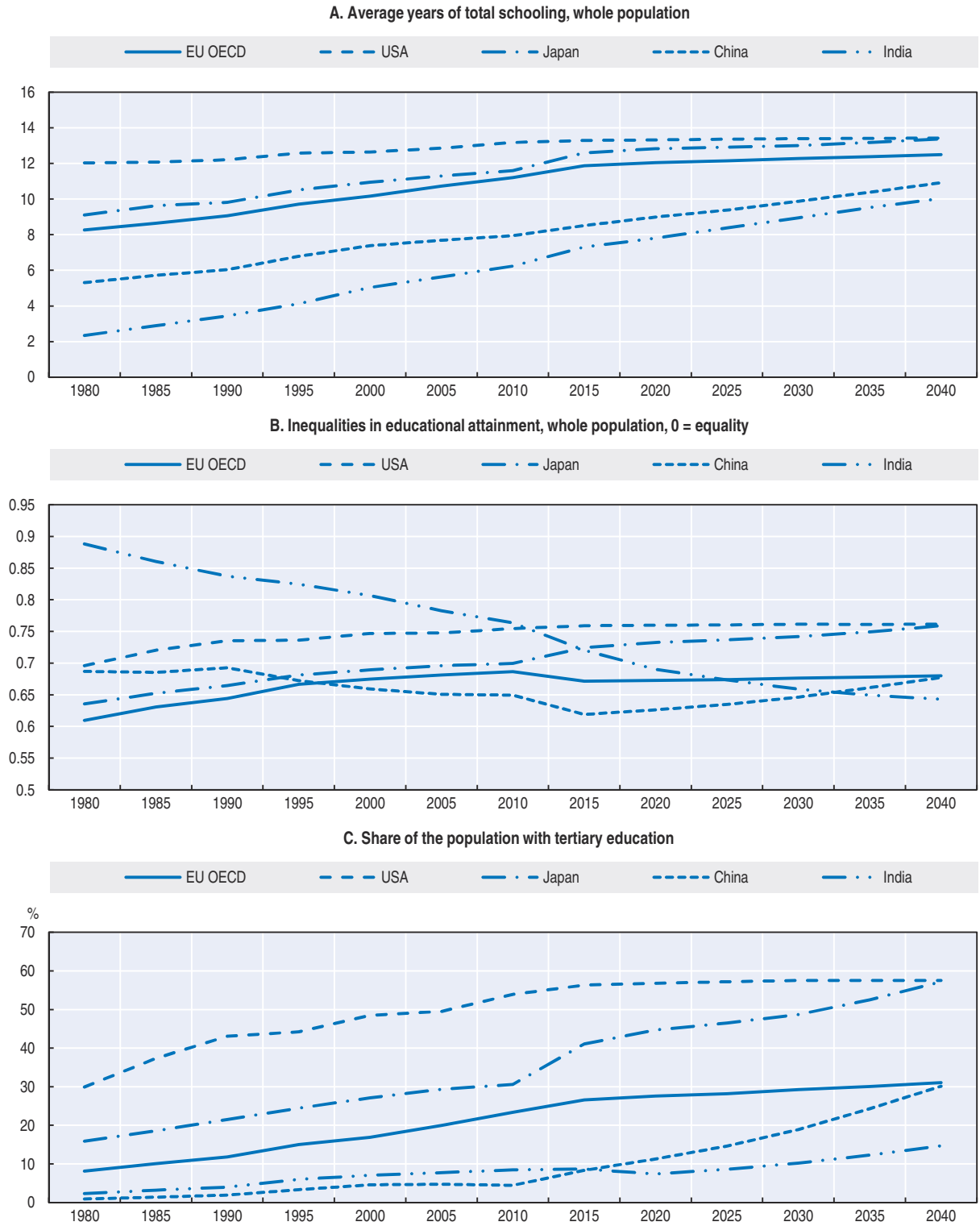
Educational attainment, the most common measure of skills, has increased in recent decades in most countries. The share of the population attaining tertiary education has more than doubled since the 1980s in many countries, including China and Japan, but remains the highest in OECD countries (Figure 2.12). At the same time, the gap between those with the lowest educational attainment and those with the highest has declined in countries where the gap was large to start with, such as India and – to a lesser extent – China, but has increased in several OECD countries, including Japan and the United States.

These trends suggest that the comparative advantage of most OECD countries in terms of educated workers has decreased and will continue to do so, although educated workers will remain abundant in some of these countries, according to projections of educational attainment (Barro and Lee, 2013).

The evolution of participation in GVCs seems to be linked to the evolution of educational attainment. There is a positive correlation between the share of domestic value added in foreign final demand, which measures the extent to which a country reaches final consumers through its exports (forward participation), and the change in average educational attainment of the population (Figure 2.13).

However, educational attainment does not account for the skills and experience gained after initial education. In addition, as it does not directly measure the skills obtained at school, it does not reflect differences in the quality of education systems across countries. Some studies have corrected for differences between the quality of education systems by using available international mathematics and science test results as a proxy for skills

Figure 2.12. **Long-term trends in educational attainment**

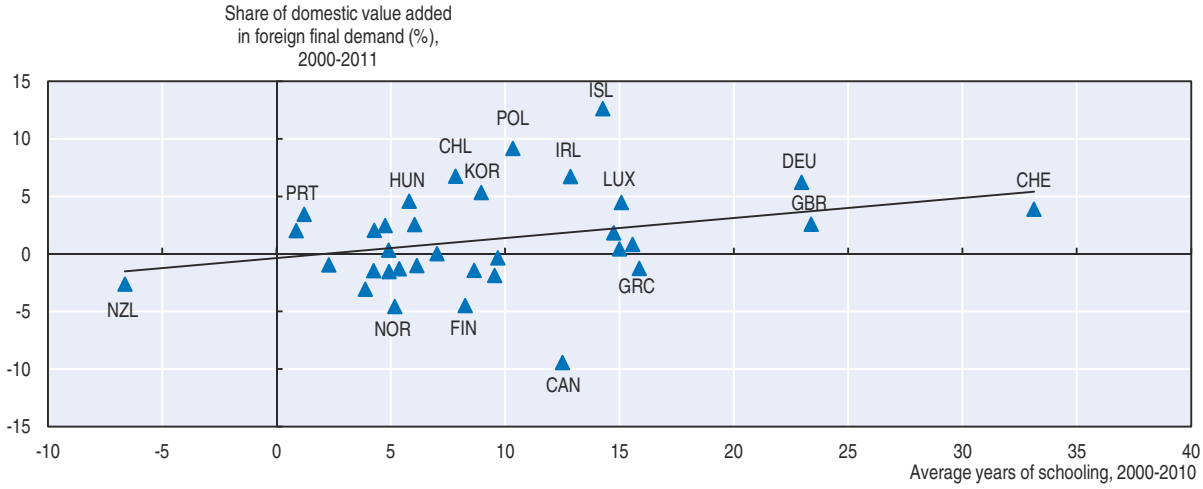


Note: Data for the whole population are for those aged above 15 until 2010 and estimates are given for the population 15-64 after 2010. Inequalities in educational attainment are measured by the coefficient of variation of average years of schooling.

Source: OECD calculations based on Barro and Lee (2013), "A new data set of educational attainment in the world, 1950-2010.", *Journal of Development Economics*, Vol. 104.

StatLink http://dx.doi.org/10.1787/888933474153

Figure 2.13. **Trends in education attainment and forward participation in global value chains**



Source: Barro and Lee (2013), "A new data set of educational attainment in the world, 1950-2010." *Journal of Development Economics*, Vol. 104; OECD Trade in Value Added Database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*.

StatLink *http://dx.doi.org/10.1787/888933474160*

(Hanushek and Woessmann, 2009). The Survey of Adult Skills, a product of the OECD Programme for International Assessment of Adult Competencies (PIAAC), directly measures some cognitive skills of the adult population and thereby accounts for the quality of education and other channels of skills development. However, it gives only limited information on the evolution of skills.

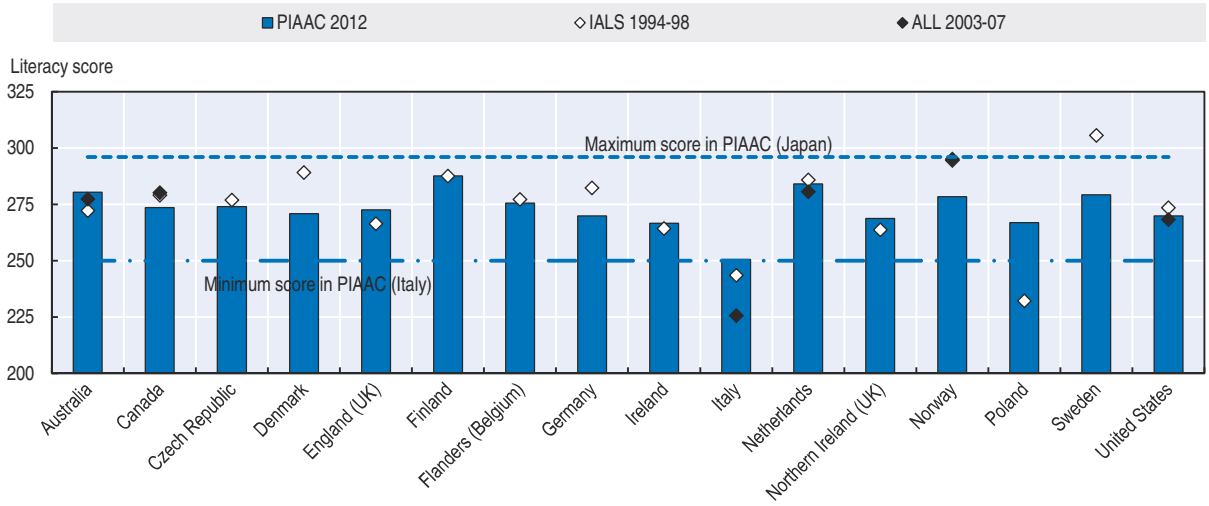
The trend in the development of skills is much less clear than educational attainment trends. Prior to the Survey of Adult Skills undertaken in 2011, two international assessments of adult skills were conducted in OECD countries: the International Adult Literacy Survey (IALS) between 1994 and 1998, and the Adult Literacy and Life Skills Survey (ALL) between 2003 and 2007. The Survey of Adult Skills was designed to be linked with IALS and ALL in the domain of literacy, and with ALL in the domain of numeracy, but differences in the implementation of the surveys may have affected the comparability of the data. Comparisons between IALS and PIAAC and between ALL and PIAAC show a mixed picture (Paccagnella, 2016; Figure 2.14).

Literacy skills appear to have declined in some countries (Canada, Denmark, Germany, Norway, Sweden), to have increased in few countries (Australia, Italy and Poland), and to have stagnated among another group (Belgium, the Czech Republic, Finland, Ireland, the Netherlands, the United Kingdom and the United States). The smallest changes have been observed among youth and the biggest among the oldest, which is consistent with the tapering off of the increase in educational attainment. In most countries, the skills of individuals with an upper secondary or tertiary level qualification have declined over the last decades – either because the quality of education has deteriorated or because higher educational attainment has been achieved by lowering skills acquisition requirements.

Simple correlations at a country level can only provide a first glance at the links between skills and GVCs. Chapter 3 will investigate these links, based on the Survey of Adult Skills and the TiVA database. These links have never been analysed, as all past studies have looked at trade performance with exports defined in gross terms, not in value-added terms.

Figure 2.14. **Trends in literacy proficiency**

Literacy scores assessed in IALS, ALL and PIAAC



Note: Some caution is needed in interpreting the changes in proficiency observed between International Adult Literacy Survey (IALS), Adult Literacy and Life Skills Survey (ALL) and PIAAC for all countries, due to differences in the implementation of the surveys between countries and over time that may affect the comparability of the data from the different studies. There are specific concerns about the reliability of IALS and ALL data for Italy, England (UK), Northern Ireland (UK) and Poland.

Source: Paccagnella (2016), "Literacy and numeracy proficiency in IALS, ALL and PIAAC", *OECD Education Working Papers*, No. 132, *http://dx.doi.org/10.1787/5jlpq7qglx5g-en*.

StatLink http://dx.doi.org/10.1787/888933474170

Skills are necessary to achieve productivity gains in global value chains

Skills are one of the factors that play a key role in ensuring that participation in GVCs translates into productivity gains. By enabling workers to absorb technology and knowledge, skills aid the diffusion of knowledge not only to firms that are part of GVCs but also to the rest of the economy (Morisson, Pietrobelli and Rabellotti, 2008; OECD, 2015c).

Skills are needed for the assimilation of technology, its adaptation and improvement, quality and inventory control, monitoring of productivity, co-ordination of different production stages, and for the process and product innovations related to basic research activity (Box 2.3). Specific skills are also needed to establish technology linkages among enterprises, with service suppliers, and with science and technology institutions.

The idea that international linkages can play a crucial role in accessing technological knowledge and enhancing learning and innovation is at the core of the concept of "economic upgrading". This generally refers to the process of "moving up the value chain", or moving from activities that generate little value added to those that are more complex and sophisticated (Figure 2.1).

A vast literature in the fields of international development, economic geography and sociology has illustrated the role of skills in participation in GVCs through activities that generate more value added. While this literature does not lead to a clear definition of economic upgrading and does not propose how to measure it, it supports the idea that skills can be a bolster against the risk that globalisation will reduce employment or increase inequalities. Overall, there is a need to adopt a clearer definition of economic upgrading in order to apply this concept using available databases.

At an industry or country level, economic upgrading can be defined as achieving productivity gains from participation in GVCs through the development of skills or

Box 2.3. **Knowledge-based capital and participation in global value chains**

Skills and technology combine to create non-tangible capital – usually called knowledge-based capital – that contributes to firms' performance. Three types of knowledge-based capital assets are generally considered: computerised information (software and databases); innovative property (patents, copyrights, designs, trademarks); and economic competencies (including brand equity, firm-specific human capital, and organisational know-how that increases enterprise efficiency) (Corrado, Hulten and Sichel, 2005).

The relationship between knowledge-based capital and GVCs runs in both directions. Investing in knowledge-based capital may enhance firms' ability to co-ordinate with and monitor suppliers; to integrate into production inputs of different quality or technological content; and to better match workers with tasks in production. Investing in knowledge-based capital can thus increase the benefits from backward participation in GVCs. In the other direction, participation in GVCs can stimulate investment in knowledge-based capital by providing access to greater varieties of inputs; reducing costs and thus freeing resources for investment; and enhancing the pace of reallocation within and across sectors, thanks to competition.

Such mutually reinforcing dynamics between knowledge-based capital investment and the use of foreign intermediates can nevertheless be dampened by the possibility that in-house production is downsized in favour of production elsewhere, to such an extent that investment in knowledge-based capital ultimately gets reduced at home.

A recent OECD empirical study investigates the links between two forms of knowledge-based capital – investment in software and organisational capabilities – and backward participation in GVCs (Marcolin, Le Mouel and Squicciarini, forthcoming). Investment in organisational capabilities captures the amount that industries devote to the compensation of workers whose occupations are intensive in managerial and organisational tasks (Squicciarini and Le Mouel, 2012; Le Mouel, Marcolin and Squicciarini, 2016).

This study shows that that the relationship between investment in organisational capabilities and software on the one hand and backward participation in GVCs on the other hand does indeed run in both directions, suggesting that investment in knowledge-based capital is complementary to relocating part of production offshore. Such a complementarity may arise from firms' improved ability to adapt production processes and the labour force engaged in them, especially if offshored inputs are of different quality or technological content than domestic production. Greater offshoring of inputs, in turn, may further enhance investment in organisational capabilities and software through channels such as greater foreign competition on the input market or improved technological content of production.

Investing in R&D, skills and organisational know-how helps firms to reap the full benefits of new technologies and the fragmentation of production. These features of knowledge-based capital investment highlight the importance of policies sustaining the creation and absorption of knowledge in the economy, and of the need to co-ordinate innovation, skills and trade policies.

Source: Corrado, C., C. Hulten and D. Sichel (2005), "Measuring capital and technology: An expanded framework", in *Measuring Capital in the New Economy*.

Le Mouel, M., L. Marcolin and M. Squicciarini (2016), "Investment in organisational capital: Methodology and panel estimates", *SPINTAN Working Paper*, No. 2016/21.

Marcolin, L., M. Le Mouel and M. Squicciarini (forthcoming), "Investment in knowledge-based capital and backward linkages in global value chains", *OECD Science, Technology and Industry Working Papers*.

Squicciarini, M. and M. Le Mouel (2012), "Defining and measuring investment in organisational capital: Using US microdata to develop a task-based approach", *OECD Science, Technology and Industry Working Papers*, No. 2012/5, *http://dx.doi.org/10.1787/5k92n2t3045b-en*.

innovation (Box 2.4). This definition implies that upgrading can be gauged by looking at both the generation of value added and the evolution of skills and technologies involved in the production process. It also implies that skills are at the core of upgrading. Some of the potential productivity gains at an industry level from participation in GVCs (Figure 2.8) come from the fact that countries that have increased participation in GVCs also had a high level of skills, proxied by the level of education, at the beginning of the period (Figure 2.15). This tentative estimate suggests that productivity gains are strongest when skills development and participation in GVCs go together.

Box 2.4. **What is meant by economic upgrading?**

The concept of economic upgrading has been mainly used in the context of developing economies, as the process according to which countries and firms that enter GVCs through low-skilled activities move to higher value added activities in production with improved technology, knowledge, and skills (e.g. Barrientos, Gereffi and Rossi, 2011). It is mainly used in the fields of international development, economic geography and sociology (Gereffi, 1994, 1999; Giuliani, Pietrobelli and Rabellotti, 2005; Kaplinsky, 2000; Humphrey and Schmitz, 2002; Pietrobelli and Rabellotti, 2007).

Upgrading is defined in opposition to other paths for achieving gains in value added based on the use of developing countries' cheap labour (Rossi, 2013). Hence, upgrading has generally been defined as achieving a certain goal: increased value added, through specific means, more knowledge and skills. However, there is no consensus on what is meant by upgrading (Humphrey and Schmitz, 2002; Blažek, 2015). Some authors consider that upgrading can consist in moving into market niches that have entry barriers and are therefore isolated from pressures to maintain or increase income in the face of competition. Other authors have argued that channels other than skills and innovation should also be included, such as exposure to different managerial models and increased demand to meet certain standards (Ponte and Ewert, 2009).

In general, four types of upgrading channels are proposed:

- *Process upgrading* is achieved through changes in the production process with the objective of making it more efficient. This can involve the substitution of capital to labour to achieve higher productivity through automation. Process upgrading is expected to reduce the demand for workers in routine tasks.
- *Product upgrading* occurs where products with superior technological sophistication and quality are introduced, which often require more skills to make.
- *Functional upgrading* is achieved when firms can provide competitive products or services in new segments or activities of a GVC that are associated with higher value added. It involves the development of skills and possibly the introduction of new skills to become competitive in new segments of the production process.
- *Chain upgrading* is achieved when firms are able to participate in new GVCs that produce higher value-added products or services, often leveraging the knowledge and skill acquired in the current chain.

This classification may not match the complexity of concrete situations but it is useful to illustrate the role of skills and of different types of skills for maintaining competitiveness in GVCs.

The difficulty in defining economic upgrading leads to a corresponding difficulty in measuring it. A definition that matches firms' dynamics cannot be applied at an industry or country level; upgrading at an industry or country level cannot be simply defined as the

Box 2.4. **What is meant by economic upgrading?** *(cont.)*

summing up of specific firms' behaviour. The spillover effects to other firms have implications for performance of the industry and the country. For instance, upgrading in some firms may come at the cost of other domestic firms downgrading in GVCs. Conversely, firms that are linked to firms participating in GVCs, either directly or indirectly, may benefit from the diffusion of knowledge and technology. In addition, the performance of countries within GVCs depends on the dynamic process of firms, with new competitors entering GVCs and others quitting the market.

Increasing the domestic value-added content of exports has often been taken as a signal of upgrading. This is not always the case, however, as countries may rely on imports of inputs not because they are unable to produce these inputs but because they focus on parts of the production process where they have comparative advantages (Escaith, 2016). Upgrading may mean gaining overall competitiveness by offshoring non-core inputs.

Overall, if the concept of economic upgrading is to be used at a country level – for instance, as a policy objective – it could be understood more generally as achieving productivity gains from participation in GVCs through the development of skills or innovation.

Sources: Barrientos, S., G. Gereffi and A. Rossi (2011), "Economic and Social Upgrading in Global Production Networks: A New Paradigm for a Changing World", *International Labour Review*, Vol. 150, No. 3-4, pp. 319-340.

Blažek, J. (2015), "Towards a typology of repositioning strategies of GVC/GPN suppliers: the case of functional upgrading and downgrading", *Journal of Economic Geography*, Vol. 16/4, pp. 849-869, *https://doi.org/10.1093/jeg/lbv044*.

Escaith, H. (2016), "Revisiting growth accounting from a trade in value-added perspective", *WTO Working Papers*, ERSD-2016-01.

Gereffi, G. (1994), "The organization of buyer-driven global commodity chains: how US retailers shape overseas production networks", in G. Gereffi and M. Korzeniewicz (Eds), *Commodity Chains and Global Capitalism*.

Gereffi, G. (1999), "International trade and industrial upgrading in the apparel commodity chain", *Journal of International Economics*, Vol. 48, pp. 37-70.

Giuliani, E., C. Pietrobelli and R. Rabellotti (2005), "Upgrading in global value chains: lessons from Latin America clusters", *World Development*, Vol. 33, pp. 549-573.

Humphrey, J. and H. Schmitz (2002), "How does insertion in global value chains affect upgrading industrial clusters?", *Regional Studies*, Vol. 36, pp. 1017-1027.

Kaplinsky, R. (2000), "Globalisation and unequalisation: What can be learned from value chain analysis?", *Journal of Development Studies*, Vol. 37, pp. 117-146.

Pietrobelli, C. and R. Rabellotti (2007), *Upgrading to Compete. Global Value Chains, Clusters and SMEs in Latin America*, Harvard University Press Cambridge, MA.

Ponte, S. and J. Ewert (2009), "Which way is "Up" in upgrading? Trajectories of change in the value chain for South African wine", *World Development*, Vol. 37, pp. 1637-1650.

Rossi, A. (2013), "Does economic upgrading lead to social upgrading in global production networks? Evidence from Morocco", *World Development*, Vol. 46, pp. 223-233.

Similarly, studies that trace the skills content of participation in GVCs show that skills influence future specialisation in GVCs. Countries with higher initial shares of high-skilled workers show a faster increase in the share of high-skilled workers in GVCs (Figure 2.16).

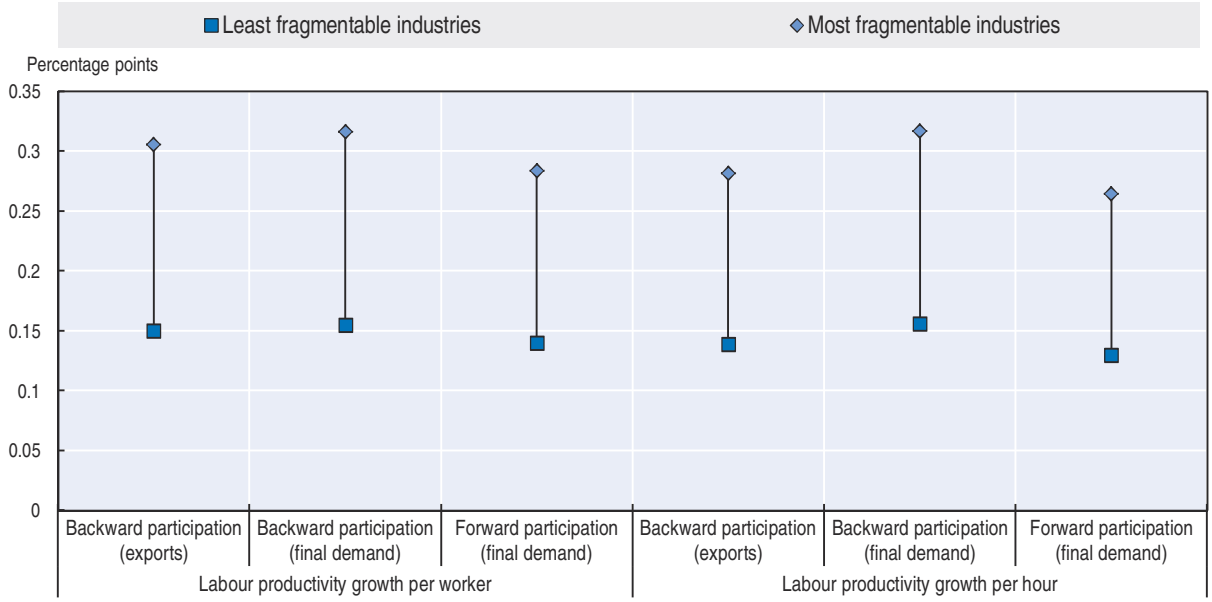
Skills can connect local firms to multinationals

Many GVC activities are concentrated around multinationals, which themselves often concentrate skills and technology. As multinationals relocate activities to get access to skilled workers, a pool of workers with strong skills helps to attract FDI.

However, small and medium-sized enterprises (SMEs) also contribute to the development of GVCs. Data for a group of OECD countries show that the contribution of SMEs to the

Figure 2.15. **Estimated gains in productivity growth coming from an increase in participation in global value chains, through the skill channel**

By degree of industry fragmentability, average annual increase in labour productivity growth over the period 1995-2009



Note: Gains in labour productivity growth coming from an increase from the 25th percentile to the 75th percentile of the distribution of the participation indicators channelled by skills. This corresponds to an increase of 15 percentage points for backward participation in terms of exports, 13 percentage points for backward participation in terms of final demand, and 12 percentage points for forward participation in terms of final demand.

The assessment comes from comparing the effect of participation in GVCs on productivity gains when the skill intensity of industries is accounted for or not. See Box 2.2.

Source: OECD calculations based on OECD Trade in Value Added Database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*; and World Input-Output Database (WIOD), *www.wiod.org/home*.

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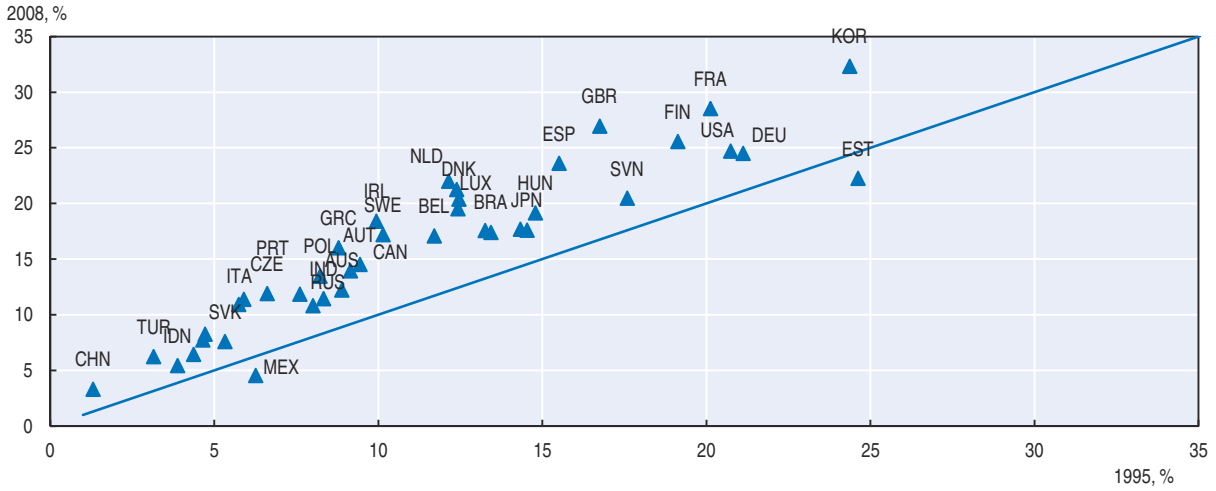
Figure 2.16. **Shares of high-skilled labour in value added of all global value chains of manufacturing industries, by country**



Note: Types of labour skills are classified on the basis of educational attainment levels as defined in the International Standard Classification of Education (ISCED): low-skilled (ISCED categories 1 and 2), medium-skilled (ISCED 3 and 4) and high-skilled (ISCED 5 and 6).

Source: Timmer et al. (2014), "Slicing up global value chains", *Journal of Economic Perspectives*, Vol. 28/2.

StatLink http://dx.doi.org/10.1787/888933474199

domestic value added of exports is above 50% in business services and above 40% in manufacturing in most countries of the group when their provision of intermediate goods and services to exporting firms is taken into account (OECD/World Bank, 2015).

SMEs tend to channel their value added for exports through large multinational firms rather than through other SMEs. On average, parent companies usually specialise in conception and design stages, and their affiliates and other local suppliers specialise in marketing and after-sales service (Antras and Yeaple, 2014). Nonetheless, some SMEs are also strongly involved in tasks at the higher end of the value chain, such as R&D, design and branding.

Exposure to GVCs can enable local firms to increase productivity by learning about advanced technologies or good organisational and managerial practices (Saia, Andrews and Albrizio, 2015). Lead firms require more and better inputs from local suppliers, creating a highly competitive environment, as well as incentives for local firms to meet higher standard requirements and opportunities to learn through imitation. Using foreign intermediate goods in production often also requires that firms adopt more sophisticated technology (Keller, 2004).

However, the gap in productivity growth between leading firms and other firms has increased over time, suggesting that the diffusion of knowledge from globally connected firms to leading national firms and from leading national firms to laggard firms has not operated well (Andrews, Criscuolo and Gal, 2015). One explanation is that low levels of skills have prevented highly productive national firms from catching up with globally connected firms. Even if workers in national firms have strong cognitive and technical skills, they may lack foreign language skills, cultural understanding, and knowledge of ways of doing business.

The skills of workers in SMEs are an important factor in the diffusion of knowledge to the whole economy. Foreign investors want face-to-face interactions and more responsive supply chains, so they prefer not to have to rely on importing goods and services where cost-effective scope exists for domestic suppliers to compete by upgrading skills and standards (OECD/World Bank, 2015). Some multinationals train local workers so they can use their knowledge-based assets, substituting for domestic educational and training systems. In developing countries, knowledge transfer occurs between headquarters and foreign affiliates (Javorcik, 2014). However, multinationals sometimes bring all the technology, management and know-how that they need, and choose not to rely on local know-how if it is too far from international standards (Baldwin and Lopez Gonzalez, 2013). The Survey of Adult Skills shows that workers in smaller firms have lower cognitive skills than those in larger firms, putting these workers at a higher risk of not meeting the skills requirements of multinationals (Figure 2.17).

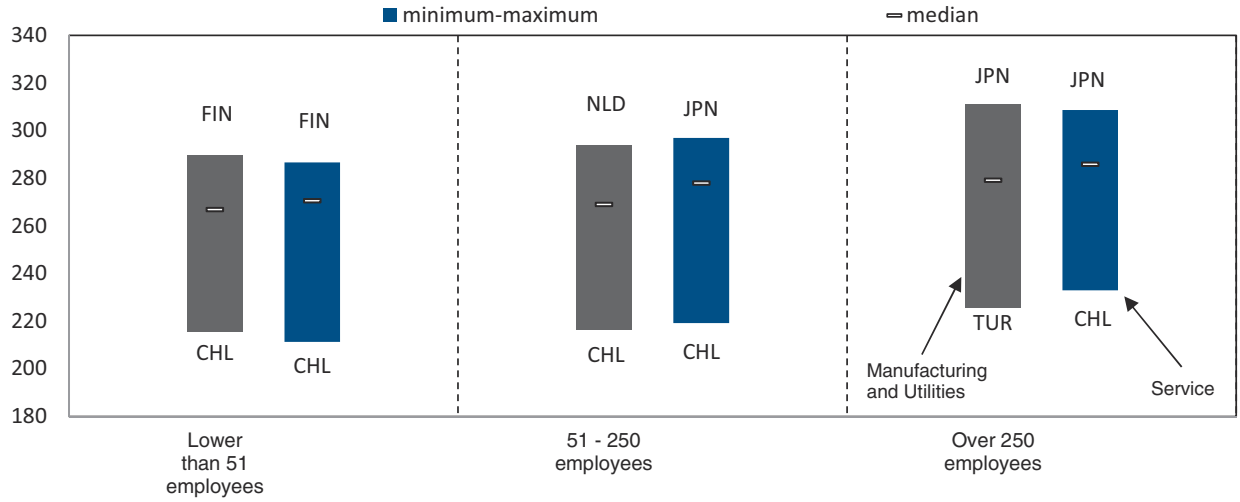
Relationships between multinationals and affiliates (or local suppliers) – and their respective bargaining powers – may influence the diffusion of knowledge and technology and thereby firms' ability to gain a larger share of the value generated within GVCs (Gereffi, 1994 and 1999; Giuliani, 2005; Kaplinsky, 2000). Having the skills capacity to absorb new technologies can help SMEs to develop the types of relationships that foster the diffusion of knowledge.

What makes jobs vulnerable to globalisation and the implications for skills

The task content of jobs plays a key role in determining which jobs are favoured by globalisation, and which skills will maintain workers' employability if offshoring exposes them to the risk of losing their jobs.

Figure 2.17. **Numeracy skills of workers by firm size**

2012 or 2015



Source: OECD calculations based on OECD Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis*.

StatLink *http://dx.doi.org/10.1787/888933474204*

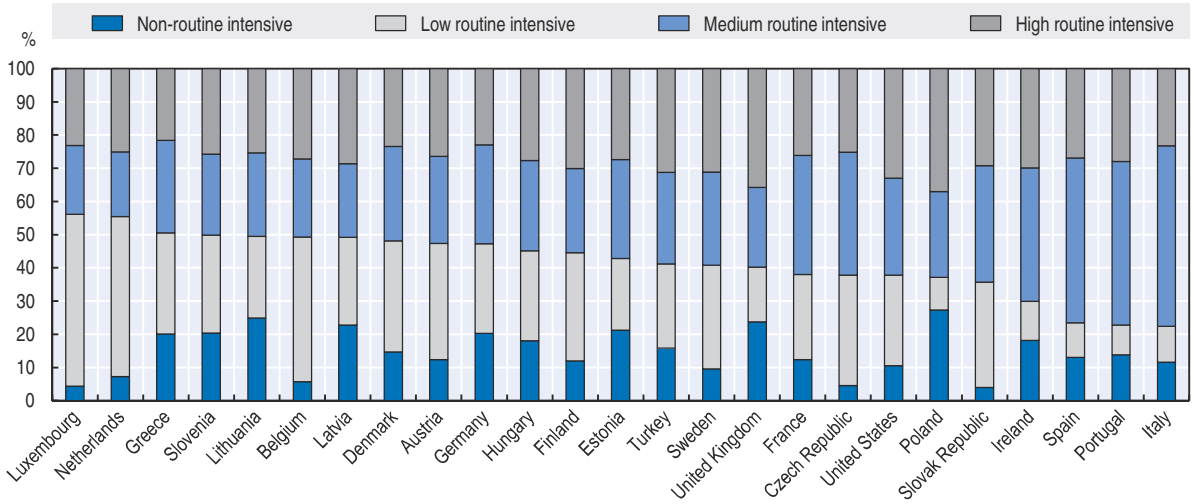
A first main dimension is the routine content of jobs. Evidence in the United States shows that demand for routine cognitive and manual tasks has declined since 1970, while the demand for non-routine analytic and interactive tasks has increased (Autor, Levy and Murnane, 2003).[2] According to this study, substitution of routine by non-routine labour input is pervasive at all educational levels, but globalisation could be only one of several reasons for the shift of labour demand towards jobs intensive in non-routine tasks and skills. These authors consider that technology and automation are the main reasons for the collapse of jobs intensive in routine tasks. Other studies also find that the correlation between the routine content of jobs and the likelihood that they will be relocated offshore appears to be low (Blinder and Krueger, 2013). While routine tasks are easier to relocate than jobs requiring complex thinking, judgment and human interaction, a wide variety of complex tasks that involve high levels of skills and human judgment can also be relocated via telephone, fax or Internet.

The Survey of Adult Skills reveals significant differences in the average proportion of employment accounted for by occupations of different routine intensity (Marcolin, Miroudot and Squicciarini, 2016; Figure 2.18). The share of non-routine and low routine-intensive workers ranges between about 55% in Luxembourg and 20% in Italy for the period 2000-11. The average share of workers employed in high routine-intensive occupations ranges between over 20% in Greece and 35% in the United Kingdom. Since the Survey of Adult Skills has only one point in time at the moment, the evolution of employment by routine content over time rests on the assumption that the routine content of each occupation has remained unchanged.[3]

The evidence based on the Survey of Adult Skills on the link between the routine content of jobs and their likelihood of being relocated offshore is not conclusive (Marcolin, Miroudot and Squicciarini, 2016). This is because interactions between the routine content of occupations, skills, technology, industry structure and trade are complex, which makes it difficult to identify "winners" and "losers" in a GVC context.

Figure 2.18. **Percentage of employment by quartile of routine intensity**

Average of 2000, 2005, 2008-11



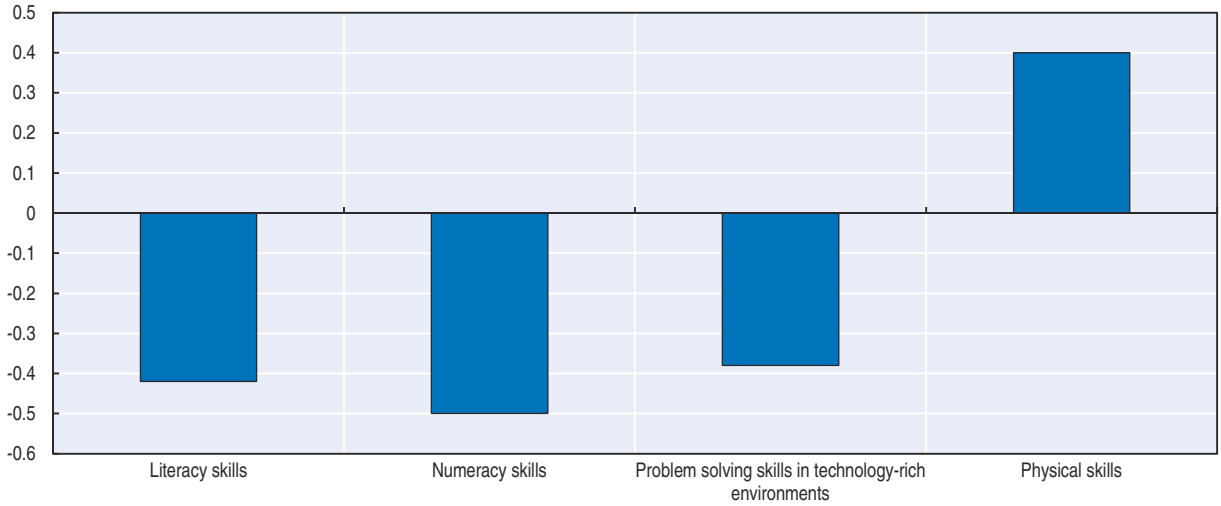
Source: Marcolin, Miroudot and Squicciarini (2016), "Routine jobs, employment and technological innovation in global value chains", *OECD Science, Technology and Industry Working Papers*, No. 2016/01. *http://dx.doi.org/10.1787/5jm5dcz2d26j-en*.

StatLink http://dx.doi.org/10.1787/888933474217

These results suggest that routine content is not the only characteristic that makes activities likely to be relocated. Others include the ability of a task to be performed in a remote location without substantial quality degradation (Acemoglu and Autor, 2011). It is possible that any job that does not need to be done in person (i.e. face-to-face) can ultimately be outsourced, regardless of whether its primary tasks are abstract, routine or manual (Blinder, 2009; Blinder and Krueger, 2013). The need for on-site work and the importance of decision taking may make jobs more difficult to relocate (Firpo, Fortin and Lemieux, 2012).

Figure 2.19. **Correlation between the employment share in high routine intensity tasks and average workers' skills**

Country and industry level



Note: The employment share in high routine intensity tasks is an average over the period 2000-11. Average workers' skills are in 2012.
Source: OECD calculations based on OECD Survey of Adult Skills (PIAAC) (2012); *www.oecd.org/skills/piaac/publicdataandanalysis*; and Marcolin, Miroudot and Squicciarini (2016), "Routine jobs, employment and technological innovation in global value chains", *OECD Science, Technology and Industry Working Papers*, No. 2016/01, *http://dx.doi.org/10.1787/5jm5dcz2d26j-en*.

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The possibility of offshoring certain tasks increases the importance of some skills and makes others obsolete. Tasks with a low degree of routine intensity and a high degree of abstract thinking may require stronger cognitive skills. Indeed, the OECD routine intensity index is negatively correlated with workers' cognitive skills, as measured by the Survey of Adult Skills, but it is positively linked to physical skills (Figure 2.19). The strong managing, communicating and interacting skills that are required in decision-making also put workers less at risk of losing the domestic demand for their expertise.

Skills and the implications of global value chains for job quality

A key question about participation in GVCs and economic upgrading is whether they have improved quality of employment, or led to "social upgrading" – jobs with better wages, working conditions, social protection and rights (Barrientos, Gereffi, and Rossi, 2011; Rossi 2013). There has not been any comprehensive attempt to assess the extent of social upgrading, mainly because it is difficult to measure some of its aspects, such as working conditions and enabling rights. The OECD job quality framework assesses some of these aspects, however, by examining three dimensions:

- Earnings quality: The level of earnings and their distribution across the workforce.
- Labour market security: The risk of unemployment and the income support to which workers are entitled if unemployed.
- Quality of the working environment: The nature and content of work performed, working-time arrangements and workplace relationships.

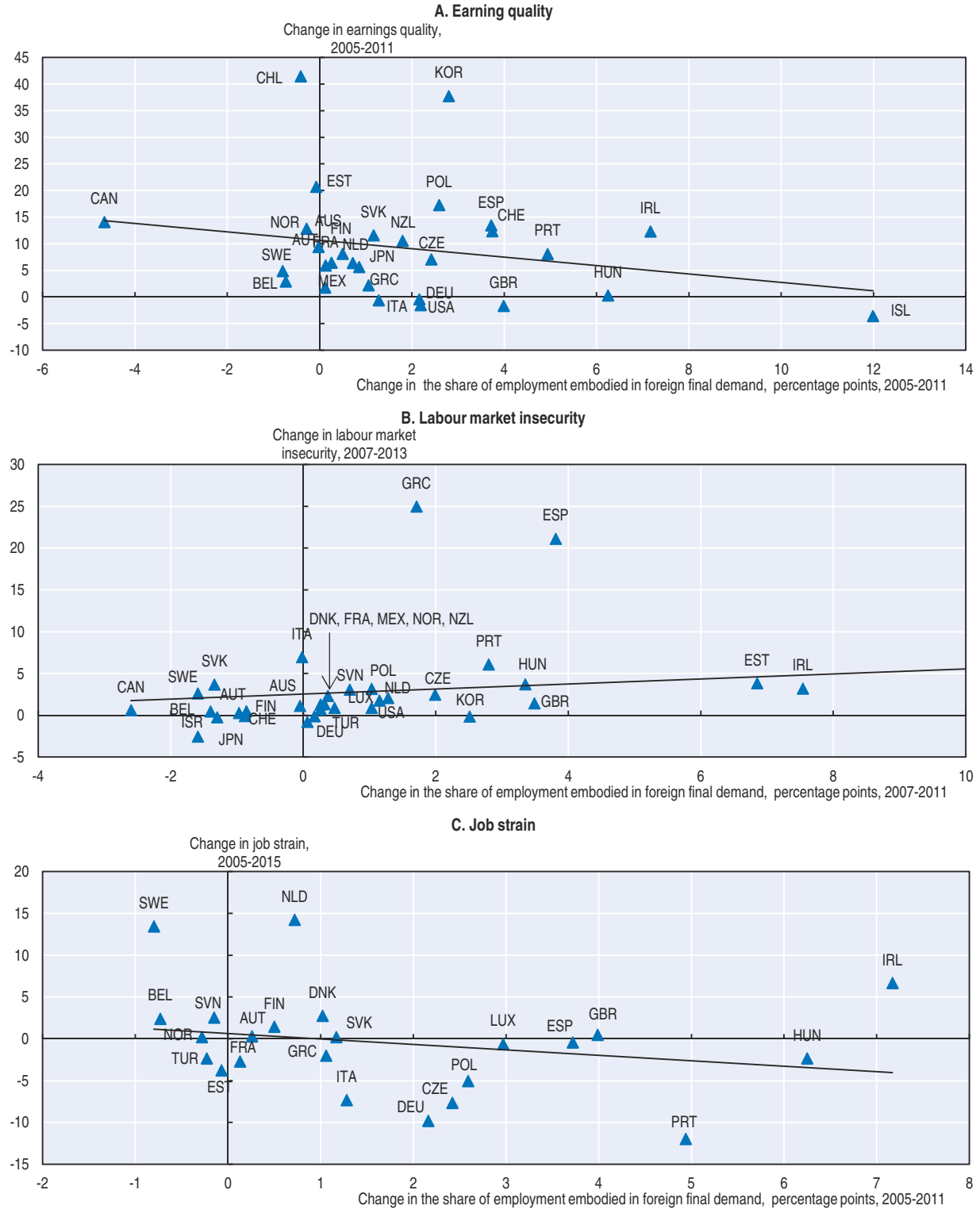
One way of gauging the impact of participation in GVCs on job quality is to consider the relationships between the change in the share of employment sustained by foreign final demand and changes in the various aspects of job quality (earnings, labour market security and working environment) over the same period (Figure 2.20). These relationships are weak, with earnings quality lowered the most by employment exposure to GVCs.

Earnings quality was heavily affected by the fact that the jobs lost during the 2008 global economic crisis were predominantly low-paid, which led to an apparent increase in earnings quality on average during the crisis and the recovery period (OECD, 2016c). Countries where employment exposure to GVCs has increased may have seen a smaller reduction in low-paid jobs and an apparent smaller increase in earning quality.

Labour market insecurity has increased in most countries in the last decade but with no strong link with employment exposure to GVCs. Job strain, which occurs when job demands are high and workers' control and resources are low, reflects the quality of the working environment. It has increased in some countries and decreased in others but has not increased more in countries in which the share of employment exposed to GVCs has increased. These links need to be interpreted with care as they cover a limited number of countries and do not demonstrate any causal relationship between job quality and participation in GVCs. In addition, institutional factors and country characteristics are major determinants of job quality.

Workers with the highest skills, as measured by level of education, enjoy the greatest job quality in all three dimensions – earnings, job security and working environment (Figure 2.21). In most countries, having a tertiary degree makes the most difference in terms of employment quality – particularly for earnings, but also for labour market security and working environment in many countries.

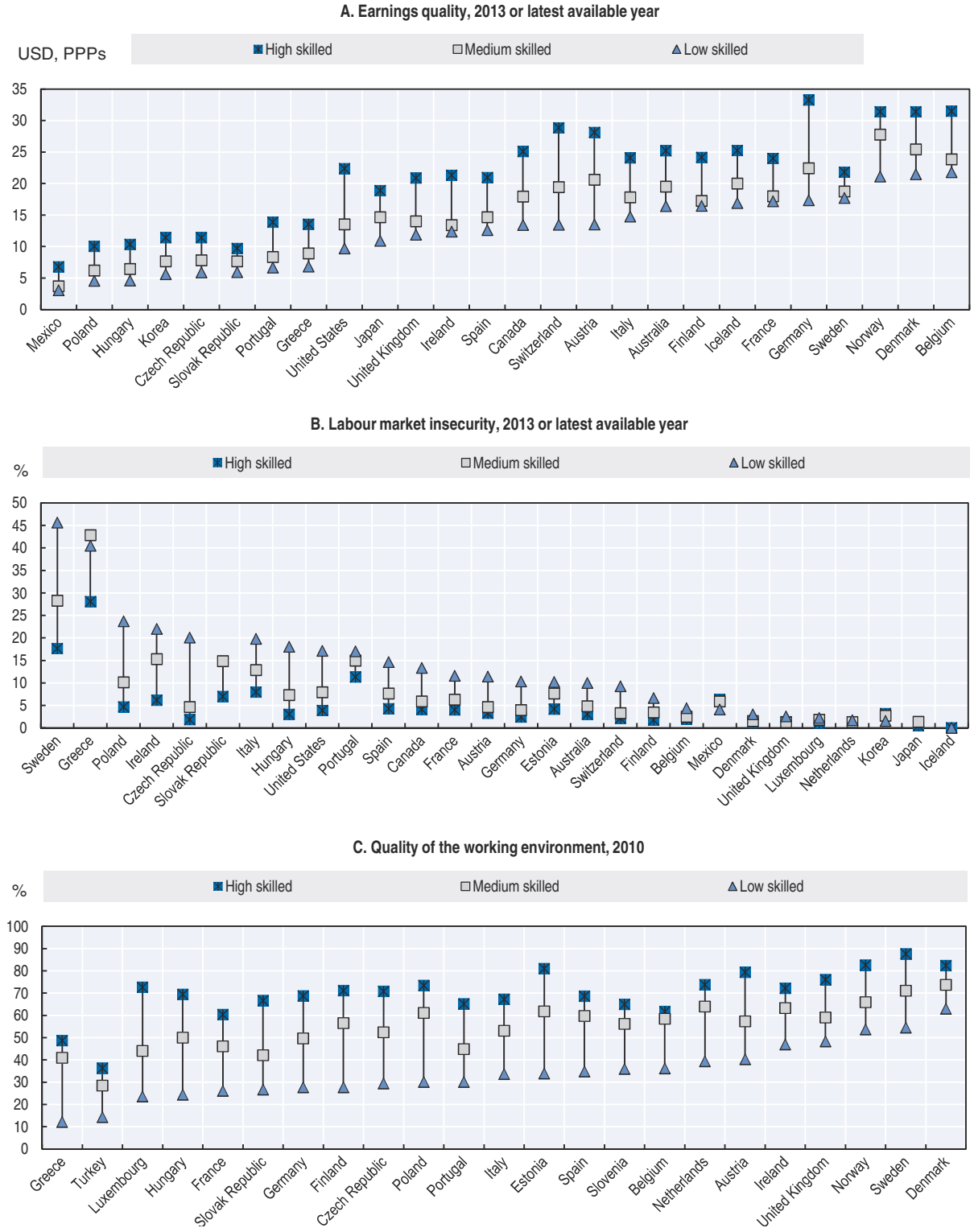
Figure 2.20. **Job quality and participation in global value chains**



Source: OECD calculations based on the OECD Job Quality Database, *https://stats.oecd.org/Index.aspx?DataSetCode=JOBQ*; and OECD Trade in Value Added Database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*.

StatLink http://dx.doi.org/10.1787/888933474239

Figure 2.21. **Job quality in OECD countries by level of education**



Note: The skill levels are based on the International Standard Classification of Education (ISCED, 1997). *Low (skills)* corresponds to less than upper secondary ISCED levels 0, 1, 2 and 3C short programmes. *Medium (skills)* corresponds to upper secondary and post-secondary non-tertiary ISCED levels 3A, 3B and 3C long programmes, and ISCED 4. *High (skills)* corresponds to tertiary ISCED levels 5A, 5B and 6.
Source: OECD Job Quality Database, *https://stats.oecd.org/Index.aspx?DataSetCode=JOBQ*.

StatLink *http://dx.doi.org/10.1787/888933474245*

To determine whether skills can prevent participation in GVCs from lowering job quality, one can look at the relationship between the gap in job quality between low-skilled and high-skilled workers, on one hand, and participation in GVCs on the other hand. This gap varies greatly from country to country. The difference in earnings quality between low-skilled and high-skilled workers is large in Austria, Germany and Switzerland and much lower in France and Sweden. Labour market institutions contribute to these differences across countries, but participation in GVCs might be another explanation. The gap in job strain between low-skilled and high-skilled workers increases with the use of foreign intermediates, suggesting that participation in GVCs might create stronger work pressure for low-skilled workers (Figure 2.22). In contrast, the gap in earnings quality between low-skilled and high-skilled workers decreases with the use of foreign intermediates.

In developing and emerging countries exposed to globalisation, the evolution of wages, working conditions, social protection and workers' rights has raised concerns. These concerns escalated when more than 1 100 people died in the 2013 collapse of the Rana Plaza, a commercial building in Dhaka, Bangladesh, that housed several factories making garments for retailers in developed countries. The OECD job quality framework clearly shows that job quality is lower in emerging economies than on average in OECD countries, in all three dimensions (OECD, 2015d) (Figure 2.23).

Educated workers in emerging countries are less exposed to the risk of low job quality (Figure 2.23). Workers with a high level of educational attainment enjoy not only higher earnings but also more earnings equality than less educated workers. They are much less exposed to labour market insecurity and the quality of their work environment is better.

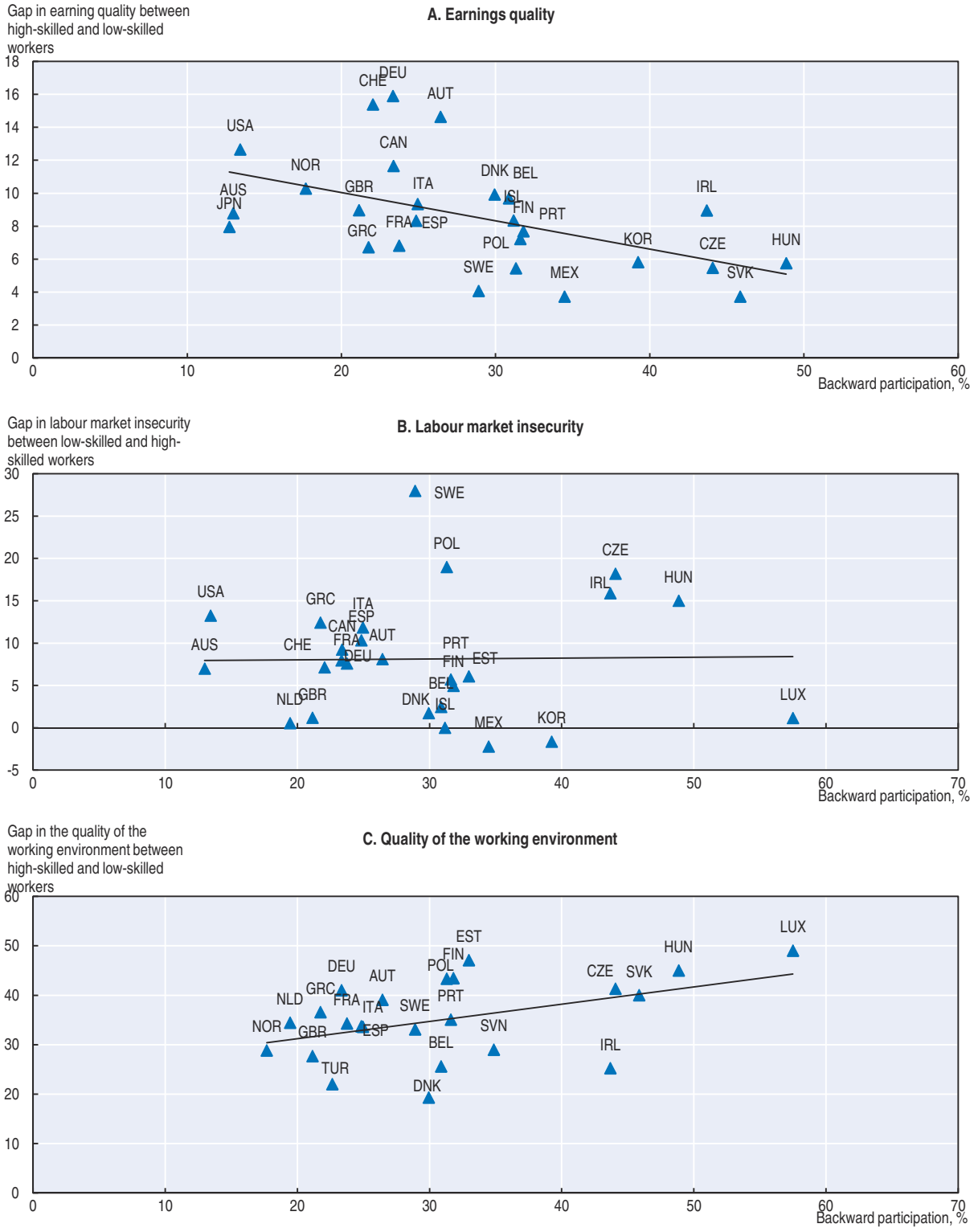
Due to data limitations, it is not possible to link the evolution of job quality in emerging economies to their participation in GVCs. However, case studies of industries or firms illustrate how participation in GVCs can influence job quality and what role skills play in giving workers access to better jobs within GVCs. A study of 19 garment supplier firms in Morocco showed that increased value added in these firms did not lead to better working conditions for all workers (Rossi, 2013). Distinguishing between the various forms of economic upgrading (Box 2.4), the study showed that functional upgrading – a change in the activities of the firm (e.g. from manufacturing to product conception or packaging) – led to an increase in inequalities between workers. High-skilled workers benefited from training, as well as increased responsibilities and wages, while low-skilled workers, who were often on temporary contracts or in irregular jobs, faced pressure to work longer days and accept poorer working conditions.

Summary

Participation in GVCs poses both challenges and opportunities for countries. The main opportunity takes the form of higher productivity gains. New estimates in this chapter show that countries with the highest participation in GVCs experience higher productivity gains in industries that offer greater potential for fragmentation of the production process. Skills appear to play a key role in realising these productivity gains. For participation in GVCs to benefit to a maximum number of firms, including smaller ones, their workers need a level of skills high enough for the firm to realise the productivity gains offered by increased specialisation in tasks and exposure to more sophisticated inputs.

The main challenges posed by participation in GVCs are the risks of reduced employment and higher inequality. Competition from imports from China seems to have

Figure 2.22. **Gap in job quality between high-skilled and low-skilled workers and participation in global value chains**



Source: OECD calculations based on OECD Job Quality Database, *https://stats.oecd.org/Index.aspx?DataSetCode=JOBQ*; and OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*.

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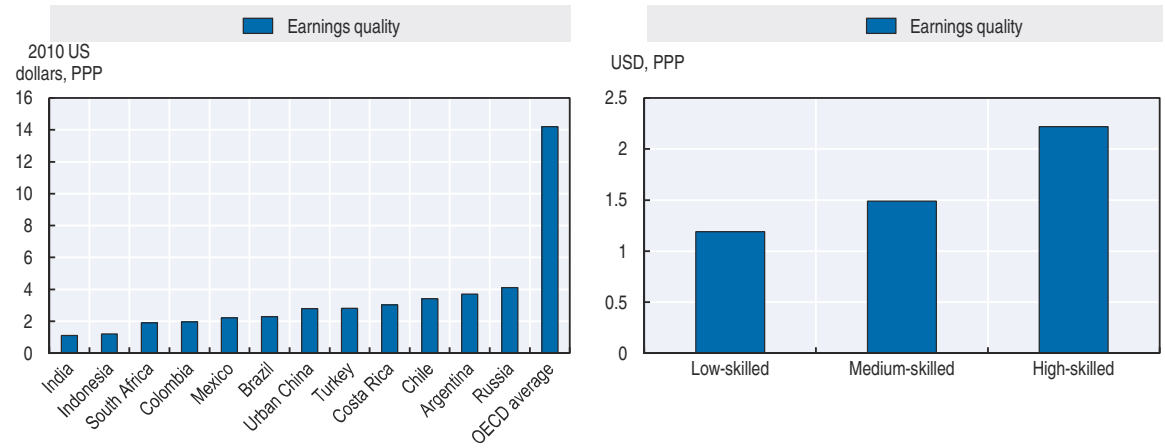
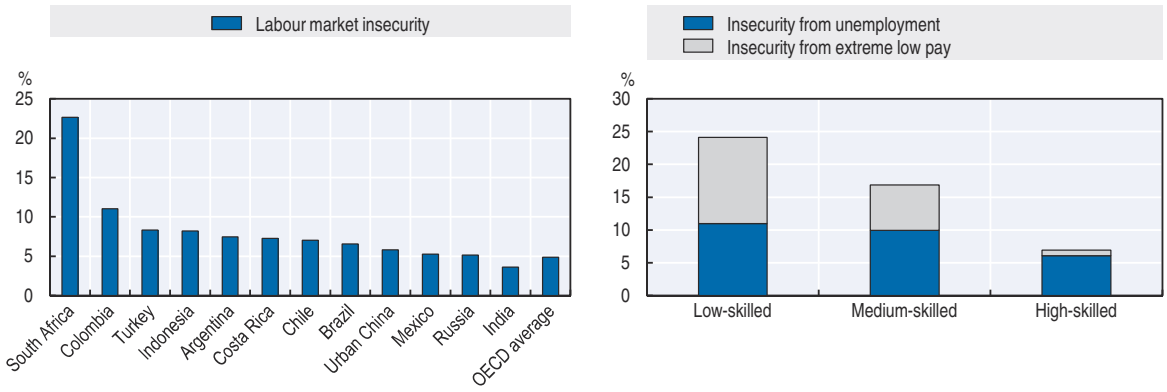
Figure 2.23. **Job quality in emerging economies**

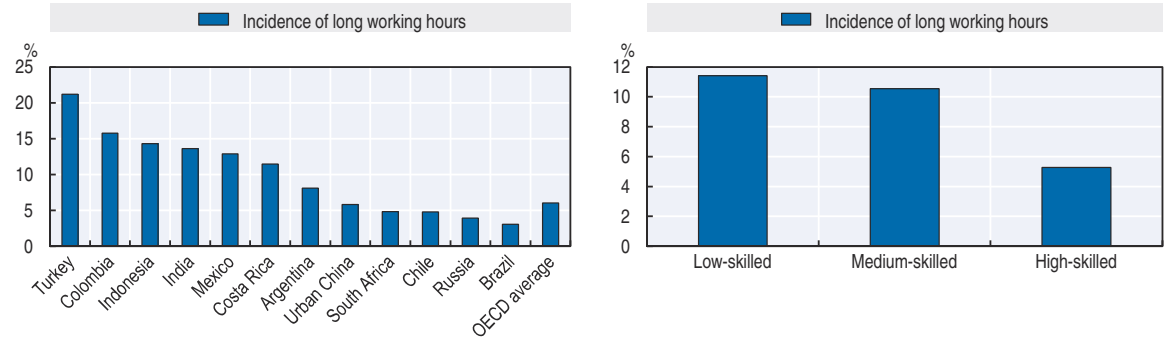
A. Earnings quality, PPP-adjusted international dollars



B. Labour market insecurity due to unemployment



C. Incidence of very long working days



Note: Earnings quality is in 2010, labour market insecurity in 2010 to 2012 depending on countries and the incidence of very long working days in 2010 to 2011 depending on countries. Earnings quality is given for a medium inequality aversion.

The right-hand panels represent unweighted country averages of 12 sampled emerging economies (Argentina, Brazil, Chile, China, Colombia, Costa Rica, India, Indonesia, Mexico, the Russian Federation, South Africa, Turkey) except that China, India, Indonesia and the Russian Federation are excluded from the calculation of overall labour market insecurity due to missing information on social transfers.

The skill levels are based on the International Standard Classification of Education (ISCED, 1997). Low-skilled corresponds to less than upper secondary ISCED levels 0, 1, 2 and 3C short programmes. Medium-skilled corresponds to upper secondary and post-secondary non-tertiary ISCED levels 3A, 3B and 3C long programmes, and ISCED 4. High-skilled corresponds to tertiary ISCED levels 5A, 5B and 6.

For more information about the construction of these indicators, see the source document.

Source: OECD (2015d), *OECD Employment Outlook 2015*, *http://dx.doi.org/10.1787/empl_outlook-2015-en*.

StatLink *http://dx.doi.org/10.1787/888933474266*

had a greater influence on employment than on inequality, because both low-skilled and high-skilled jobs are affected by the use of foreign intermediates. In addition, factors other than the development of GVCs appear to play a bigger role in explaining inequality. Findings on the impact of GVCs on employment and inequality are sometimes difficult to reconcile, however, and generally look at only one aspect of GVCs, the risk of offshoring.

Jobs that involve a higher proportion of routine tasks are more exposed to the risk of offshoring, whereas factors such as face-to-face contact, the need to be on-site and involvement in the decision process tend to make jobs less easy to offshore. Overall, investing in skills development is important to reduce workers' exposure to offshoring.

Participation in GVCs can also reduce job quality, for instance by putting workers under greater pressure. Workers in emerging economies who have a low or medium level of education are particularly exposed to this risk, but workers in OECD countries are also affected. The gap in the quality of the working environment between workers with low and high levels of education tends to increase with as participation in GVCs increases in OECD countries.

In many respects, investing in skills can help countries seize the benefits of GVCs. A broad range of skills is needed, including skills to absorb new technologies, to communicate with other workers in the value chain, and to adapt to change. Skills can also directly shape countries' positioning and specialisation in GVCs (see Chapter 3). While some OECD countries used to have a clear advantage because their workers had a higher level of education, this is becoming less and less the case. What makes the most difference now is the quality of education – the overall set of skills of the population, and how workers use these skills – rather than the overall level of education.

Notes

1. Due to data limitations, these studies approximate skills by the education level of workers to assess the evolution of the content of GVCs in terms of skills.
2. The literature on the evolution of the demand for tasks mainly concerns the United States by exploiting the information on job task requirements from the Dictionary of Occupational Titles (Autor, Levy and Murnane, 2003) or its successor database, O*NET (Acemoglu and Autor, 2010), over several decades. This information is combined to employment data by occupation to form a panel that allows for analysing changes in task input within industries, education groups, and occupations in the United States.
3. Some studies have looked at the evolution of the distribution of occupations to derive some implications on the evolution of the demand for skills, assuming that (Aedo et al; 2013): 1) the content of occupations in terms of skills has remained unchanged; and 2) the skill intensities for each occupation is that of the United States as presented in the O*NET database. The authors find that the intensity of non-routine skills indeed increases across countries and time in a rather monotonic manner but that the shift with respect to routine skills, both manual and cognitive, is not uniform. This assumes that occupations are similar across countries and identical to occupations in the United States.

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Chapter 3

What kinds of skills give countries a global advantage?*

The chapter analyses how different types of skills relate to export performance and participation in global value chains (GVCs) and investigates how skills characteristics shape countries' comparative advantages in GVCs. To investigate the links between skills and GVCs, this chapter uses a new set of empirical analyses based on the Survey of Adult Skills and the Trade in Value Added (TiVA) database. It puts forward two major skills characteristics that shape countries' comparative advantages in GVCs: the skills mix of the population and the role of pools of workers performing at the expected level. The chapter also indicates which industries countries could specialise in, given their skills sets, and what countries would need to do to specialise in technologically advanced industries.

*The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

While skills are believed to make a crucial contribution to performance in global value chains (GVCs), there is little evidence about how skills actually affect such performance. Trade experts consider that skills play an important role in countries' trade performance and specialisation, and that a skilled workforce is a source of comparative advantage that enables countries to specialise in high-skilled segments of exports. The Heckscher-Ohlin model, a pillar of international trade theory, identifies skills as one of the factors that have a strong direct effect on countries' industry specialisation and international integration. Studies that have tried to assess these links empirically share two types of limitation, however, both due to lack of data: skills are most often approximated by educational attainment and the emergence of this new pattern of trade, GVCs, is not taken into account.

Many OECD countries used to enjoy a comparative advantage because the education level of their population was higher, but this advantage is vanishing as tertiary education expands in many developing and emerging economies. Countries are increasingly competing not only through the education level of their population but also through the quality of skills, their effective use and efficient allocation of skills to industries. Chapter 2 showed that a broad range of skills can help countries to realise the benefits of GVCs. This chapter goes deeper by investigating which types of skills are important for participation and performance in GVCs. It also considers which characteristics of skills can shape specialisation in GVCs, and shows how these characteristics have to correspond to industries' requirements for these industries to be able to export more.

To investigate the links between skills and GVCs, this chapter uses a new set of empirical analyses based on the Survey of Adult Skills, a product of the OECD Programme for International Assessment of Adult Competencies (PIAAC), and the Trade in Value Added (TiVA) database. In particular, this chapter:

- Builds a set of new skills indicators based on the Survey of Adult Skills to characterise not only the cognitive skills of workers in each country, but also skills linked more closely to social and emotional aspects of jobs, which are particularly valued by employers. These skills indicators can also be used to describe the skills requirements of each industry.
- Analyses how different types of skills relate to export performance and participation in GVCs, by investigating how countries' skills in each industry are linked to their exports and GVC activities with various trade partners in the same industry. The chapter also examines how industries differ in their skills requirements.
- Investigates how skills characteristics shape countries' comparative advantages in GVCs. The chapter puts forward two major skills characteristics:
  - The skills mix: Each individual needs to have high levels of several types of skills, rather than specialising in only one skill.
  - Pools of workers: Most technologically advanced industries require pools of workers with reliable skills; such pools emerge in countries where individuals have the skills that would be expected given their various characteristics, including education level.

- Explains the need to ensure that countries' skills characteristics match industries' skills requirements. The chapter indicates which industries countries could specialise in, given their skills sets, and what countries would need to do to specialise in technologically advanced industries.

The main findings in this chapter include:

- When their workers have higher cognitive skills and stronger readiness to learn, as measured by the Survey of Adult Skills, countries tend to add more value to exports and participate more in GVCs.
- Industries differ in their needs for skills in information and communications technologies (ICT); science, technology, engineering and mathematics (STEM); managing and communication; marketing and accounting; and self-organisation. In most industries, however – especially high-tech manufacturing and complex business services – workers perform several types of tasks requiring not only cognitive skills but also social and emotional skills. This means education systems need to develop a broad set of skills.
- Skills policies can shape countries' specialisation and give them a comparative advantage in GVCs, for instance by ensuring a better alignment of countries' skills characteristics with the skills requirements of high-tech manufacturing and complex business service industries. By the same token, policies that favour a specific industry can lead to misallocation of skills and lower countries' comparative advantage in other industries, generating costs for the economy.
- Workers need to have a mix of skills to perform in an internationally competitive environment. Strong literacy or numeracy skills are not enough; workers also need strong problem-solving skills for technology-rich environments. Differences in the skills mix can lead to up to 60% differences in exports in one industry relative to another between two countries.
- To be able to specialise in technologically advanced industries, a country's population should, on average, have a level of the main skill required by an industry that is higher than that of other skills and higher than in other countries, and those with the higher level of the main skill should have the right mix of skills. Countries with the stronger alignment of the mix of skills with these industries' skills requirements are Canada, Estonia, Israel, Korea and Sweden.
- Countries need pools of workers with qualifications that reliably reflect what they can do ("reliable workers") to be able to export more than other countries in high-tech manufacturing and complex business service industries, which require all workers to perform at the expected level. Pools of reliable workers emerge when individuals with similar characteristics (including education attainment) tend to share similar skills, such as in Japan, which can export (in value added terms) much more than Chile in high-tech manufacturing and complex business service industries relative to other industries. Japan, the Czech Republic, the Netherlands, and the Slovak Republic show a small dispersion of the skills of individuals with similar characteristics, helping them to provide pools of reliable workers.
- Most OECD countries have gained comparative advantages in services and high-tech manufacturing industries. To maintain this specialisation, or specialise in other technologically sophisticated industries, countries have to ensure that overall, workers' skills are strongly aligned with industries' skills requirements. Countries whose skills

characteristics are best aligned with technologically advanced industries' requirements include the Czech Republic, Estonia, Japan, Korea and New Zealand. Australia, Ireland, the United Kingdom and the United States need to better align their skills characteristics with industries' skills requirements to maintain or deepen specialisation in these industries.

Skills for economic performance

A taxonomy of skills

Thanks to the pioneering work of James Heckman, individuals' skills – in all their diversity – are now recognised as fundamental determinants of economic and social success. Cognitive skills involve conscious intellectual effort and include long- and short-term memory, auditory and visual processing, processing speed, and logic and reasoning. Non-cognitive skills, also known as soft skills, social and emotional skills or personality traits, involve the intellect in a more indirect and less conscious fashion than cognitive skills, and relate to individuals' personality, temperament, attitudes, integrity and personal interaction. Several analyses stress the importance of both cognitive and non-cognitive skills for occupational attainment and performance on the job (e.g. Heckman, Stixrud, and Urzua, 2006; Kautz et al., 2014).

General cognitive skills, which partly reflect the ability to learn, help predict the occupational level workers attain, their job performance and their ability to benefit from training (e.g. Schmidt, 2002; Schmidt and Hunter, 2004). There is strong empirical evidence that cognitive skills, rather than the level of schooling reached, influence individual earnings, the distribution of income and more generally economic growth (Hanushek and Woessmann, 2008).

Numeracy and mathematical skills are directly conducive to business success, particularly in technologically advanced industries (Hoyles et al., 2002). Many of the fastest-growing occupations and emerging industries require numeracy, knowledge of scientific and mathematical principles, as well as the ability to generate, understand and analyse empirical data and solve complex problems (UKCES, 2011). These skills make technological breakthroughs possible.

ICT skills play a key role in improving companies' performance. Firms with high ICT capabilities tend to outperform comparable firms in the same industry on a sustained basis (Bharadwaj, 2000; Santhanam and Hartono, 2003). ICT investment seems to pay off for some companies but not others, because of organisational learning and ICT competencies in particular (Tippins and Ravipreet, 2003).

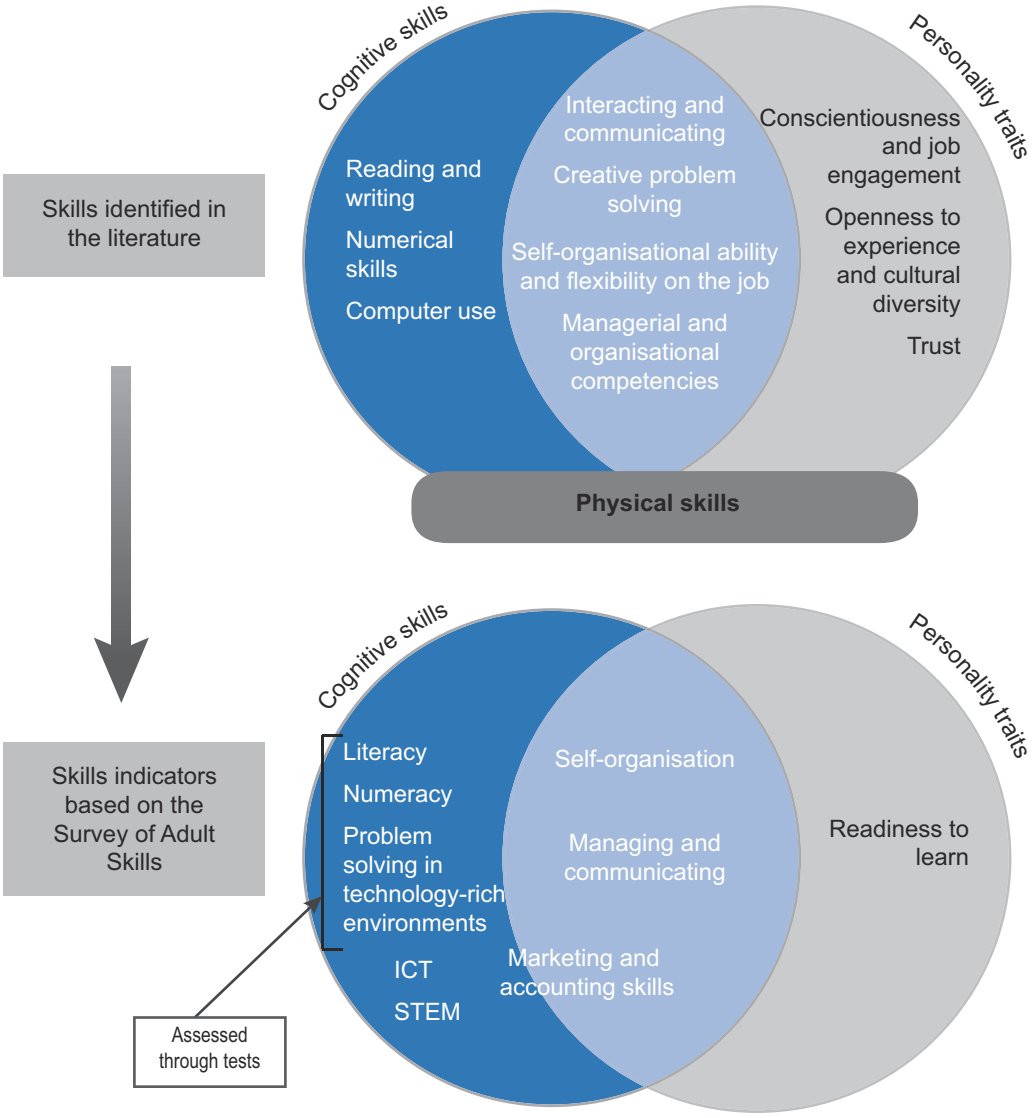
Along with cognitive skills, a wide range of personality traits matter for economic performance (Heckman and Rubinstein, 2001). Some authors argue that for many outcomes, these skills are just as important as cognitive skills, or even more so (Kautz et al., 2014). Many researchers group personality measures under five key factors: extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience (Goldberg, 1990). Agreeableness includes skills like empathy, perspective taking, co-operation, and competitiveness. Conscientiousness includes grit, perseverance, delay of gratification, impulse control, achievement striving, ambition, and work ethic. Emotional stability includes self-evaluation and self-esteem, self-efficacy and optimism. Many of these are a mix of traits that individuals are born with and abilities that can be learnt and improved over time.

On the job, some specific skills such as communication, management, self-organisation and problem solving are highly valued by employers and contribute to firm performance (Hitt,

Ireland and Hoskisson, 2012; Bloom and Van Reenen, 2010; Bloom et al., 2012; Ichniowski, Shaw and Prennushi, 1997). These skills combine cognitive skills and personality traits.

Overall, skills that matter for job performance form a continuum, from skills that are mostly cognitive to skills mostly linked to personality traits, with skills in between that combine both (Figure 3.1, first part). In addition, physical skills are crucial in several sectors, such as construction, health and well-being, and the arts.

Figure 3.1. **Skills indicators: From the literature review to indicators based on the Survey of Adult Skills**



Building skills indicators from the Survey of Adult Skills

The Survey of Adult Skills provides a broad range of information about adults' skills and the tasks they perform. This information can be used to measure some of the skills that researchers have identified as important for job performance and firm performance. The survey assesses three domains of cognitive skills (numeracy, literacy and problem

solving in technology-rich environment) through administered tests. In addition, a background questionnaire asks how often individuals perform tasks including reading, writing, numeracy, ICT and problem solving, partially matching the set of cognitive skills assessed through tests. The survey also gathers information on how often other types of tasks are performed, such as those involving management, communication, organisation and planning, and physical work. Finally, the survey provides information on attitudes towards learning, trust, health and other issues.

Alongside the three cognitive skills assessed in the Survey of Adult Skills, the large set of information related to the skills of individuals has been summarised in six task-based skills indicators through a statistical method (Box 3.1): ICT skills, readiness to learn, management and communication skills, self-organisation skills, marketing and accounting skills, and STEM skills (Figure 3.1, second part). Since most of the task-based skills indicators[1] are based on information about how often tasks are performed, they do not directly capture the skills possessed by workers.

Box 3.1. **Developing a taxonomy of performance-relevant skills based on the Survey of Adult Skills**

In a first step, a set of skills indicators was developed following a normative approach (Grundke et al., forthcoming a). Based on an extensive literature survey on the determinants of performance on the job and firm performance, 17 skills indicators that could be grouped into five categories were constructed, initially using the Survey of Adult Skills. The idea behind this categorisation was that skills should be seen as a continuum, with some mainly cognitive, others close to personality traits and a large group combining the two aspects.

The normative approach leads to skills indicators that can be easily interpreted, but it does not ensure that they are statistically relevant in terms of the covariance structure of the question items from the Survey of Adult Skills. In a second step, a set of new skills indicators were derived from an exploratory factor analysis, relying thus on a data-grounded method. An exploratory factor analysis assumes the existence of a certain number of unobserved latent variables, called factors (the new skills indicators), whose joined variation explains the correlation pattern of a larger set of observed variables. Each factor is a weighted combination of the observed variables, whereby the weights on the observed variables are called *factor loadings*. The number of factors is a parameter of the model and needs to be chosen carefully using certain criteria established in the literature (Conti et al. 2014; Costello and Osborne 2005).

One of the main drawbacks of the classical exploratory factor analysis is that observed variables may be associated with all factors, making the factors difficult to interpret. This issue can be addressed by following a three-step procedure (as in Costello and Osborne, 2005), which ensures that each observed item contributes to no more than one single factor. In a first step, factors are rotated to form groups of items loading on certain factors. In a second step, items that load on at least two factors with similar loadings (so-called double loadings) are dropped. Finally, in a third step, only items with loadings above a threshold of 0.45 are assigned to a certain factor.

As a result of the factor analysis, 33 items – variables from the background questionnaire of the Survey of Adult Skills – were retained from an initial set of 57 items. They were grouped into six factors that can be interpreted on the basis of the normative typology as

Box 3.1. **Developing a taxonomy of performance-relevant skills based on the Survey of Adult Skills** *(cont.)*

follows: ICT skills, readiness to learn, management and communication skills, self-organisation skills, marketing and selling skills, and STEM skills – which are called task-based skills in this chapter, as opposed to skills that are assessed through test.

ICT skills: This consists of ten items with very high positive loadings and one item with a negative loading. The items with positive loadings all describe tasks associated with ICT use, from reading and writing emails to using word-processing or spreadsheet software, or a programming language. The factor is strongly associated with office jobs, as indicated by negative loading on "physical activities".

Readiness to learn consists exclusively of items designed in the Survey of Adult Skills to measure this dimension, e.g. "Relate new ideas into real life" or "Like learning new things".

Management and communication skills: This gathers a more diverse set of items, from "teaching people" to "planning others' activities". All these activities involve communicating with and managing other people, whether they are co-workers or not.

Self-organisational skills, like *readiness to learn,* consist exclusively of items designed in the Survey of Adult Skills to measure this dimension. It includes items such as "Work flexibility – Speed of work" or "Work flexibility – Sequence of tasks".

Marketing and accounting skills is a newly constructed indicator that does not correspond to any indicator in the normative typology. "Reading financial statements", "calculating costs or budgets" and "selling products or services" are associated with this factor, as well as "using a calculator". Although the last item also loads on "*ICT contents*" and "STEM contents" (with loadings close to 0.25), it seems that calculators are mainly used for marketing and accounting purposes.

STEM skills: This factor has not been present in the normative typology. Like *Marketing and Accounting Skills*, it involves numeric tasks such as "Use Simple algebra or formulas" or "Use advanced math or statistics", but they are more complex and less specific than those loading on the previous factor. This factor is interpreted broadly as skills necessary for Science, Technology, Engineering and Mathematics.

Each task-based skills indicator has a score ranging from 0 to 1. A higher score is associated with a higher frequency of performing these tasks on the job.

Sources: Conti, G. et al. (2014), "Bayesian exploratory factor analysis", *Journal of Econometrics*.

Costello, A.B and J.W. Osborne (2005), "Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis", *Practical Assessment, Research & Evaluation*.

Grundke, R. et al. (forthcoming a), "Skills and global value chains: Characterisation and evidence", *OECD Science, Technology and Industry Working Papers*.

Some relevant skills dimensions cannot be measured, while others are measured only imperfectly, because there is always a gap between conceptualising skills and measuring them. When subjected to measurement, personality traits tend to include a component of cognitive aspects and cognitive skills also depend on individuals' personality traits. In addition, while the Survey of Adult Skills offers a wealth of information, it was not conceived to measure all the various skills needed at work. The set of items used in developing the skills indicators is constrained by the list of items available in this survey.

In particular, while many of the personality traits affect work outcomes, openness to experience is the only trait that can be represented by an indicator stemming from the

Survey of Adult Skills, the readiness to learn indicator. Openness to experience can improve firm performance by encouraging workers to undertake training and adapt when they face unfamiliar environments. It also appears important for complex jobs that involve autonomy and require unconventional thinking and the adoption of new behaviours and ideas to achieve high job performance (Mohan and Mulla, 2013).

The different types of skills indicators available through the Survey of Adult Skills provide for more precise measures of skills than educational attainment, which is frequently used as a proxy for skills, including in most of the empirical literature on skills and trade. Educational attainment contributes to cognitive and other skills but disguises differences in the quality of countries' education systems. It does not account for differences in the way skills are developed on the job or for the large range of skills that could influence countries' performance within GVCs.

Skills patterns across countries and industries

Countries differ in their workers' skills sets. For the three domains of assessed cognitive skills, Japan and Finland have the most proficient workers, while workers in Greece, Turkey, Chile and Italy have the lowest scores, on average, among OECD countries (Figure 3.2). The picture is much more mixed in terms of task-based skills (Figure 3.3). The top performers in cognitive skills tend to rank well in terms of task-based skills, while some countries like the United States, whose workers have average or below average cognitive skills, rank high on these indicators.

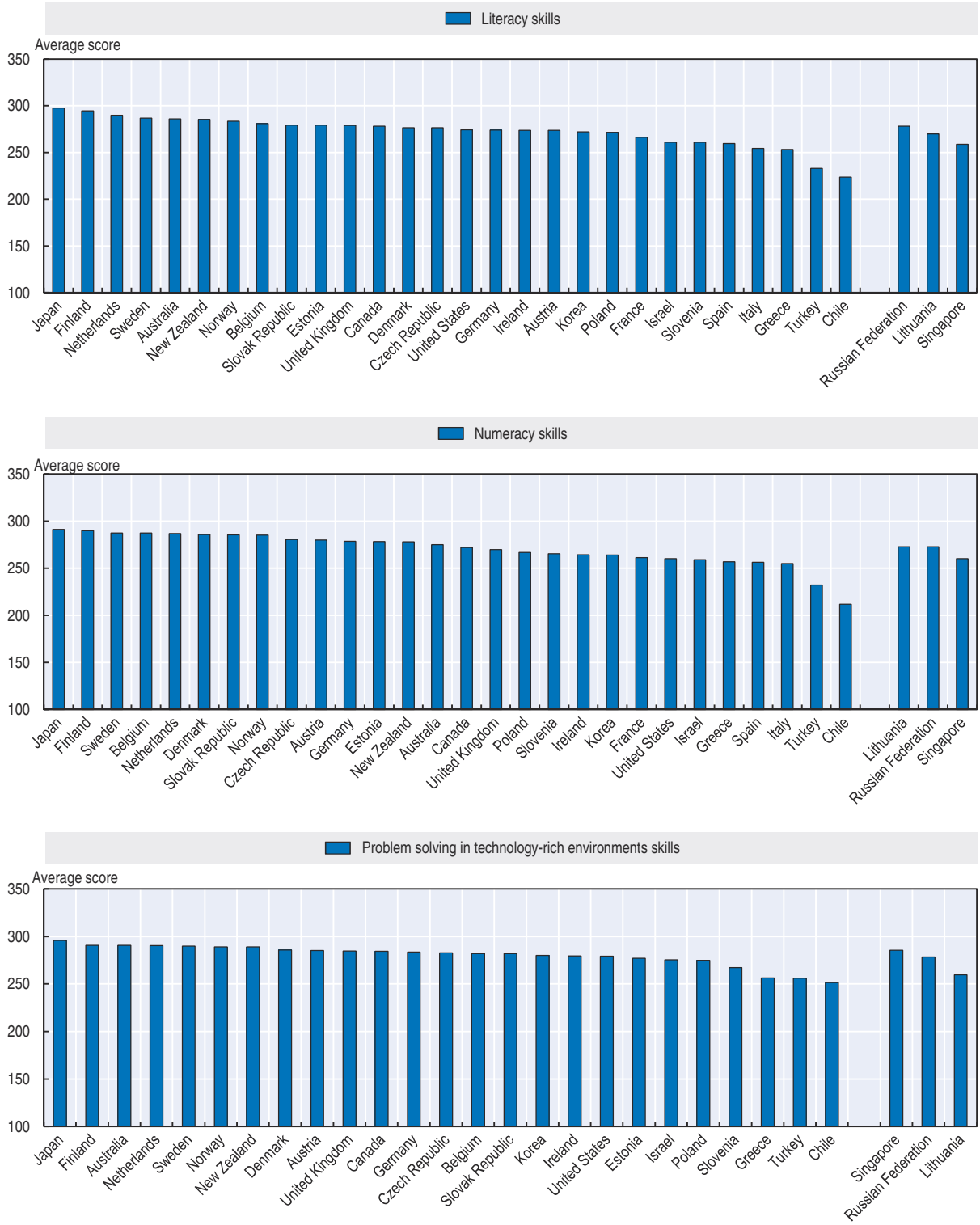
The variation between countries depends on the skills indicator (Figures 3.2 and 3.3). Countries tend to differ the most in terms of cognitive skills assessed through tests (literacy, numeracy and problem solving in technology-rich environments), and the least for marketing and accounting, and STEM skills, two task-based skills. Large cross-country differences also emerge for readiness to learn, with Japan and Korea appearing at the bottom, which reveals the importance of cultural norms. However, given that this indicator is based on self-reported information, it is difficult to know the extent to which differences between countries emerge from real differences in attitudes towards learning or in the way questions are answered.

In terms of countries' performance in GVCs, it is not just countries' levels of skills that are important, but also their allocation of skills across industries, which reflects their capacities to specialise and perform well in some activities and industries. On the one hand, industries requiring higher skilled workers and those in which countries tend to perform well because of other reasons than skills (e.g. historical reasons or the availability of some type of capital specific to the industry) should attract more skilled workers, but this depends on countries' overall skills level and on the efficiency of the allocation process. On the other hand, industries in which countries perform well make greater efforts to enhance their workers' skills through training.

For all types of skills, workers in business services have on average higher skills than workers in other industries (Figures 3.4 and 3.5). Within a given industry, the heterogeneity of workers' skills across countries varies by type of skills. In most industries, large differences exist between countries in terms of cognitive skills assessed through tests and readiness to learn reflecting the dispersion of these skills across countries. Heterogeneity is much lower for the other task-based skills, revealing that industry characteristics play a bigger role than country specificities in determining the allocation of these skills (Figure 3.5).

Figure 3.2. **Workers' cognitive skills as measured in the Survey of Adult Skills**

Country average, 2012 or 2015



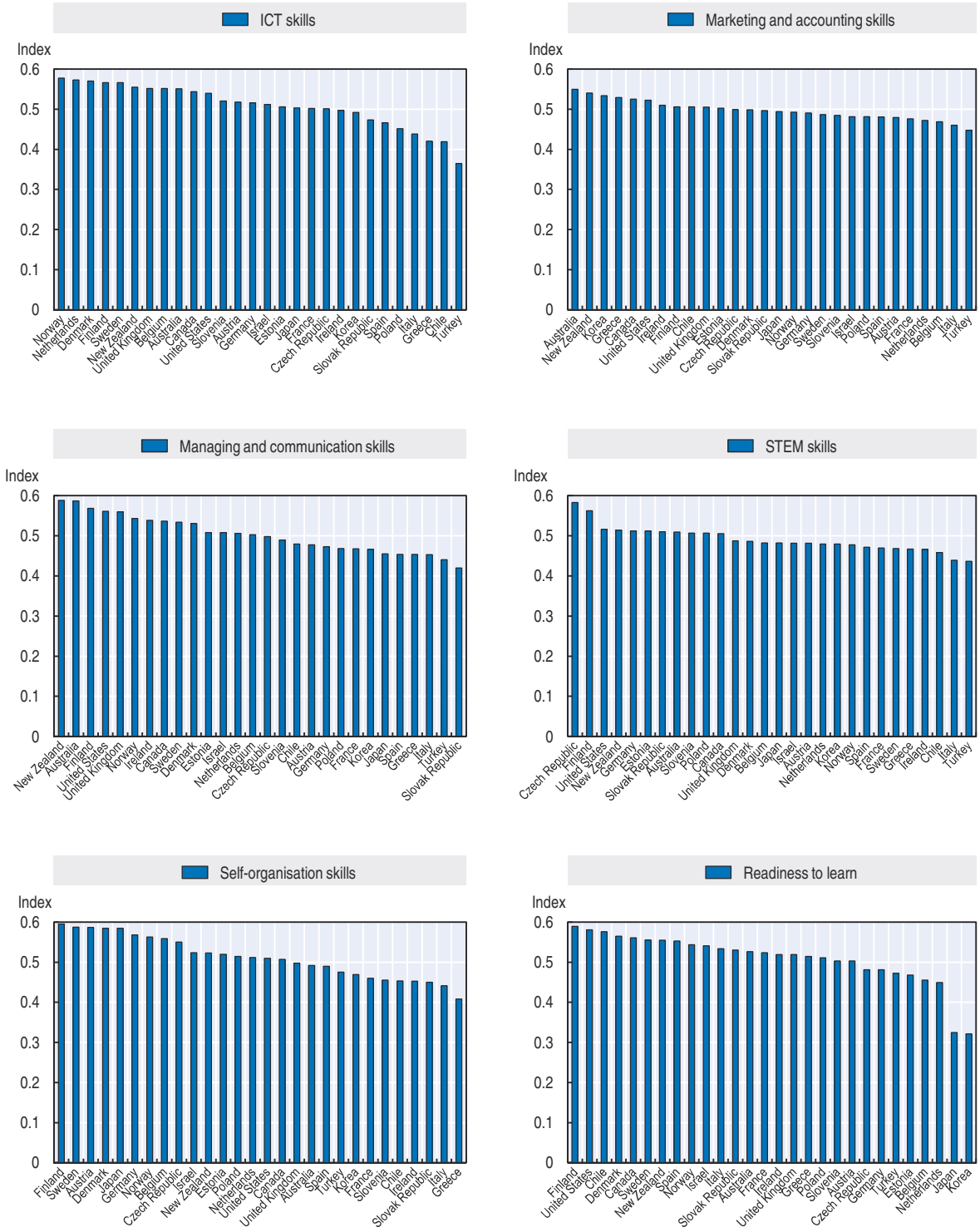
Note: Chile, Greece, Israel, Lithuania, New Zealand, Singapore, Slovenia and Turkey: Year of reference 2015. All other countries: Year of reference 2012. Data for Belgium refer only to Flanders and data for the United Kingdom refer to England and Northern Ireland jointly.

Source: Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis.*

StatLink http://dx.doi.org/10.1787/888933474273

Figure 3.3. **Workers' task-based skills, country level**

Country average, 2012 or 2015

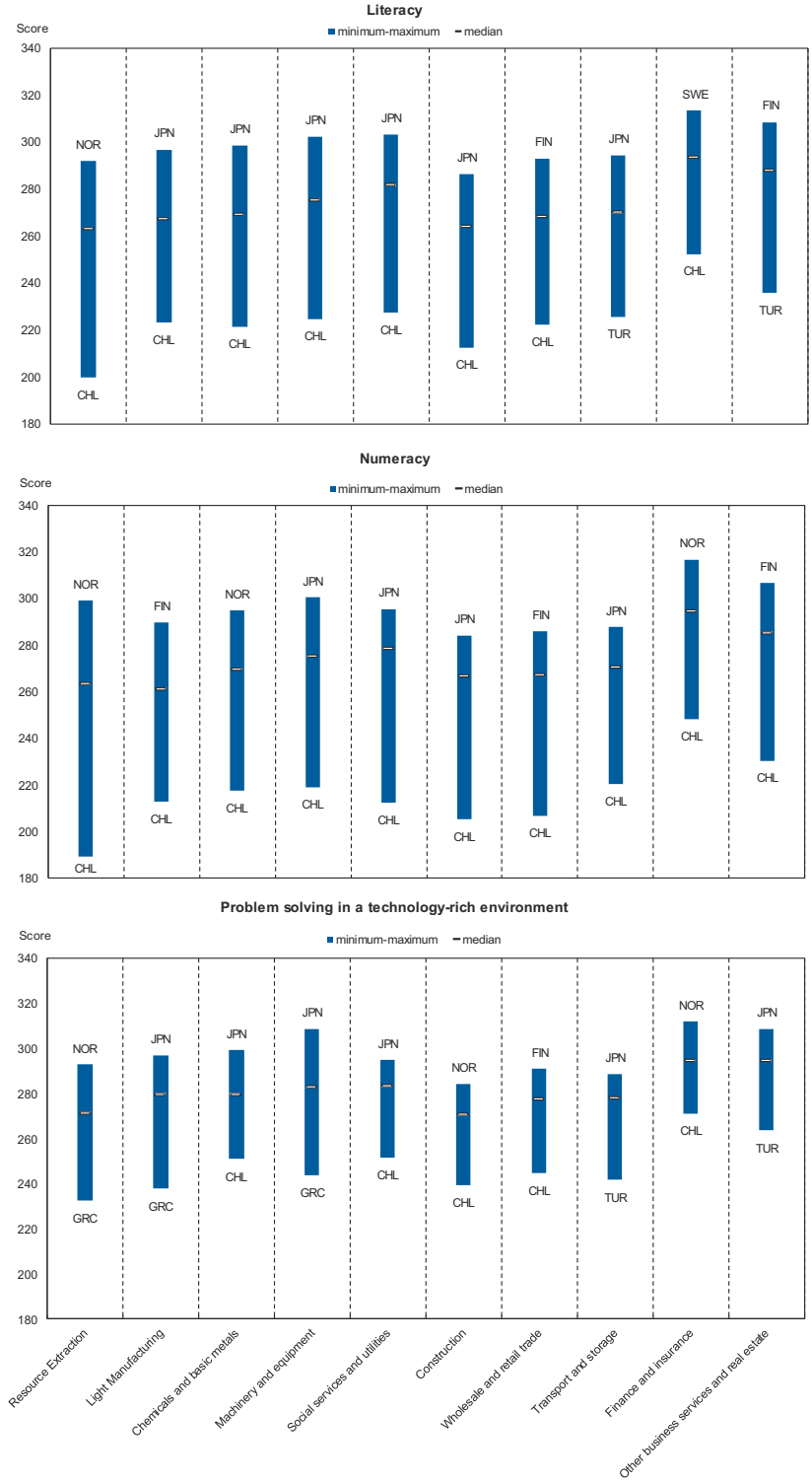


Note: Skills indicators are based on an exploratory factor analysis as described in Box 3.1.
A higher score is associated with a higher frequency of performing these tasks on the job.
Chile, Greece, Israel, New Zealand, Slovenia and Turkey: Year of reference 2015. All other countries: Year of reference 2012. Data for Belgium refer only to Flanders and data for the United Kingdom refer to England and Northern Ireland jointly.
Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis.*

StatLink http://dx.doi.org/10.1787/888933474282

Figure 3.4. **Workers' cognitive skills as measured in the Survey of Adult Skills, industry level**

2012 or 2015



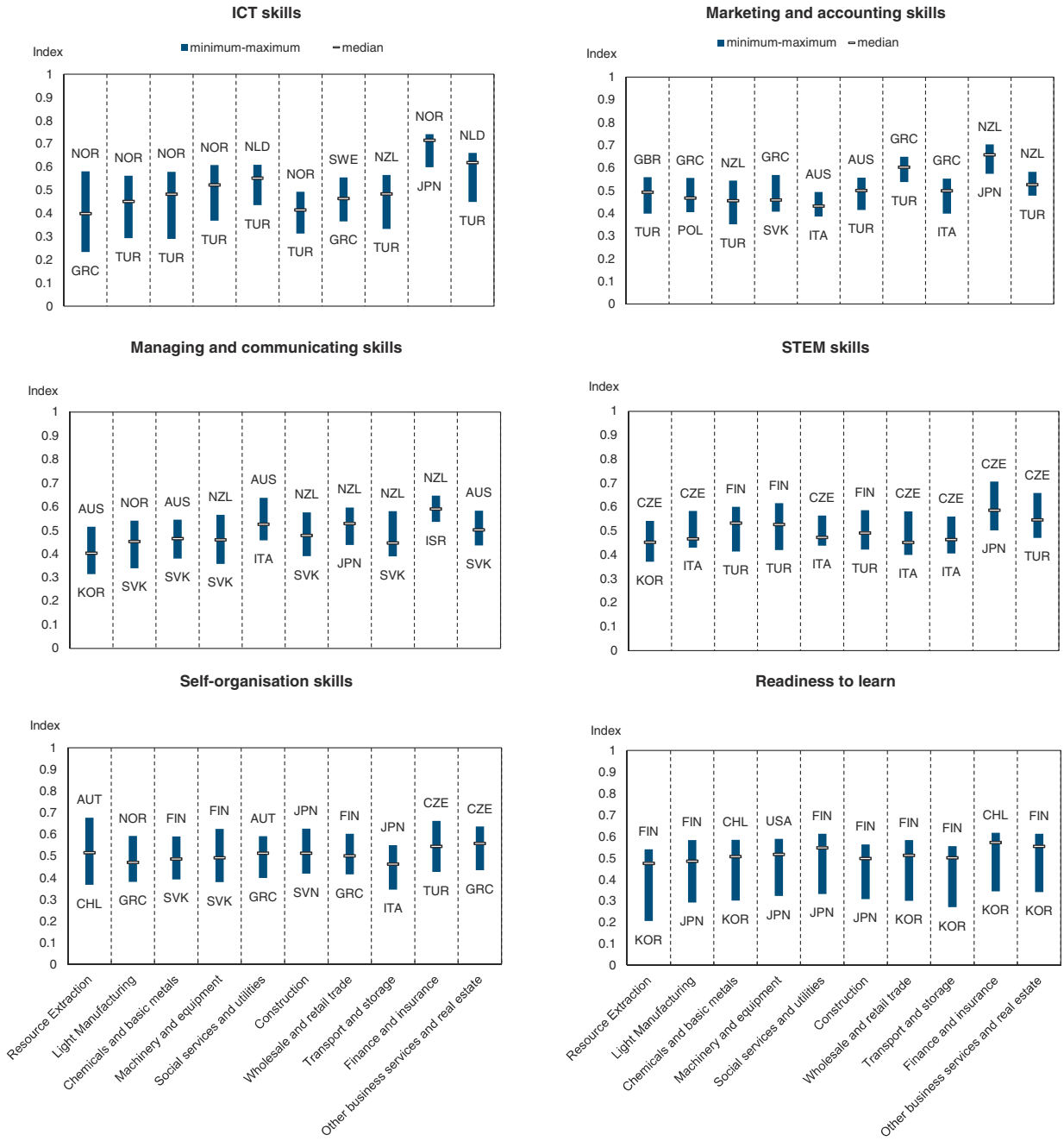
Note: Chile, Greece, Israel, New Zealand, Slovenia and Turkey: Year of reference 2015. All other countries: Year of reference 2012. Data for Belgium refer only to Flanders and data for the United Kingdom refer to England and Northern Ireland jointly.

Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis.*

StatLink *http://dx.doi.org/10.1787/888933474296*

Figure 3.5. **Workers' task-based skills, industry level**

2012 or 2015



Note: Skills indicators are based on an exploratory factor analysis as described in Box 3.1.
Chile, Greece, Israel, New Zealand, Slovenia and Turkey: Year of reference 2015. All other countries: Year of reference 2012. Data for Belgium refer only to Flanders and data for the United Kingdom refer to England and Northern Ireland jointly.
Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis.*

StatLink *http://dx.doi.org/10.1787/888933474306*

Large variations emerge among industries in the use of ICT skills, with business services making the highest use. Among the high-skilled industries (such as business services), some countries make a much lower use of ICT skills than the top country performers. Insufficient ICT skills for some countries in some industries raise concerns, as

this can dampen their capacity to grow and upgrade activities in the current technology-rich environment.

As with other task-based skills, marketing and accounting skills exhibit large variations between industries, yet minimal variations among countries. Two patterns emerge when comparing different industries. First, business services industries (with the exception of wholesale and retail trade), along with construction and transportation, display larger cross-country gaps, which may reflect the specialisation of some countries in marketing and accounting tasks. Second, not only are the gaps among these services industries larger, but their medians are also much higher than those in the manufacturing sector. This result is in line with the nature of occupations within these industries, involving intense interaction with customers, as well as the trend among manufacturing companies to outsource the marketing and distribution activities of their products to service companies, which are better trained to perform these tasks.

The need for a diversity of skills

The varying role of different types of skills for export performance and participation in global value chains

Workers' skills are generally considered crucial for countries' participation in GVCs and export performance, but little is known about which skills are most relevant for each type of export and each kind of participation in GVCs. Some skills, particularly cognitive abilities, could contribute directly to value creation in firms (Barney, 1991; Wright, McMahan and McWilliams, 1994) and subsequently add more value to exports and to intermediates exported for use in third countries' exports (forward linkages or participation). Other skills may encourage offshoring of activities and the use of intermediates from abroad (backward linkages or participation).

Skills can matter for integration into GVCs not only in their diversity but also in the way workers' proficiency varies. A large volume of international activity takes place between developed countries with similar average skills and technologies. The abilities of professionals, production workers and other workers differ among otherwise similar countries, which might explain why these countries benefit from trade.

As countries and industries differ in terms of their levels of skills and their participation and performance in GVCs, it is possible to shed light on the relationship between the two by assessing the links between countries' skills levels by industry, on one hand, and their exports and GVC activities with various trade partners in the same industry on the other hand (Box 3.2).

Such analysis confirms that cognitive skills and personality traits matter for exports, in gross and value added terms, and for participation in GVCs (Figure 3.6). Literacy, numeracy, problem solving in technology-rich environments and readiness to learn all tend to be stronger where exports are stronger, even more so when exports are expressed in value added terms, with cognitive skills having the strongest links. These skills are also likely to be higher where participation in GVCs is stronger, through both backward and forward linkages. These results support the idea that knowledge and learning play a fundamental role in international integration as workers need them to apprehend, share, and assimilate new knowledge in order for countries to participate and grow in evolving markets.

The cognitive skills of different groups of workers – medium, low and high skilled – matter in different ways for exports in value added terms and participation in GVCs

Box 3.2. **The empirical links between different types of skills and performance in GVCs**

The discussion in this section is based on work testing how various types of skills are related to trade and participation in GVCs (Grundke et al., forthcoming a). For this purpose, several indicators of exports and participation in GVCs are linked to various skills indicators one by one, measured in terms of average skills level, skills dispersion, and the median, upper and lower parts of the skills distribution. The skills indicators include the three assessed cognitive skills from the Survey of Adult Skills (literacy, numeracy and problem solving in technology-rich environments), and the six task-based skills indicators resulting from the factor analysis, as described in Box 3.1 (ICT skills, readiness to learn, management and communication skills, self-organisational skills, marketing and accounting skills, STEM skills). They are all country-industry specific.

All indicators of trade and participation in GVCs stem from the Trade in Value Added Database and are used in the analysis at the bilateral industry level and in log form. Exports are considered in gross and value added terms. Three indicators of participation in GVCs are considered: domestic value added embodied in foreign final demand for forward participation (or linkages) in terms of final demand; foreign value added embodied in domestic final demand for backward participation in terms of final demand; foreign value added in exports for backward participation in terms of exports.

The model also includes a series of independent country-industry variables – physical capital intensity, human capital intensity (measured by educational attainment) and expenditure for research and development –to reflect how well countries are able to meet the requirements of industries along various technological dimensions. Barriers to trade are also included, as well as fixed effects to account for country, partner country and industry characteristics.

Country-industry groups that have fewer than 25 observations in the Survey of Adult Skills are removed to reduce measurement error. Standard errors are clustered at the importer-exporter pair level.

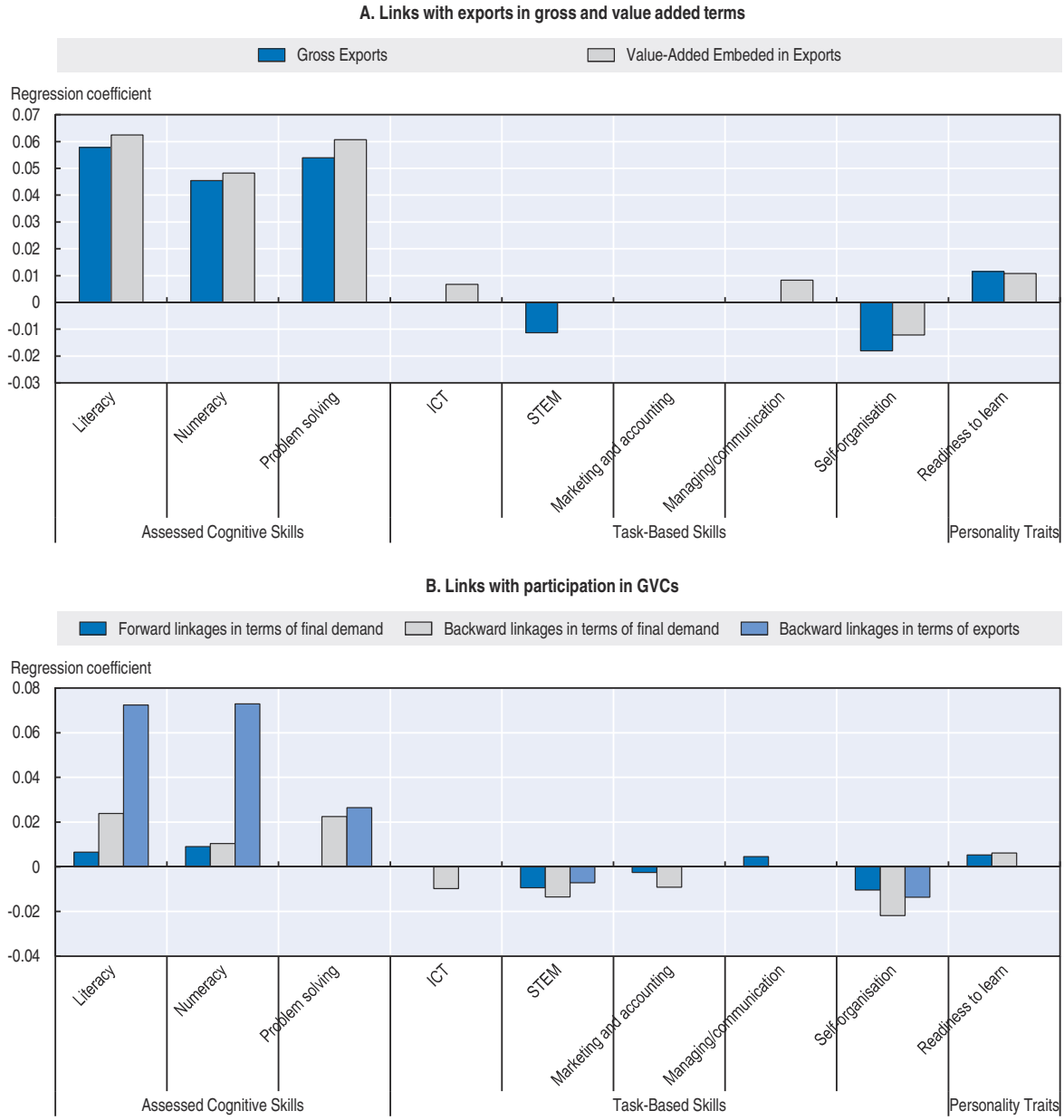
Sources: Grundke, R. et al. (forthcoming a), "Skills and global value chains: Characterisation and evidence", *OECD Science, Technology and Industry Working Papers*.

(Figures 3.7 and 3.8). For literacy, the skills of the most proficient matter most. By contrast, numeracy skills seem to be important across the industry (i.e., at the median of the distribution). This suggests that numeracy is needed not only for innovation and value creation for exports (reflected in forward linkages and exports in value added terms) but also for integrating foreign value added in the domestic production process (backward participation). For problem-solving skills in technology-rich environments, both low-skilled workers (the lower 10th percentile) and high-skilled ones (90th percentile) need to be proficient in their categories to bring domestic value added to international markets (forward participation) as well as to process inputs at the assembly line (backward participation).

Readiness to learn[2] across various types of workers is also likely to be higher where performance in GVCs is stronger. Those most ready to learn tend to have the strongest effect on export activities and participation in GVCs.

In an increasingly competitive and technology-based global economy, it is not surprising to see a positive link between ICT skills and exports, especially when expressed in value added terms (Figure 3.6). The negative link between ICT skills and STEM skills, on one hand, and participation in GVCs, on the other hand, is more ambiguous. A possible

Figure 3.6. **The links between the average of various types of skills and trade within global value chains**



Note: Each bar shows the coefficient of a single specification relating TiVA indicators of exports and participation in GVCs to the average of the indicated skills indicator, while controlling for other variables.

All TiVA indicators are at the bilateral industry level, in 2011, and in log form. Exports are considered in gross and value added terms. Three indicators of participation in GVCs are considered: domestic value added embodied in foreign final demand for forward linkages in terms of final demand; foreign value added embodied in domestic final demand for backward linkages in terms of final demand; foreign value added in exports for backward linkages in terms of exports.

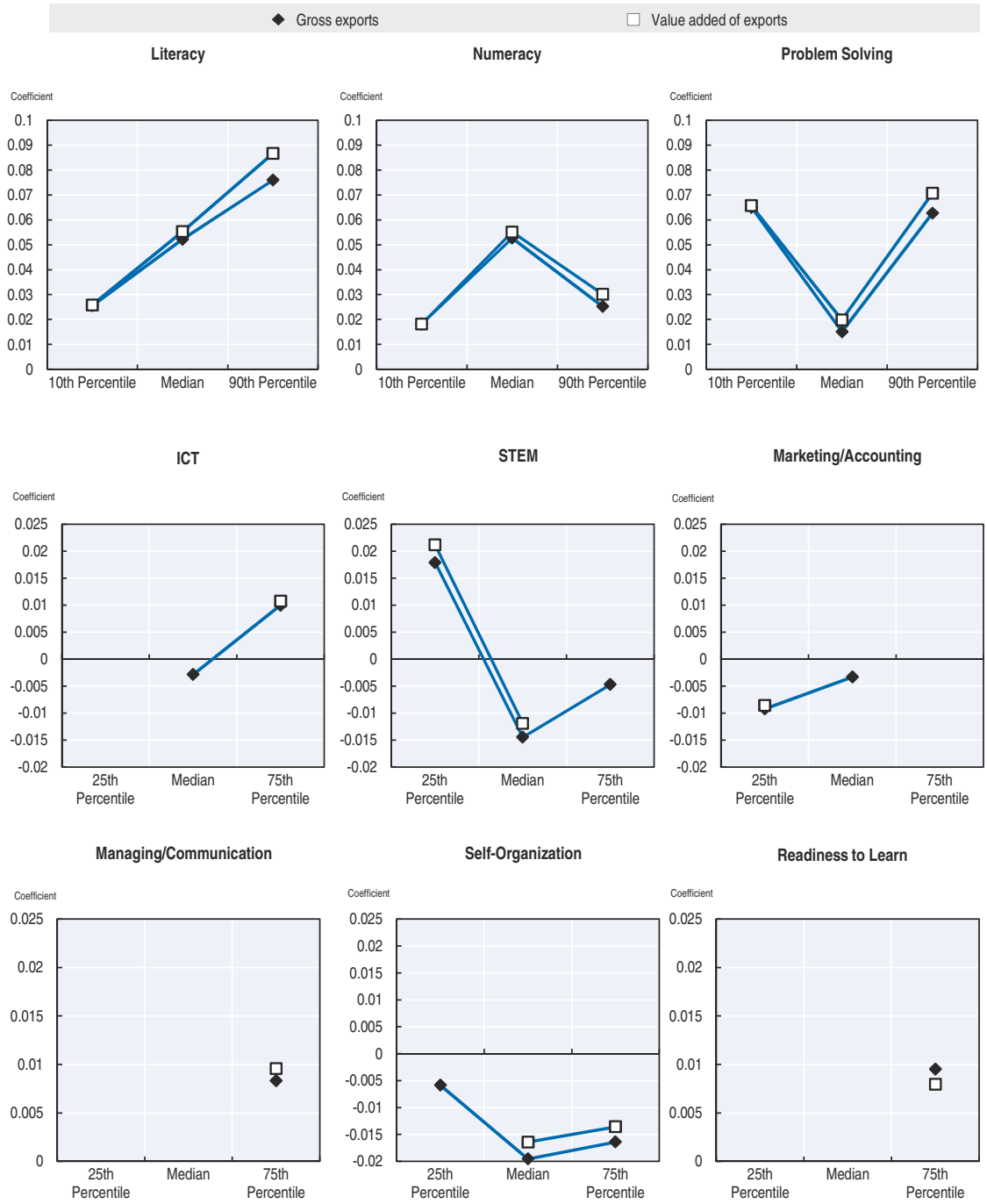
The skills indicators are the mean by country and industry in 2012 or 2015. Country-industry groups that have fewer than 25 observations in the Survey of Adult Skills are removed to reduce measurement error.

Standard errors are clustered at the importer-exporter pair level. Only the coefficients that are significant at the 1%, 5% or 10% levels are shown.

Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis*; OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*; OECD Annual National Accounts, SNA93, *http://stats.oecd.org/*; OECD STAN STructural ANalysis Database, *http://stats.oecd.org/*; Mayer and Zignago (2011), "Notes on CEPII's distances measures: the GeoDist Database", *CEPII Working Paper 2011-25;* World Input-Output Database (WIOD), *www.wiod.org/home*.

StatLink *http://dx.doi.org/10.1787/888933474318*

Figure 3.7. **The links between various parts of the skills distribution and exports in gross and value added terms**

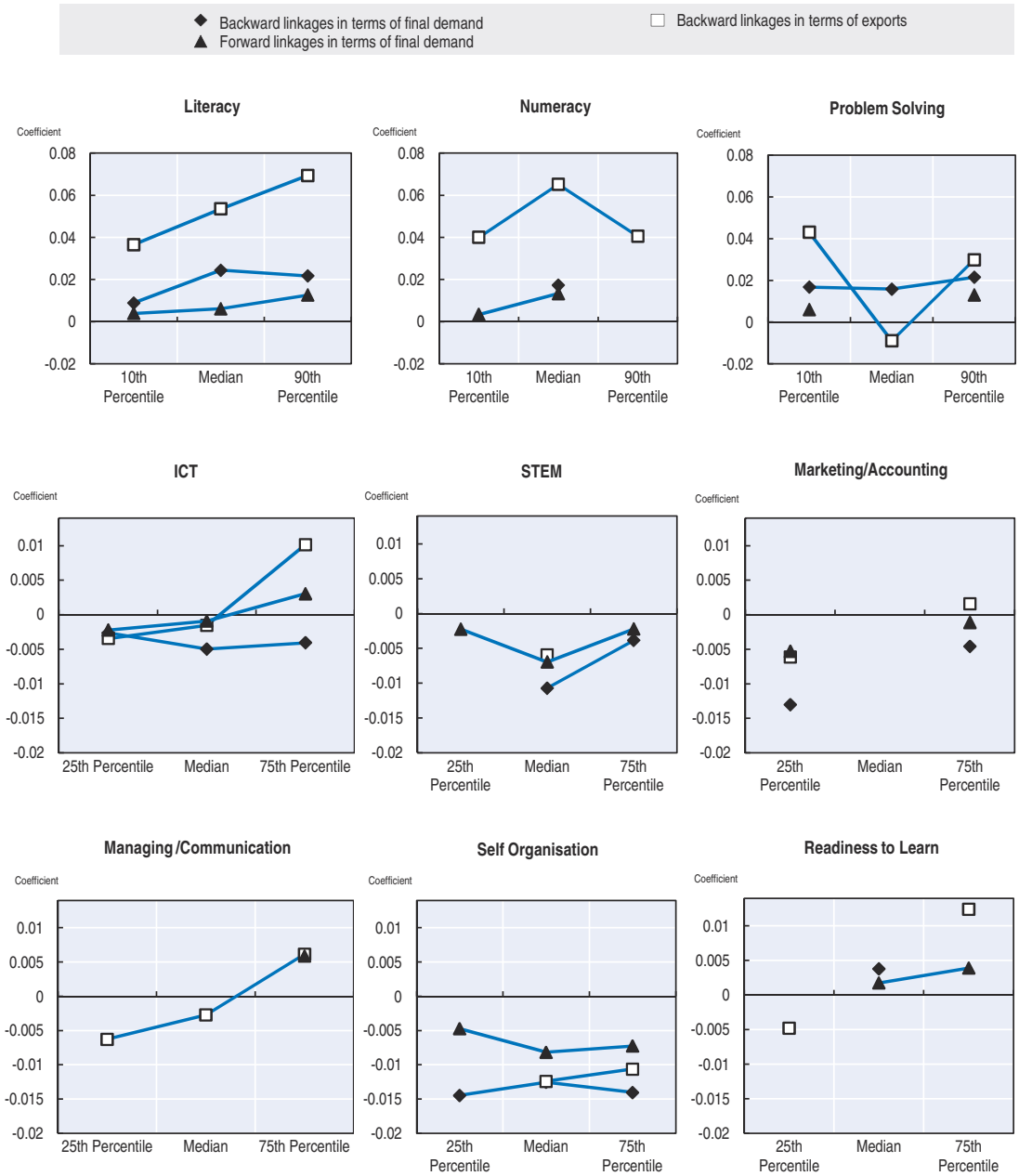


Note: Each mark shows the coefficient of a single specification relating exports to one moment of the distribution of the indicated skills indicator and other variables (Box 3.2). Three moments are considered: the 25th percentile, the median and the 75th percentile. Only the coefficients that are significant at the 1%, 5% or 10% levels are shown. For instance, concerning Marketing/Accounting skills, the 25th percentile relates negatively to exports in gross and value added terms while the median relates negatively to exports in gross terms. No significant relationship is found in other cases.

Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis*; OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*; OECD Annual National Accounts, SNA93, *http://stats.oecd.org/*; OECD STAN STructural ANalysis Database, *http://stats.oecd.org/*; Mayer and Zignago (2011), "Notes on CEPII's distances measures: the GeoDist Database", *CEPII Working Paper 2011-25;* World Input-Output Database (WIOD), *www.wiod.org/home*.

StatLink http://dx.doi.org/10.1787/888933474323

Figure 3.8. **The links between various parts of the skills distribution and participation in global value chains**



Note: Each mark shows the coefficient of a single specification relating participation in GVCs to one moment of the distribution of the indicated skills indicator and other variables (Box 3.2). Three moments are considered: the 25th percentile, the median and the 75th percentile. Three indicators of participation in GVCs are considered: domestic value added embodied in foreign final demand for forward linkages in terms of final demand; foreign value added embodied in domestic final demand for backward linkages in terms of final demand; foreign value added in exports for backward linkages in terms of exports.

Only the coefficients that are significant at the 1%, 5% or 10% levels are shown. For instance, concerning Marketing/Accounting skills, the 25th percentile relates negatively to backward and forward linkages while the 75th percentile relates negatively to backward and forward linkages in terms of final demand, and positively to backward linkages in terms of exports. No significant relationship is found in other cases.

TiVA indicators are in 2011 and skills indicators are in 2012 or 2015.

Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis*; OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*; OECD Annual National Accounts, SNA93, *http://stats.oecd.org/*; OECD STAN STructural ANalysis Database, *http://stats.oecd.org/*; Mayer and Zignago (2011), "Notes on CEPII's distances measures: the GeoDist Database", *CEPII Working Paper 2011-25*; World Input-Output Database (WIOD), *www.wiod.org/home*.

StatLink http://dx.doi.org/10.1787/888933474335

explanation is that certain tasks in industries and occupations intensive in these skills are typically more difficult to offshore.[3]

Many studies have underlined the relevance to firms' performance of skills combining cognitive and personality trait aspects such as management, communication, marketing, and self-organisation. However, some of these skills appear to be only weakly related to performance and participation in GVCs.

Managing and communication skills matter for exports in value added terms, and for international integration in the case of forward linkages (Figure 3.6). Communication and interaction skills can develop complementarities among workers in production, facilitate gains from specialisation, and encourage gains from knowledge transfer, which in turn would benefit forward and backward participation in GVCs alike. Combined with strategic management abilities, communication and interaction skills can generate sustainable advantages and enhance competitiveness in global markets.

Strong marketing and accounting skills, as well as self-organisation skills, do not appear to be important for exports and integration in GVCs[4] (Figure 3.6). Self-organisation skills may be negatively linked with backward participation because these skills are most frequently used by managers, who are less concerned by offshoring. Although these skills may not by themselves be strongly linked to performance in GVCs, they could have an impact when considered jointly with other skills and firm capabilities. Such counterintuitive results might also stem from the fact these indicators are based on questions about the frequency of the performance of related tasks, which imperfectly approximate the skills workers have.[5]

Some levels of task-based skills of groups of workers relate negatively to GVC indicators while others relate positively (Figures 3.7 and 3.8). For instance, the higher the ICT skills and managing and communication skills of the bottom percentile, the less industries use foreign intermediates in their exports, but the higher the skills of the top percentile, the more so industries use foreign intermediates. This suggests that the use of foreign inputs could be a substitute for low ICT skills and managing and communication skills, but needs to be complemented by high levels of these skills for top performers. In contrast, the higher the STEM skills of the lower part of the distribution, the more industries export, suggesting that these skills are important for low-skilled workers in an international environment. Hence, some skills need to be possessed by all workers while others are particularly important for low or top performers.

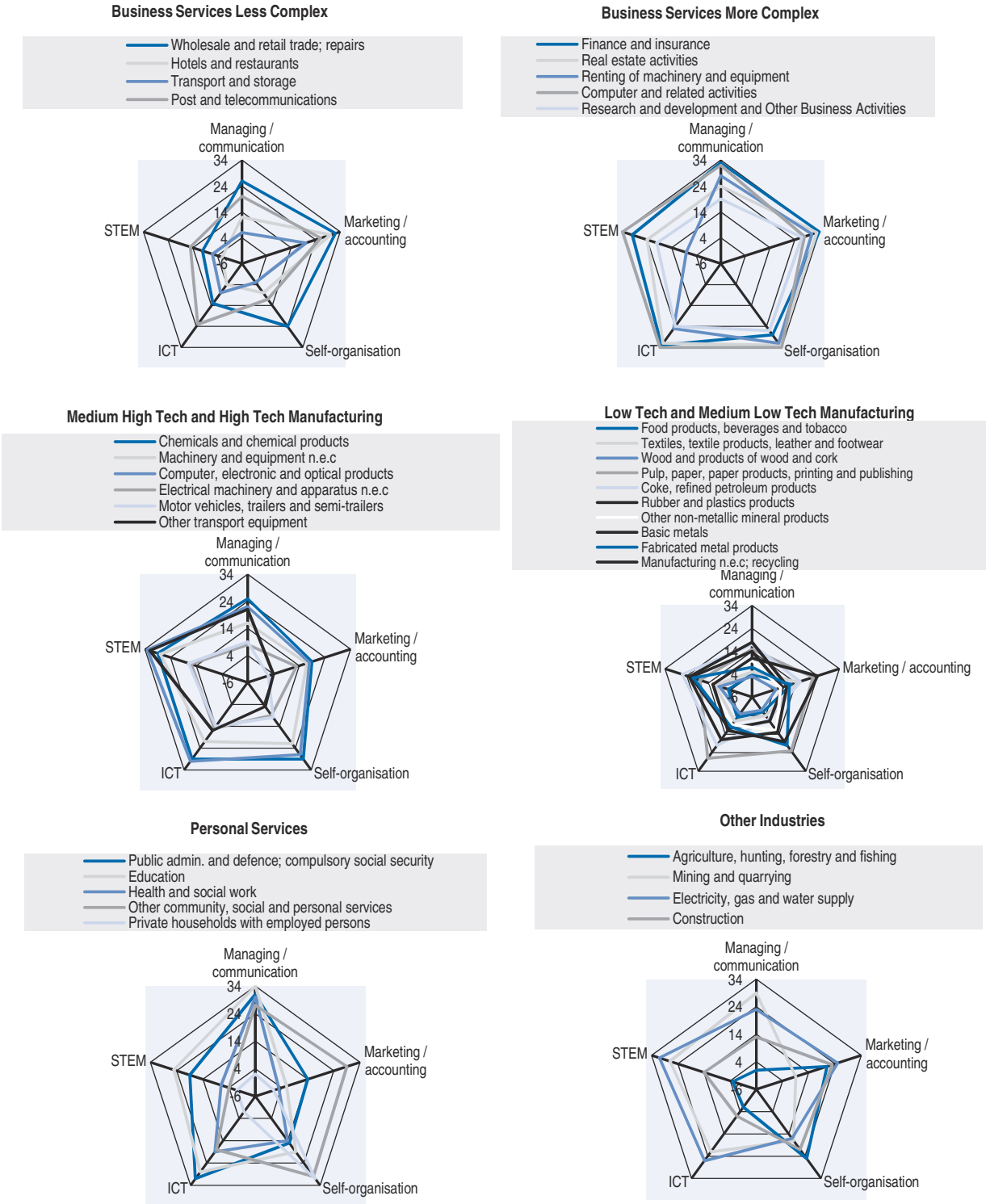
The results presented here suggest that policies boosting certain workers' levels of different skills could play an important role in raising countries' integration into GVCs. However, these results do not show a causal link from skills supplied at the country-industry level to the performance of industries in GVCs. Since workers are mobile between industries, changes in the economic performance and participation in GVCs of these industries might strongly influence the allocation of workers among industries within a given country and thus the supply of skills – especially of task-based skills – at the country-industry level.

How industries differ in their skills requirements

If they are taken at an industry level, the task-based skills indicators computed from the Survey of Adult Skills (ICT, STEM, managing and communicating, marketing and accounting, and self-organisation; see Box 3.1) reflect the extent to which an industry involves more of these tasks and hence requires more of the necessary skills. According to these indicators, most industries are intensive in a broad range of tasks, suggesting that they require workers with a broad range of skills (Figure 3.9).

Figure 3.9. **Task intensities of industries**

Rank among the 34 industries, 2012



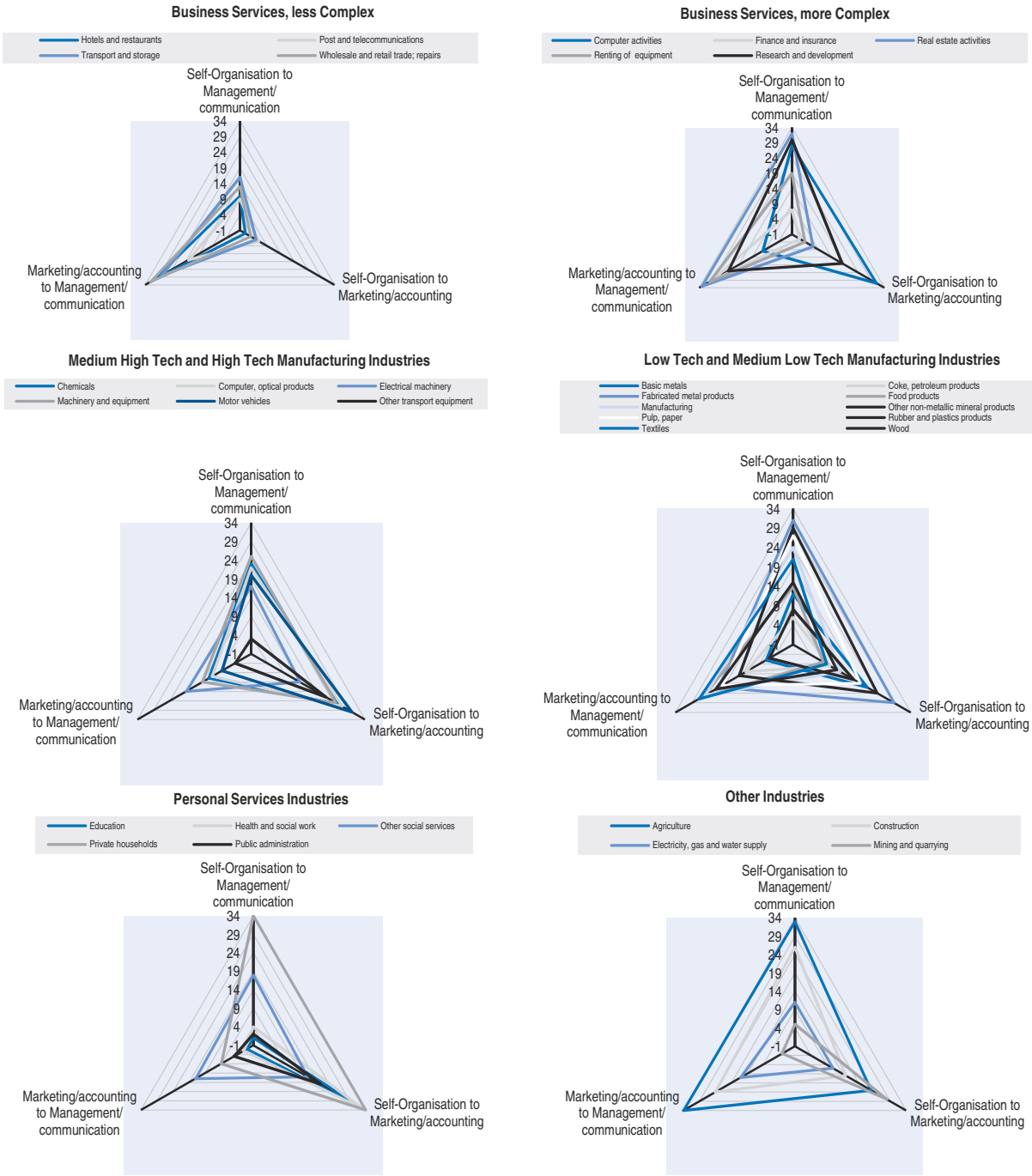
Note: Industries are ranked according to their intensity in each of the tasks corresponding to the skills-based indicators (Box 3.1). The highest rank corresponds to the industry showing the highest task intensity and the lowest rank corresponds to the one with the lowest task intensity. Each panel of the figure shows how a group of industries rank according to five dimensions of task intensities.

Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012), *www.oecd.org/skills/piaac/publicdataandanalysis.*

StatLink http://dx.doi.org/10.1787/888933474340

Figure 3.10. **A selection of relative task intensities of industries, average across countries**

Rank among the 34 industries, 2012



Note: Industries are ranked according to their relative intensity between two tasks, with the highest rank corresponding to the industry showing the highest relative task intensity and the lowest rank corresponding to the one with the lowest relative task intensity between the two tasks. Each panel of the figure shows how a group of industries rank according to three dimensions of relative intensity. Each relative task intensity is calculated as the ratio between the average values of each two task-based skills indicators at an industry level: "Self-organisation" versus "Management/Communication", "Self-organisation" versus "Marketing/Accounting", and "Marketing/Accounting" versus "Management/Communication".

Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012), *www.oecd.org/skills/piaac/publicdataandanalysis*.

StatLink http://dx.doi.org/10.1787/888933474350

As might be expected, more complex business services and high-tech manufacturing are more task-intensive than less complex business services and low-tech manufacturing. However, even less complex business services and low-tech manufacturing use a broad range of skills, including management and communication skills and self-organisation skills. High-tech manufacturing is more intensive in STEM tasks but also frequently involves tasks requiring "soft" skills such as managing and communicating. Overall, it is difficult to characterise industries by the performance of one specific task. Several different types of industries are intensive in ICT and STEM tasks.

To gain a clearer picture of industries' skills needs, by gauging the proportions in which different industries need specific skills, the same task-based skills indicators can be used to compare the frequency of one specific task with the frequency of another (Figure 3.10). Many high-tech manufacturing sectors show higher intensity in self-organisation tasks than in management and communication tasks, or marketing and accounting tasks.[6] Business services tend to be more intensive in marketing and accounting tasks than in communication tasks, with some complex business services also intensive in self-organisation tasks. These results support the idea that a broad set of skills is required by industries and that industries can be characterised by their relative intensity in the performance of these tasks.

Understanding countries' specialisation in GVCs

Countries differ in their skills endowments while industries vary in their skills requirements. This section examines how the interaction between countries' skills characteristics and industries' requirements partly explains why countries perform better in some industries within GVCs, as measured by the extent to which they export more in value added terms in one industry rather than in another one. While the focus is put on skills, other factors are taken into account, such as physical capital and trade costs that also influence specialisation in GVCs.

Having the right mix of skills

Employers expect workers to have a mix of skills, and firms' performance depends on this diversity of skills. Within GVCs, workers may have to perform technical tasks but also to communicate with foreign colleagues, requiring them to have technical and communication skills. The extent to which workers have the right mix of various skills influences countries' performance within GVCs. For instance, a survey on India found that only one in four graduates of engineering schools were employable, as most were deficient in at least one of the required skills – technical skills, fluency in English, the ability to work in a team or to deliver basic oral presentations (Ohnsorge and Treffler, 2007[7]). Concerns about the skills of Indian graduates arose in a context of increasing offshoring from developed economies and competition to attract foreign investments. Likewise, studies based on employer surveys in Europe put forward the role of a combination of social and emotional skills, technical skills and cognitive skills for firms' performance (Humburg, van der Velden and Verhagen, 2013). The lack of interpersonal skills can create a strong barrier to employment, especially for low-skilled jobs (Heckman and Kautz, 2013). These studies show that it is important for each worker to have the right mix of skills, rather than for firms to have a set of workers with each specialised in one skill.

While there is a broad consensus that having the right mix of skills is important for employability and firms' performance, very few studies try to characterise countries'

endowment in terms of combinations of skills or to assess the impact of skills mixes on performance in GVCs.

To understand how the skills mix can shape countries' specialisation in GVCs and how this can be assessed empirically, it is useful to consider two skills (for instance numeracy and literacy skills, or quantitative and communication skills). Workers can be characterised by the absolute levels in these two skills, their absolute skills advantage, and whether they are better in one skill than another – the relative skills advantage. Industries differ according to their relative skills requirements, as illustrated in Figure 3.10. The allocation of workers across industries is not determined by how much of each type of skills a worker has, but by the ratio of one skill to the other (workers' relative skills advantage). For example, a worker with a high ratio of numeracy to literacy skills works in industries more intensive in quantitative tasks. The absolute value of skills does not influence the sorting of workers across industries, but it does affect the productivity of workers, who in fact need both numeracy and literacy skills.

A country's capacity to be internationally competitive in certain industries and to specialise in these industries depends on the country-wide correlation between the relative and absolute skills advantage across the population. In the above case of a relative skills advantage measured as a high ratio of numeracy to literacy skills, and of an absolute advantage measured as strong literacy and numeracy skills, a country with a high positive correlation between the two will specialise in quantitative-intensive industries. The best workers – those with an absolute advantage in both skills – will sort into the quantitative-intensive industry and thus increase the absolute productivity of this industry compared with countries where the correlation is lower. Conversely, the country with the lower correlation would specialise in industries requiring literacy skills such as those intensive in communication tasks, as its workers have an absolute advantage in communication-intensive industries relative to other countries (Box 3.3).

Box 3.3. **The empirical link between countries' skills mix and specialisation in GVCs**

The discussions in the current section and the following one are based on OECD work testing the role that each country's skills mix plays in its specialisation in certain industries in GVCs (Grundke et al., forthcoming b). The empirical specification is based on a theoretical model which assumes that workers are heterogeneous and endowed with a mix of two skills (e.g. quantitative and communication skills) (Ohnsorge and Treffler, 2007). Industries differ according to their skills requirements, while the marginal product of a specific skills mix differs across industries. The key parameter explaining countries' specialisation in certain industries is the country-wide correlation between the relative and absolute skills advantage across the population. This correlation indicator, jointly with the relative skills endowment, explains countries' comparative advantage in GVCs.

This publication uses the assessed skills of literacy, numeracy and problem solving in technology-rich environment from the Survey of Adult Skills to measure the country-wide skills mix. All three possible combinations of skills mixes (numeracy to literacy, problem solving to numeracy and problem solving to literacy) are tested. The relative intensity of industries in these three types of skills is computed by using the task-based skills indicators from the factor analysis at the industry level (Box 3.1), after establishing a correspondence between the assessed skills and the industry intensity in tasks that relate to these specific

Box 3.3. **The empirical link between countries' skills mix and specialisation in GVCs** *(cont.)*

skills (Table 3.1). Based on the description of the cognitive assessment tests in the Technical Report of the Survey of Adult Skills, it is reasonable to assume that literacy skills are more in demand in industries intensive in management and communication tasks, as measured by the task-based skills indicator. Similarly, numeracy skills can be associated with the task-based skills indicator marketing and accounting, and problem solving in technology-rich environments with the task-based skills indicator self-organisation.

To test the importance of skills mixes for countries' specialisation in GVCs, the empirical analysis explains exports in value-added terms in each industry of a country towards its trade partners by the country-specific correlation of relative and absolute advantage of workers (in two types of cognitive skills) in relation to the relative intensity of industries in two specific tasks (that correspond to the two cognitive skills). The other major explanatory variable is the country-industry interaction of the relative skills advantage with the relative task intensity of industries. Each specification is estimated for each possible combination of two assessed skills (numeracy to literacy, problem solving to numeracy and problem solving to literacy) with their respective corresponding relative industry task intensity (marketing and accounting to management and communication, self-organisation to marketing and accounting, and self-organisation to management and communication).

The empirical analysis uses the typical sectoral gravity model for bilateral trade flows that are used in the empirical literature on comparative advantage (Romalis 2004, Nunn 2007, Levshenko 2007, Chor 2010). The constructed bilateral industry-level dataset includes 23 exporting countries, 62 importing countries (including rest of world) and 34 TiVA industries. Exports in value-added terms are taken for the year 2011 from the TiVA 2015 database. All specifications include the final demand at the importer-industry level as an independent variable. Additional explanatory variables include traditional Heckscher-Ohlin country-industry measures of relative endowments of physical and human capital, bilateral trade costs variables from the CEPII GeoDist database (Mayer and Zignago, 2011) and fixed effects to account for exporter, importer and industry characteristics, as well as dummy variables that control for all omitted aggregated sector characteristics for the exporting and importing country (34 industries are aggregated into the three sectors resource extraction, manufacturing and utilities, and services). Robust standard errors are clustered at the exporter-importer level.

Sources: Chor, D. (2010), "Unpacking sources of comparative advantage: A quantitative approach", *Journal of International Economics*.

Grundke, R. et al. (forthcoming b), "Having the right mix: The role of skills bundles for comparative advantage and industry performance in GVCs", *OECD Science, Technology and Industry Working Papers*.

Levchenko, A.A. (2007), "Institutional quality and international trade", *Review of Economic Studies*.

Nunn, N. (2007), "Relationship-specificity, incomplete contracts, and the pattern of trade", *The Quarterly Journal of Economics*.

Mayer, T. and S. Zignago (2011), "Notes on CEPII's distances measures: the GeoDist Database", *CEPII Working Paper 2011-25*.

Ohnsorge, F. and D. Treffler (2007), "Sorting it out: International trade with heterogeneous workers", *Journal of Political Economy*.

Romalis, J. (2004), "Factor proportions and the structure of commodity trade", *American Economic Review*.

The Survey of Adult Skills gives information on the mix of skills of the population. As it includes assessment of proficiency in three skills – literacy, numeracy, and problem solving in technology-rich environments – it is possible to investigate how these various skills are correlated to each other.

Countries vary in their population's skills mix (Figure 3.11). In a group of countries, including the United States, workers who are more proficient in numeracy than in literacy skills (with a relative skills advantage in numeracy) also have high literacy skills (an absolute skills advantage) while the reverse is true in other countries, such as the Czech Republic. This means that in the United States, the part of the population with a relative advantage in numeracy skills (high ratio of numeracy to literacy scores) is also the one with higher absolute scores in both cognitive skills, i.e. numeracy and literacy. In contrast, in the Czech Republic, workers with a relative advantage in numeracy skills have low absolute scores in both skills. In all countries, workers whose skills in problem solving in technology-rich environments are higher than either their numeracy or literacy skills lack high numeracy or literacy skills in absolute terms, but there are variations among countries.

To understand how workers are shared among industries, a correspondence between workers' cognitive skills and industries' skills requirement needs to be established (Box 3.3, Table 3.1). As cognitive skills measured in the Survey of Adults Skills capture a large set of abilities, they can be matched to industries' skills requirements. The literacy dimension more broadly measures the ability to analyse complex social contexts and to deal with social interaction using a language, which is expected to be required in industries intensive in management and communication tasks. The numeracy dimension measures the ability to understand, use and communicate mathematical information, and is thereby expected to be needed in industries intensive in marketing and accounting tasks. Problem solving in technology-rich environments includes identifying problems, setting goals and being self-organised to find solutions. This type of skill is important in industries intensive in self-organisation tasks.

Table 3.1. **Correspondence between industries' task intensities and skills requirements**

Industry task intensity	Correspondence in terms of cognitive skills requirement
Managing and Communication	Literacy
Marketing and Accounting	Numeracy
Self-Organisation	Problem solving in technology-rich environments

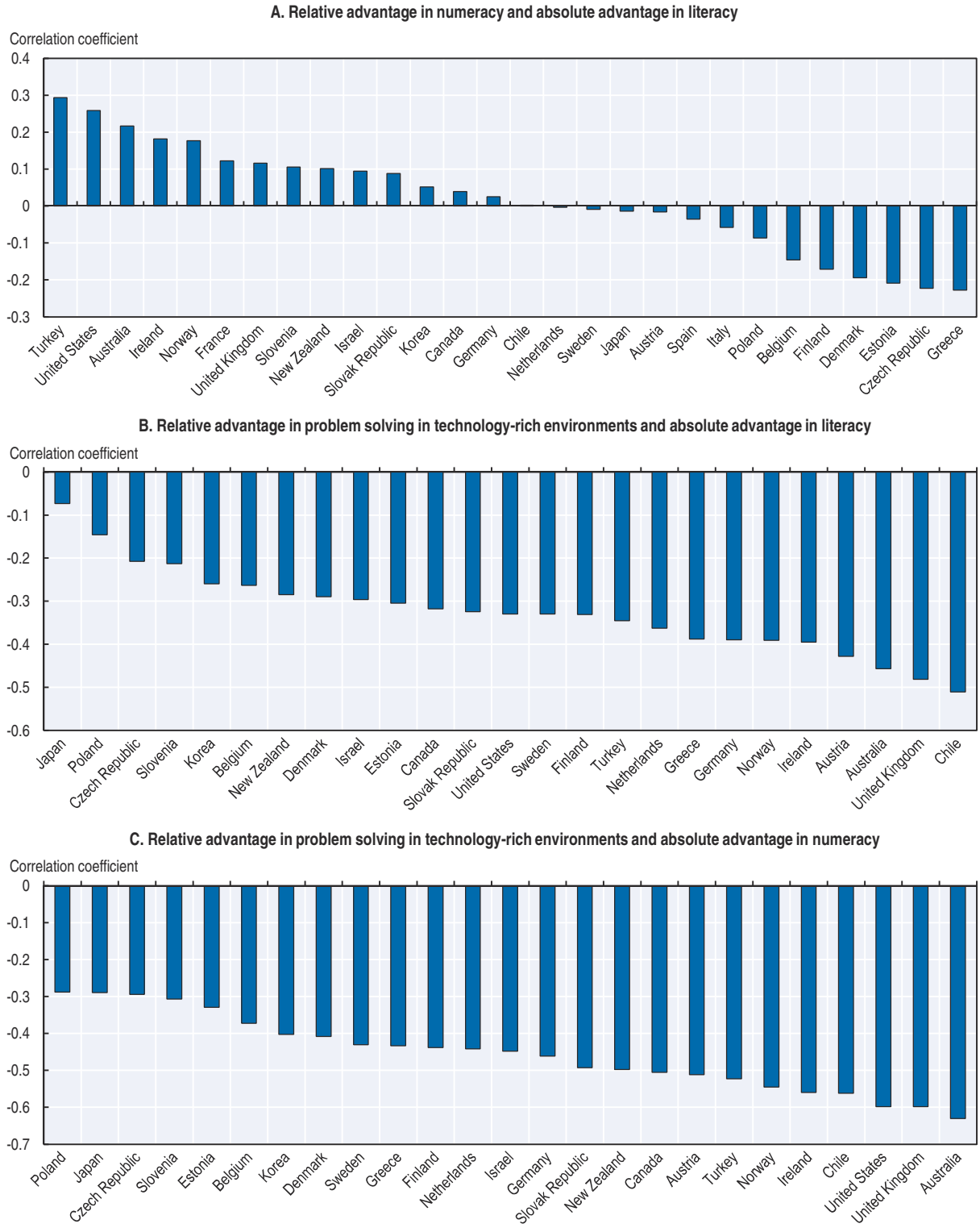
Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012), *www.oecd.org/skills/piaac/publicdataand analysis*.

Industries vary in their task intensities, and countries differ in their skills mix to provide for these industry-specific skills requirements; comparative advantage within GVCs stems from such country-industry matches. Estimates using the Survey of Adult Skills and TiVA database show that:

- Countries with highly correlated relative skills advantage in numeracy as compared with literacy and absolute advantage in these skills can export more in industries that are more intensive in marketing and accounting tasks than management and communication tasks (Figure 3.12, Panel A). This is the case, for instance, for Australia, Ireland, Norway, Turkey and the United States, where workers with higher numeracy skills than literacy skills also have high literacy skills in absolute terms. Their skills mix gives these countries a comparative trade advantage in many business services industries, both complex (including finance and insurance, and research and development) and less complex (like wholesale and retail trade) (Figure 3.10).

Figure 3.11. **Correlations between relative and absolute skills advantages**

2012 or 2015



Note: Chile, Greece, Israel, New Zealand, Slovenia and Turkey: Year of reference 2015. All other countries: Year of reference 2012. Data for Belgium refer only to Flanders and data for the United Kingdom refer to England and Northern Ireland jointly.

Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis.*

StatLink *http://dx.doi.org/10.1787/888933474365*

Figure 3.12. **Increase in exports in terms of domestic value added of exports resulting from workers' skills mix at a country level**

A. From having high literacy skills and relatively high numeracy skills

From high to low correlations between comparative and absolute skills advantages ----->

From low to high correlations between comparative and absolute skills advantages ----->

%	Turkey	United States	Australia	Ireland	Norway	United Kingdom	Slovenia	New Zealand	Israel	Slovak Republic	Korea	Canada	Germany	Chile	Netherlands	Sweden	Japan	Austria	Poland	Belgium	Finland	Denmark	Estonia	Czech Republic
Greece	9.3	8.6	7.8	7.2	7.1	6.0	5.8	5.7	5.6	5.5	4.9	4.6	4.4	4.0	3.9	3.8	3.7	3.7	2.4	1.4	1.0	0.6	0.3	0.1
Czech Republic	9.2	8.5	7.8	7.1	7.0	5.9	5.7	5.7	5.5	5.4	4.8	4.6	4.3	3.9	3.8	3.7	3.6	3.6	2.4	1.3	0.9	0.5	0.2	
Estonia	8.9	8.3	7.5	6.9	6.8	5.7	5.5	5.4	5.3	5.2	4.5	4.3	4.0	3.7	3.5	3.5	3.4	3.3	2.1	1.1	0.6	0.2		
Denmark	8.6	8.0	7.2	6.6	6.5	5.4	5.2	5.1	5.0	4.9	4.3	4.0	3.8	3.4	3.3	3.2	3.1	3.1	1.8	0.8	0.4			
Finland	8.2	7.6	6.8	6.2	6.1	5.0	4.8	4.7	4.6	4.5	3.9	3.6	3.4	3.0	2.9	2.8	2.7	2.7	1.5	0.4				
Belgium	7.8	7.1	6.4	5.7	5.6	4.6	4.4	4.3	4.2	4.1	3.4	3.2	3.0	2.6	2.5	2.4	2.3	2.2	1.0					
Poland	6.7	6.0	5.3	4.7	4.6	3.5	3.3	3.2	3.1	3.0	2.4	2.2	1.9	1.5	1.4	1.3	1.2	1.2						
Austria	5.4	4.8	4.0	3.4	3.3	2.3	2.1	2.0	1.9	1.8	1.2	1.0	0.7	0.3	0.2	0.1	0.0							
Japan	5.4	4.7	4.0	3.4	3.3	2.2	2.1	2.0	1.9	1.8	1.1	0.9	0.7	0.3	0.2	0.1								
Sweden	5.3	4.7	3.9	3.3	3.2	2.1	2.0	1.9	1.8	1.7	1.0	0.8	0.6	0.2	0.1									
Netherlands	5.2	4.6	3.8	3.2	3.1	2.1	1.9	1.8	1.7	1.6	1.0	0.7	0.5	0.1										
Chile	5.1	4.5	3.7	3.1	3.0	2.0	1.8	1.7	1.6	1.5	0.9	0.6	0.4											
Germany	4.7	4.1	3.3	2.7	2.6	1.6	1.4	1.3	1.2	1.1	0.5	0.2												
Canada	4.4	3.8	3.1	2.4	2.4	1.3	1.1	1.1	0.9	0.8	0.2													
Korea	4.2	3.6	2.8	2.2	2.1	1.1	0.9	0.8	0.7	0.6														
Slovak Republic	3.6	2.9	2.2	1.6	1.5	0.5	0.3	0.2	0.1															
Israel	3.5	2.8	2.1	1.5	1.4	0.4	0.2	0.1																
New Zealand	3.3	2.7	2.0	1.4	1.3	0.3	0.1																	
Slovenia	3.3	2.6	1.9	1.3	1.2	0.2																		
United Kingdom	3.1	2.5	1.7	1.1	1.0																			
Norway	2.0	1.4	0.7	0.1																				
Ireland	1.9	1.3	0.6																					
Australia	1.3	0.7																						
United States	0.6																							

Due to differences in the correlation between the comparative advantage in numeracy to literacy skills and the absolute advantage in literacy skills, domestic value added in gross exports in Australia is 0.6% higher than in Ireland in industries relatively intensive in marketing and accounting skills compared to management and communication skills.

B. From having high literacy skills and relatively high problem-solving in technology-rich environments skills

From high to low correlations between comparative and absolute skills advantages ----->

From low to high correlations between comparative and absolute skills advantages ----->

%	Japan	Poland	Czech Republic	Slovenia	Korea	Belgium	New Zealand	Denmark	Israel	Estonia	Canada	Slovak Republic	United States	Sweden	Finland	Turkey	Netherlands	Greece	Germany	Norway	Ireland	Austria	Australia	United Kingdom
Chile	67.2	53.5	42.8	41.8	34.3	33.7	30.3	29.6	28.7	27.4	25.5	24.4	23.7	23.7	23.5	21.4	19.0	15.6	15.3	15.1	14.5	10.2	6.6	3.5
United Kingdom	61.5	48.3	37.9	37.0	29.8	29.2	25.9	25.2	24.3	23.1	21.2	20.2	19.5	19.5	19.3	17.3	14.9	11.6	11.4	11.2	10.6	6.5	3.0	
Australia	56.9	44.1	34.0	33.1	26.1	25.5	22.3	21.6	20.8	19.6	17.8	16.8	16.1	16.0	15.9	13.9	11.6	8.4	8.2	8.1	7.5	3.4		
Austria	51.7	39.3	29.6	28.7	21.9	21.3	18.3	17.6	16.8	15.6	13.9	12.9	12.2	12.2	12.1	10.2	8.0	4.9	4.7	4.5	3.9			
Ireland	46.0	34.0	24.7	23.9	17.3	16.7	13.8	13.2	12.4	11.2	9.6	8.6	8.0	8.0	7.8	6.0	3.9	0.9	0.7	0.5				
Norway	45.2	33.3	24.0	23.2	16.7	16.1	13.2	12.6	11.7	10.6	9.0	8.1	7.4	7.4	7.2	5.4	3.3	0.4	0.1					
Germany	44.9	33.1	23.8	23.0	16.5	15.9	13.0	12.4	11.6	10.5	8.8	7.9	7.2	7.2	7.1	5.3	3.2	0.2						
Greece	44.6	32.8	23.5	22.7	16.2	15.7	12.8	12.2	11.3	10.2	8.6	7.7	7.0	7.0	6.9	5.1	2.9							
Netherlands	40.5	29.0	20.0	19.2	12.9	12.4	9.6	9.0	8.2	7.1	5.5	4.6	4.0	3.9	3.8	2.1								
Turkey	37.7	26.4	17.6	16.8	10.6	10.1	7.4	6.8	6.0	4.9	3.4	2.5	1.9	1.9	1.7									
Finland	35.4	24.3	15.6	14.9	8.8	8.3	5.6	5.0	4.2	3.2	1.6	0.8	0.2	0.1										
Sweden	35.2	24.1	15.5	14.7	8.6	8.1	5.4	4.8	4.1	3.0	1.5	0.6	0.0											
United States	35.2	24.1	15.4	14.7	8.6	8.1	5.4	4.8	4.0	3.0	1.5	0.6												
Slovak Republic	34.3	23.4	14.7	14.0	8.0	7.5	4.8	4.2	3.4	2.4	0.8													
Canada	33.2	22.3	13.8	13.0	7.1	6.6	3.9	3.3	2.5	1.5														
Estonia	31.2	20.5	12.1	11.3	5.4	4.9	2.3	1.7	1.0															
Israel	29.9	19.3	11.0	10.2	4.4	3.9	1.3	0.7																
Denmark	29.0	18.4	10.1	9.4	3.6	3.2	0.6																	
New Zealand	28.2	17.8	9.5	8.8	3.1	2.6																		
Belgium	25.0	14.8	6.8	6.1	0.5																			
Korea	24.4	14.3	6.3	5.6																				
Slovenia	17.8	8.2	0.6																					
Czech Republic	17.1	7.5																						
Poland	8.9																							

Due to differences in the correlation between the comparative advantage in problem solving to literacy skills and the absolute advantage in literacy skills, domestic value added in gross exports in Poland is 7.5% higher than in the Czech Republic in industries relatively intensive in self organisation skills compared to management and communication skills.

Figure 3.12. **Increase in exports in terms of domestic value added of exports resulting from workers' skills mix at a country level** *(cont.)*

C. From having high numeracy skills and relatively high problem-solving in technology-rich environments skills

From high to low correlations between comparative and absolute skills advantages ----->

From low to high correlations between comparative and absolute skills advantages ----->

%	Poland	Japan	Czech Republic	Slovenia	Estonia	Belgium	Korea	Denmark	Sweden	Greece	Finland	Netherlands	Israel	Germany	Slovak Republic	New Zealand	Canada	Austria	Turkey	Norway	Ireland	Chile	United States	United Kingdom
Australia	47.8	47.5	46.7	44.6	41.0	34.2	29.7	28.9	25.6	25.2	24.5	24.0	23.1	21.2	17.0	16.3	15.4	14.5	13.1	10.2	8.4	8.1	3.8	3.8
United Kingdom	42.4	42.2	41.4	39.3	35.9	29.3	25.0	24.2	21.0	20.6	20.0	19.5	18.6	16.8	12.7	12.1	11.2	10.3	9.0	6.2	4.5	4.2	0.0	
United States	42.4	42.2	41.3	39.3	35.9	29.3	25.0	24.2	21.0	20.6	20.0	19.5	18.6	16.8	12.7	12.1	11.2	10.3	8.9	6.2	4.4	4.2		
Chile	36.7	36.5	35.7	33.7	30.4	24.1	20.0	19.2	16.2	15.8	15.2	14.7	13.8	12.1	8.2	7.6	6.7	5.9	4.6	1.9	0.3			
Ireland	36.4	36.1	35.3	33.4	30.1	23.8	19.7	18.9	15.9	15.5	14.9	14.4	13.6	11.8	7.9	7.3	6.4	5.6	4.3	1.7				
Norway	34.1	33.9	33.1	31.2	28.0	21.7	17.7	16.9	13.9	13.6	13.0	12.6	11.7	10.0	6.1	5.5	4.7	3.9	2.6					
Turkey	30.7	30.5	29.8	27.9	24.7	18.7	14.7	14.0	11.1	10.7	10.1	9.7	8.9	7.2	3.5	2.9	2.0	1.3						
Austria	29.1	28.9	28.1	26.3	23.2	17.2	13.3	12.5	9.7	9.3	8.8	8.3	7.5	5.9	2.2	1.6	0.8							
Canada	28.1	27.9	27.1	25.3	22.2	16.3	12.4	11.7	8.8	8.5	7.9	7.5	6.7	5.1	1.4	0.8								
New Zealand	27.1	26.8	26.1	24.3	21.2	15.3	11.5	10.8	8.0	7.6	7.1	6.6	5.8	4.2	0.6									
Slovak Republic	26.4	26.1	25.4	23.6	20.5	14.7	10.9	10.1	7.3	7.0	6.5	6.0	5.2	3.6										
Germany	21.9	21.7	21.0	19.2	16.3	10.7	7.0	6.3	3.6	3.3	2.7	2.3	1.5											
Israel	20.1	19.9	19.2	17.5	14.6	9.0	5.4	4.7	2.0	1.7	1.2	0.8												
Netherlands	19.2	18.9	18.3	16.5	13.7	8.2	4.6	3.9	1.2	0.9	0.4													
Finland	18.7	18.5	17.8	16.1	13.2	7.7	4.2	3.5	0.8	0.5														
Greece	18.1	17.9	17.2	15.5	12.6	7.2	3.6	2.9	0.3															
Sweden	17.7	17.5	16.8	15.1	12.3	6.8	3.3	2.6																
Denmark	14.7	14.5	13.9	12.2	9.4	4.1	0.7																	
Korea	14.0	13.7	13.1	11.5	8.7	3.4																		
Belgium	10.2	10.0	9.3	7.7	5.1																			
Estonia	4.8	4.6	4.0	2.5																				
Slovenia	2.2	2.1	1.5																					
Czech Republic	0.8	0.6																						
Japan	0.2																							

Due to differences in the correlation between the comparative advantage in problem solving to numeracy skills and the absolute advantage in numeracy skills, domestic value added in gross exports in Poland is 0.2% higher than in Japan in industries relatively intensive in self organisation skills compared to marketing and accounting skills.

Note: Estimates come from the model described in Box 3.3.

Column countries are ranked in descending order of the correlation between absolute and comparative skills advantage, while row countries are ranked in ascending order of the same indicator. Each estimate (cell) shows the increase in exports in value added terms resulting from the difference between the two countries in the correlation between absolute and comparative skills advantage in industries with a relatively high intensity in the related skills.

The industry with a high (low) intensity in a specific skill relative to another one is at the 75th (25th) percentile of the industries ranked by ratios of intensities of the two skills. The relative comparative advantage in two industries with higher (lower) difference in the relative skills intensities would be larger (lower) than the results presented in the figure.

TiVA indicators are in 2011 and skills indicators are in 2012 or 2015. Data on skills for Belgium refer only to Flanders and for the United Kingdom – England and Northern Ireland jointly.

Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis*; OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*; OECD (Annual National Accounts, SNA93, *http://stats.oecd.org/*; OECD STAN STructural ANalysis Database, *http://stats.oecd.org/*; Mayer and Zignago (2011), "Notes on CEPII's distances measures: the GeoDist Database", *CEPII Working Paper 2011-25;* World Input-Output Database (WIOD), *www.wiod.org/home*.

StatLink *http://dx.doi.org/10.1787/888933474372*

- Countries with highly correlated relative skills advantage in problem solving in technology-rich environments as compared to literacy skills, and absolute advantage in these skills, can export more in industries that are more intensive in self-organisation tasks than in management and communication tasks (Figure 3.12, Panel B). This is the case for the Czech Republic, Japan, Korea, Poland and Slovenia, where workers whose skills in problem solving in technology-rich environments are higher than their literacy skills also have high literacy skills in absolute terms. Their skills mix gives these countries a comparative trade advantage in many complex business services industries, including computer and related activities, and finance and insurance, as well as some high-technology manufacturing industries like chemicals and computer products (Figure 3.10).
- Countries with highly correlated relative skills advantage in problem solving in technology-rich environments as compared to numeracy skills and absolute advantage in these skills can export more in industries that are more intensive in self-organisation tasks than marketing and accounting tasks (Figure 3.13, Panel C). This is the case, for instance, for the Czech Republic, Estonia, Japan, Poland and Slovenia, where workers whose skills in problem solving in technology-rich environments are higher than their numeracy skills also have high numeracy skills in absolute terms. Their skills mix gives these countries a

comparative trade advantage in mostly business services, in chemicals high-tech manufacturing, as well as in low-tech industries like pulp and paper products (Figure 3.10).

The role of relative skills endowment

A country's tendency to specialise in an industry depends not only on having the right mix of skills, but also on its relative skills endowment. Countries can capture larger shares of world production and trade in GVCs in industries that use more intensively their abundant skills. Studies that have looked at how educational attainment contributes to comparative advantage show that countries abundant in highly educated workers specialise in industries that use this factor intensively (Romalis, 2004). Such studies have used educational attainment as a proxy for skills, due to data limitations.

The Survey of Adult Skills makes it possible to investigate the role of relative skills endowment in different types of skills, rather than just classifying workers as high-skilled or low-skilled. If two skills are considered, numeracy and literacy, and two tasks, quantitative and communication ones, a country in which the population is more skilled in numeracy than in literacy can export more in industries that are more intensive in quantitative tasks than in communication ones. A country in which the population is less skilled in numeracy than in literacy can, vice versa, export more in communication-intensive industries. Using the Survey of Adult Skills, the relative skills endowment of a country can be measured by the average ratio of scores in terms of two skills, such as numeracy and literacy, and the average ratio of scores in problem solving in technology-rich environments to literacy and numeracy.

Compared with other countries, the population appears to be skilled in: 1) numeracy relative to literacy in Austria, Belgium and Denmark; 2) problem solving in technology-rich environments relative to literacy in Chile, Germany, Israel and Turkey;[8] and 3) problem solving in technology-rich environments relative to numeracy in Chile, Turkey, the United Kingdom and the United States (Figure 3.13).

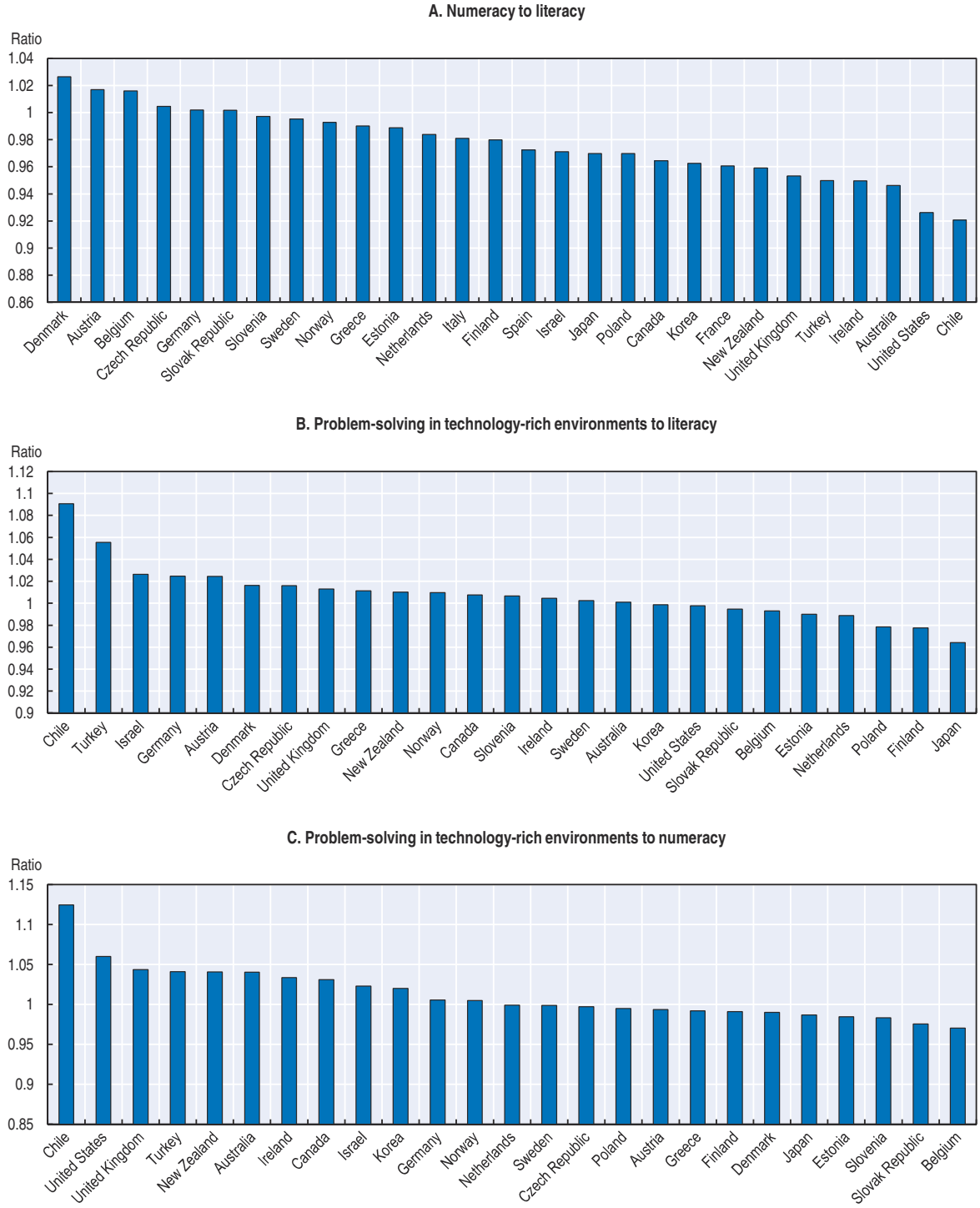
As with the correlation between relative and absolute skills advantages, the differences in the relative skills endowments of workers across countries generate comparative advantages within GVCs in some industries depending on their skills characteristics.

- Countries where numeracy skills are higher than literacy skills can export more in value added terms in industries that are more intensive in marketing and accounting tasks than in management and communication tasks (Figure 3.14, Panel A).
- Countries where skills involving problem solving in technology-rich environment are higher than literacy skills can export more in value added terms in industries that are more intensive in self-organisation tasks than in management and communication tasks (Figure 3.14, Panel B).
- Countries where skills involving problem solving in technology-rich environment are higher than numeracy skills can export more in value added terms in industries that are more intensive in self-organisation tasks than marketing and accounting tasks (Figure 3.14, Panel C).

The relative endowment and the correlation between relative and absolute skills advantage contribute to countries' specialisation in GVCs. To be able to specialise in a specific industry, the population should on average have a higher level of the main skill required by this industry compared with other skills than other countries and those with

Figure 3.13. **Countries' relative skills advantages**

2012 or 2015



Note: Figures show the average ratio of scores in terms of two skills for the whole population. A score below or above one does not mean that on average individuals are more proficient in one skill than in another one. The figure shows the ranking of countries in relative skills: individuals in Denmark are on average more skilled in numeracy relative to literacy than in all other countries covered by the survey.
Chile, Greece, Israel, New Zealand, Slovenia and Turkey: Year of reference 2015. All other countries: Year of reference 2012. Data for Belgium refer only to Flanders and data for the United Kingdom refer to England and Northern Ireland jointly.
Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis.*

StatLink *http://dx.doi.org/10.1787/888933474382*

Figure 3.14. **Increase in exports in terms of domestic value added of exports resulting from workers' relative skills advantage at a country level**

A. From having relatively high numeracy skills as compared to literacy skills

From high to low relative skills advantages ----->

From low to high relative skills advantages ----->

%	Denmark	Austria	Belgium	Czech Republic	Germany	Slovak Republic	Slovenia	Sweden	Norway	Greece	Estonia	Netherlands	Finland	Israel	Japan	Poland	Canada	Korea	New Zealand	United Kingdom	Turkey	Ireland	Australia	United States
Chile	42.8	38.5	38.1	33.1	31.9	31.9	29.9	29.0	28.0	26.9	26.3	24.3	22.6	19.1	18.6	18.5	16.4	15.6	14.4	12.0	10.7	10.7	9.3	2.0
United States	40.1	35.8	35.4	30.5	29.4	29.3	27.4	26.5	25.5	24.4	23.9	21.9	20.2	16.7	16.3	16.2	14.2	13.4	12.1	9.9	8.5	8.5	7.2	
Australia	30.6	26.7	26.3	21.8	20.7	20.6	18.8	18.0	17.1	16.1	15.6	13.7	12.2	8.9	8.5	8.4	6.5	5.8	4.6	2.5	1.2	1.2		
Ireland	29.1	25.2	24.8	20.3	19.2	19.2	17.4	16.6	15.7	14.6	14.2	12.3	10.8	7.6	7.1	7.1	5.2	4.5	3.3	1.2	0.0			
Turkey	29.0	25.1	24.8	20.3	19.2	19.2	17.3	16.6	15.7	14.6	14.1	12.3	10.8	7.6	7.1	7.1	5.2	4.5	3.3	1.2				
United Kingdom	27.5	23.6	23.2	18.8	17.8	17.7	15.9	15.2	14.2	13.2	12.8	10.9	9.4	6.3	5.8	5.8	3.9	3.2	2.1					
New Zealand	24.9	21.1	20.8	16.4	15.4	15.3	13.6	12.8	11.9	11.0	10.5	8.7	7.2	4.1	3.7	3.6	1.8	1.1						
Korea	23.5	19.8	19.4	15.1	14.1	14.1	12.3	11.6	10.7	9.7	9.3	7.5	6.0	3.0	2.5	2.5	0.7							
Canada	22.7	19.0	18.6	14.3	13.3	13.3	11.5	10.8	9.9	9.0	8.5	6.7	5.3	2.2	1.8	1.8								
Poland	20.5	16.9	16.5	12.3	11.3	11.3	9.6	8.9	8.0	7.1	6.6	4.9	3.5	0.4	0.0									
Japan	20.5	16.8	16.5	12.3	11.3	11.2	9.5	8.8	8.0	7.0	6.6	4.8	3.4	0.4										
Israel	20.0	16.4	16.0	11.8	10.8	10.8	9.1	8.4	7.5	6.6	6.1	4.4	3.0											
Finland	16.5	13.0	12.6	8.6	7.6	7.6	5.9	5.2	4.4	3.5	3.0	1.3												
Netherlands	14.9	11.5	11.1	7.1	6.2	6.1	4.5	3.8	3.0	2.1	1.7													
Estonia	13.0	9.6	9.3	5.4	4.4	4.4	2.8	2.1	1.3	0.4														
Greece	12.6	9.2	8.8	4.9	4.0	3.9	2.4	1.7	0.9															
Norway	11.6	8.2	7.9	4.0	3.1	3.0	1.5	0.8																
Sweden	10.7	7.3	7.0	3.2	2.3	2.2	0.6																	
Slovenia	10.0	6.6	6.3	2.5	1.6	1.5																		
Slovak Republic	8.3	5.0	4.7	0.9	0.0																			
Germany	8.2	5.0	4.6	0.9																				
Czech Republic	7.3	4.0	3.7																					
Belgium	3.4	0.3																						
Austria	3.1																							

Due to differences in the relative skills advantages in numeracy to literacy skills, domestic value added in gross exports in Denmark is 3.1% higher than in Austria in industries relatively intensive in marketing and accounting skills to management and communication skills.

B. From having relatively high problem solving in technology-rich envrionment skills as compared to literacy skills

From high to low relative skills advantages ----->

From low to high relative skills advantages ----->

%	Chile	Turkey	Israel	Germany	Austria	Denmark	Czech Republic	United Kingdom	Greece	New Zealand	Norway	Canada	Slovenia	Ireland	Sweden	Australia	Korea	United States	Slovak Republic	Belgium	Estonia	Netherlands	Poland	Finland
Japan	52.7	36.4	23.9	23.3	23.2	19.8	19.7	18.5	17.8	17.3	17.2	16.3	15.9	15.1	14.3	13.7	12.8	12.5	11.3	10.7	9.5	9.1	5.2	4.8
Finland	45.6	30.2	18.2	17.6	17.5	14.3	14.2	13.0	12.4	11.9	11.8	11.0	10.6	9.8	9.0	8.5	7.6	7.3	6.2	5.6	4.5	4.0	0.4	
Poland	45.1	29.7	17.8	17.2	17.1	13.9	13.8	12.6	12.0	11.5	11.4	10.6	10.2	9.4	8.6	8.1	7.2	6.9	5.8	5.2	4.1	3.7		
Netherlands	40.0	25.1	13.6	13.0	12.9	9.9	9.7	8.6	8.0	7.6	7.5	6.7	6.3	5.5	4.8	4.3	3.4	3.2	2.0	1.5	0.4			
Estonia	39.4	24.6	13.2	12.5	12.5	9.4	9.3	8.2	7.6	7.1	7.0	6.2	5.8	5.1	4.3	3.8	3.0	2.7	1.6	1.1				
Belgium	37.9	23.3	12.0	11.4	11.3	8.3	8.1	7.0	6.5	6.0	5.9	5.1	4.7	4.0	3.2	2.7	1.9	1.6	0.5					
Slovak Republic	37.2	22.6	11.4	10.8	10.7	7.7	7.5	6.5	5.9	5.5	5.3	4.6	4.2	3.4	2.7	2.2	1.4	1.1						
United States	35.7	21.3	10.2	9.6	9.5	6.5	6.4	5.3	4.7	4.3	4.2	3.4	3.0	2.3	1.6	1.1	0.3							
Korea	35.4	21.0	9.9	9.3	9.2	6.2	6.1	5.0	4.5	4.0	3.9	3.2	2.8	2.0	1.3	0.8								
Australia	34.3	20.0	9.0	8.4	8.3	5.4	5.2	4.2	3.6	3.2	3.1	2.3	1.9	1.2	0.5									
Sweden	33.6	19.4	8.5	7.9	7.8	4.9	4.7	3.7	3.1	2.7	2.6	1.8	1.4	0.7										
Ireland	32.6	18.5	7.7	7.1	7.0	4.1	4.0	2.9	2.4	2.0	1.8	1.1	0.7											
Slovenia	31.7	17.7	6.9	6.3	6.3	3.4	3.2	2.2	1.7	1.2	1.1	0.4												
Canada	31.2	17.3	6.5	5.9	5.9	3.0	2.9	1.8	1.3	0.9	0.7													
Norway	30.3	16.4	5.8	5.2	5.1	2.2	2.1	1.1	0.5	0.1														
New Zealand	30.1	16.3	5.6	5.0	5.0	2.1	2.0	1.0	0.4															
Greece	29.6	15.8	5.2	4.6	4.5	1.7	1.6	0.5																
United Kingdom	28.9	15.2	4.6	4.0	4.0	1.1	1.0																	
Czech Republic	27.6	14.0	3.6	3.0	2.9	0.1																		
Denmark	27.4	13.9	3.5	2.9	2.8																			
Austria	24.0	10.8	0.6	0.1																				
Germany	23.9	10.7	0.6																					
Israel	23.2	10.1																						
Turkey	11.9																							

Due to differences in the relative skills advantages in problem solving in technology-rich environment to literacy skills, domestic value added in gross exports in Germany is 0.1% higher than in Austria in industries relatively intensive in self-organisation skills compared to management and communication skills.

Figure 3.14. **Increase in exports in terms of domestic value added of exports resulting from workers' relative skills advantage at a country level** *(cont.)*

C. From having relatively high problem solving in technology-rich envrionment skills as compared to numeracy skills

From high to low relative skills advantages ------>

From low to high relative skills advantages <------

%	Chile	United States	United Kingdom	Turkey	New Zealand	Australia	Ireland	Canada	Israel	Korea	Germany	Norway	Netherlands	Sweden	Czech Republic	Poland	Austria	Greece	Finland	Denmark	Japan	Estonia	Slovenia	Slovak Republic
Belgium	13.3	7.8	6.4	6.1	6.1	6.1	5.5	5.3	4.6	4.3	3.1	3.0	2.5	2.5	2.3	2.1	2.0	1.9	1.8	1.7	1.4	1.2	1.1	0.4
Slovak Republic	12.8	7.3	5.9	5.7	5.7	5.6	5.0	4.8	4.1	3.9	2.6	2.6	2.1	2.0	1.9	1.7	1.6	1.4	1.3	1.3	1.0	0.8	0.7	
Slovenia	12.1	6.6	5.2	5.0	5.0	4.9	4.3	4.1	3.4	3.2	1.9	1.9	1.4	1.3	1.2	1.0	0.9	0.8	0.7	0.6	0.3	0.1		
Estonia	12.0	6.5	5.1	4.8	4.8	4.8	4.2	4.0	3.3	3.0	1.8	1.8	1.3	1.2	1.1	0.9	0.8	0.6	0.6	0.5	0.2			
Japan	11.7	6.3	4.9	4.6	4.6	4.6	4.0	3.8	3.1	2.8	1.6	1.6	1.1	1.0	0.9	0.7	0.6	0.5	0.4	0.3				
Denmark	11.4	6.0	4.6	4.3	4.3	4.3	3.7	3.5	2.8	2.5	1.3	1.3	0.8	0.7	0.6	0.4	0.3	0.2	0.1					
Finland	11.3	5.9	4.5	4.3	4.3	4.2	3.6	3.4	2.7	2.5	1.2	1.2	0.7	0.7	0.5	0.3	0.2	0.1						
Greece	11.2	5.8	4.4	4.2	4.2	4.1	3.5	3.3	2.6	2.4	1.2	1.1	0.6	0.6	0.4	0.2	0.1							
Austria	11.1	5.7	4.3	4.0	4.0	4.0	3.4	3.2	2.5	2.3	1.0	1.0	0.5	0.5	0.3	0.1								
Poland	11.0	5.5	4.1	3.9	3.9	3.9	3.3	3.1	2.4	2.1	0.9	0.9	0.4	0.3	0.2									
Czech Republic	10.8	5.3	4.0	3.7	3.7	3.7	3.1	2.9	2.2	2.0	0.7	0.7	0.2	0.2										
Sweden	10.6	5.2	3.8	3.6	3.6	3.5	2.9	2.7	2.0	1.8	0.6	0.5	0.0											
Netherlands	10.6	5.1	3.8	3.5	3.5	3.5	2.9	2.7	2.0	1.8	0.5	0.5												
Norway	10.0	4.6	3.3	3.0	3.0	3.0	2.4	2.2	1.5	1.3	0.1													
Germany	10.0	4.6	3.2	3.0	3.0	2.9	2.3	2.1	1.5	1.2														
Korea	8.7	3.3	2.0	1.7	1.7	1.7	1.1	0.9	0.2															
Israel	8.4	3.1	1.7	1.5	1.5	1.5	0.9	0.7																
Canada	7.7	2.4	1.0	0.8	0.8	0.8	0.2																	
Ireland	7.4	2.2	0.8	0.6	0.6	0.6																		
Australia	6.8	1.6	0.3	0.0	0.0																			
New Zealand	6.8	1.6	0.2	0.0																				
Turkey	6.8	1.5	0.2																					
United Kingdom	6.5	1.3																						
United States	5.2	0.0																						

Due to differences in the relative skills advantages in problem solving in technology-rich environment to numeracy skills, domestic value added in gross exports in the USA is 1.3% higher than in the United Kingdom in industries relatively intensive in self-organisation compared to marketing and accounting skills.

Note: Estimates come from the model described in Box 3.3.
Column countries are ranked in descending order of their relative skills advantage, while row countries are ranked in ascending order of the same indicator. Each estimate (cell) shows the increase in exports in value added terms resulting from the difference between the two countries in the relative skills advantage in industries with a relatively high intensity in the related skills.
The industry with a high (low) intensity in a specific skill relative to another one is at the 75th (25th) percentile of the industries ranked by ratios of intensities of the two skills. The relative exports in two industries with higher (lower) difference in the relative skills intensities would be larger (lower) than the results presented in the figure.
TiVA indicators are in 2011 and skills indicators are in 2012 or 2015. Data on skills for Belgium refer only to Flanders and for the United Kingdom – England and Northern Ireland jointly.
Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis*; OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*; OECD Annual National Accounts, SNA93, *http://stats.oecd.org/*; OECD STAN STructural ANalysis Database, *http://stats.oecd.org/*; Mayer and Zignago (2011), "Notes on CEPII's distances measures: the GeoDist Database", *CEPII Working Paper 2011-25;* World Input-Output Database (WIOD), *www.wiod.org/home*.

StatLink *http://dx.doi.org/10.1787/888933474395*

the higher level of the main skill should also have the other skills required by this industry. Except for the combination of literacy and numeracy skills, the comparative advantages in GVCs stemming from the relative skills of the population is smaller than those emerging from having the right mix of skills. These two determinants of specialisation can be combined in an overall skills mix effect (Box 3.5).

The role of countries' skills dispersion: providing pools of reliable workers

Each country's dispersion of skills influences what industry it specialises in, as well as its competitiveness patterns. Even if two countries have identical average skills endowments, they will trade with each other depending on the properties of their human capital dispersion (Asuyama, 2012; Bombardini, Gallipoli and Pupato, 2009; Bougheas and Riezman, 2007; Grossman, 2004 and 2013; Grossman and Magi, 2000). This publication is the first to investigate the role that skills dispersion plays in specialisation patterns within GVCs (Box 3.4).

The main reason that has been put forward to explain why the dispersion of skills, and not only average skills, matter for trade is the degree of complementarity between the skills of a worker and the skills of any other team member with whom the worker is paired (Grossman, 2013). Industries differ in such complementarity of workers' skills across tasks in

Box 3.4. **Analysing the effect of countries' unobservable skills dispersion on specialisation in GVCs**

The discussion in the current section is based on OECD work assessing the effect of countries' skills dispersion on industry specialisation in GVCs (Grundke et al., forthcoming b). The empirical specification is based on a theoretical model that assumes workers are heterogeneous and production requires teams of workers (Bombardini, Gallipoli and Pupato, 2009 and 2012). Industries differ in the extent to which workers' skills within the production team are complementary or substitutable. Some industries, especially those involving long sequences of tasks, require all workers to perform at the expected level, while others, in which skills are more easily substitutable, can cope with workers of low performance. The key parameter explaining countries' specialisation in certain industries is the dispersion of skills after accounting for the observable skills determinants, hence the unobservable skills dispersion. According to the model, a country with a narrow dispersion of unobserved skills exports more in industries characterised by higher complementarity of workers' skills in the production process than in industries with a lower skills complementarity.

Measures of countries' unobserved skills dispersions and industries' complementarity are based on information available in the Survey of Adult Skills. The unobserved skills are calculated by taking, for each worker, the difference between his/her literacy score and the estimated literacy score of a worker with similar characteristics in terms of education, age, gender, immigrant status and participation in adult education or training programmes 12 months before the survey date. The dispersion of these unobserved skills gives the skills dispersion that cannot be explained by countries' characteristics. Industries' degrees of complementarity are approximated by the average across countries for each industry of the task-based skills indicator management and communication, derived from the factor analysis (Box 3.1). This approach follows other studies that have used the O*NET database to approximate industries' degree of skills complementarity (Bombardini, Gallipoli and Pupato, 2009 and 2012). The frequency of management and communication tasks reflects the importance of coordinating tasks to achieve a given level of output quality and thereby characterises industries' degree of complementarity. Industries are ranked according to the complementarity index.

The empirical specification follows past studies (Bombardini, Gallipoli and Pupato, 2009 and 2012). The aim is to test the importance of unobservable skills dispersion for countries' specialisation in GVCs. The empirical analysis explains exports (in value added terms) in each industry of a country towards its trade partners by the country-specific unobservable skills dispersion (for literacy skills) in relation to the industry degree of complementarity. The degree of complementarity is measured by the task-based skill indicator management and communication, as calculated at the industry level across all countries participating in the Survey of Adult Skills.

The empirical analysis follows the same approach and uses the same data as for the assessment of the role of the skills mix for specialisation in GVCs (Box 3.3). It uses the typical sectoral gravity model for bilateral trade flows. All specifications include final demand at the importer-industry level as an independent variable. Additional explanatory variables include traditional Heckscher-Ohlin country-industry measures of relative endowments of physical and human capital, bilateral trade costs variables from the CEPII GeoDist database (Mayer and Zignago, 2011), and fixed effects to account for exporter, importer and industry characteristics, as well as dummy variables that control for all omitted aggregated sector characteristics for the exporting and importing country. Robust standard errors are clustered at the exporter-importer level.

Sources: Bombardini, M., G. Gallipoli and G. Pupato (2012), "Skill dispersion and trade flows", *American Economic Review*.

Bombardini, M., G. Gallipoli and G. Pupato (2009), "Skill dispersion and trade flows", *NBER Working Papers*.

Grundke, R. et al. (forthcoming b), "Having the right mix: The role of skills bundles for comparative advantage and industry performance in GVCs", *OECD Science, Technology and Industry Working Papers*.

Mayer, T. and S. Zignago (2011), "Notes on CEPII's distances measures: the GeoDist Database," *CEPII Working Paper 2011-25*.

the production process. Some industries, such as aerospace or engine manufacturing, require completing long sequences of tasks and poor performance at any single stage greatly reduces the value of output. These industries have high skills complementarity, known as the O-ring model (Kremer, 1993), in which efficiency improves when workers of similar skills are employed in every stage of production. In other industries, such as paper manufacturing, skills are more easily substitutable (low skills complementarity) and poor performance in some tasks can be mitigated by superior performance in others.

The degree of skills complementarity of an industry can be approximated by the degree of communication, contact and teamwork between workers in the industry (Bombardini, Gallipoli and Pupato, 2012). The more complementarity there is between a worker's skills and the skills of other members of the team, the more they need to communicate with one another. In the Survey of Adult Skills, the questions covering these topics are summarised in the task-based skills indicator management and communication (see Box 3.1). According to this indicator, all complex business services and high-tech manufacturing industries show a high level of skills complementarity (Figure 3.9).

Industries requiring good performance at all stages of production because of the high complementarity of skills would benefit from a pool of reliable workers, or workers who perform at the expected level. In contrast, industries with low complementarity of skills can cope with workers with uneven skills. When recruiting, firms cannot fully observe the skills of applicants. However, they can observe a number of characteristics such as the level of education and training, and age, and they base their recruitment decisions on the basis of these observable skills determinants. Pools of reliable workers emerge in countries where individuals perform at the expected level or where individuals' skills present no unwelcome surprises once their various characteristics have been accounted for, including education level. These countries have a small dispersion of unobservable skills. Overall, countries with smaller dispersions of unobservable skills have a trade comparative advantage in industries characterised by greater complementarities in the production process. Countries with a larger dispersion of unobservable skills have a trade comparative advantage in industries characterised by greater substitutability in the production process.

The Survey of Adult Skills shows how countries differ in their skills dispersion, for instance in terms of literacy skills (Table 3.2, first two columns).[9] Several factors contribute to the population's skills and therefore to the skills dispersion. Some are observable, such as the level of education, participation in training, age, and gender. However, individuals with similar observable characteristics do not have the same skills. In the same way, countries' skills dispersions can be separated into two parts: one that comes from the dispersion of observable characteristics such as differences in education levels and the demographic structure; and one that cannot be explained by differences in observable characteristics, called the unobservable skills dispersion in Table 3.2. Countries do not have the same ranking in terms of the usual standard deviation of literacy scores and in terms of the unobservable skills dispersion. The unobservable skills dispersion can be large when there are differences in the quality of education programmes at the same level of education, or when characteristics that are more difficult to observe play an important role. Countries with a small unobservable skills dispersion can have pools of reliable workers in the sense that workers with the same observable characteristics would tend to perform at the same level.

Table 3.2. **Characteristics of the literacy skills dispersion**

2012 or 2015

Country	Standard deviation of Literacy scores		Unobservable skills dispersion	
	Rank	Value	Rank	Value
Australia	24	50.47	22	0.18
Austria	5	43.96	6	0.15
Belgium	11	47.08	7	0.15
Canada	23	50.41	20	0.17
Chile	27	52.65	28	0.22
Czech Republic	3	40.79	4	0.14
Denmark	15	47.72	17	0.17
Estonia	7	44.40	9	0.15
Finland	26	50.67	8	0.15
France	20	49.02	19	0.17
Germany	14	47.40	10	0.15
Greece	9	46.65	25	0.18
Ireland	12	47.19	18	0.17
Israel	28	55.55	27	0.22
Italy	8	44.69	16	0.17
Japan	1	39.71	1	0.12
Korea	4	41.69	2	0.13
Netherlands	18	48.39	5	0.15
New Zealand	13	47.39	12	0.16
Norway	10	47.02	11	0.16
Poland	16	47.98	21	0.17
Slovak Republic	2	40.07	3	0.14
Slovenia	17	48.15	24	0.18
Spain	21	49.03	23	0.18
Sweden	25	50.56	14	0.16
Turkey	6	44.11	26	0.19
United Kingdom	19	48.97	15	0.17
United States	22	49.19	13	0.16

Note: All statistics are shown for the whole population in a country.
The unobservable skills dispersion is computed by: 1) estimating a regression of the logarithm of literacy scores on education, age, gender, immigration background and training; 2) computing the residuals of the regression for each individual (logarithm of literacy scores minus fitted values); 3) computing the standard deviation of the residuals by country. Lower ranks indicate low skills dispersion and high mean while high ranks indicate high skills dispersion and low mean. Chile, Greece, Israel, New Zealand, Slovenia and Turkey: Year of reference 2015. All other countries: Year of reference 2012. Data for Belgium refer only to Flanders and data for the United Kingdom refer to England and Northern Ireland jointly.
Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdata andanalysis*.

Having pools of reliable workers (or a narrow unobservable skills dispersion) enables countries to have a comparative advantage in trade in industries characterised by a high skills complementarity (Figure 3.15). Countries have the highest differences in exports in value added terms with countries that show the highest difference in the unobservable skills dispersion. For instance, because Japan has a narrow unobservable skills dispersion, providing for pools of reliable workers, it can export (in value added terms) 23% more than Chile in industries with high skills complementarity (relative to industries with low skills complementarity). These results are symmetric: likewise, due to Chile's large unobservable skills dispersion, its exports in industries with low skills complementarity (relative to industries with high skills complementarity) are 23% higher than those of Japan. As Korea also has a narrow unobservable skills dispersion, Japan's exports in industries with high skills complementarity are only 2.6% higher than those of Korea.

Figure 3.15. **Relative increase in exports in industries with high skills complementarity resulting from having pools of reliable workers**

In terms of the domestic value added of exports

From low to high unobservable literacy score dispersion ----->

From high to low unobservable literacy score dispersion ----->

%	Japan	Korea	Slovak Republic	Czech Republic	Netherlands	Austria	Belgium	Finland	Estonia	Germany	Norway	New Zealand	United States	Sweden	United Kingdom	Italy	Denmark	Ireland	France	Canada	Poland	Australia	Spain	Slovenia	Greece	Turkey	Israel
Chile	23.3	20.1	18.6	17.6	16.9	16.5	16.4	15.2	14.9	14.8	14.1	14.0	13.9	12.4	11.6	11.5	11.4	11.3	11.1	10.8	10.0	9.4	9.4	8.6	7.8	6.4	0.5
Israel	22.7	19.5	18.0	17.0	16.4	15.9	15.8	14.7	14.4	14.3	13.6	13.4	13.3	11.9	11.1	11.0	10.9	10.8	10.6	10.2	9.5	8.9	8.9	8.1	7.3	5.9	
Turkey	15.9	12.9	11.5	10.5	9.9	9.5	9.4	8.3	8.1	8.0	7.3	7.1	7.0	5.7	5.0	4.8	4.7	4.7	4.5	4.1	3.4	2.9	2.8	2.1	1.3		
Greece	14.3	11.4	10.0	9.1	8.5	8.0	8.0	6.9	6.6	6.5	5.9	5.7	5.6	4.3	3.6	3.5	3.3	3.3	3.1	2.8	2.0	1.5	1.5	0.7			
Slovenia	13.5	10.6	9.2	8.3	7.7	7.3	7.2	6.1	5.9	5.8	5.1	5.0	4.9	3.5	2.8	2.7	2.6	2.5	2.3	2.0	1.3	0.8	0.7				
Spain	12.7	9.8	8.5	7.5	6.9	6.5	6.4	5.3	5.1	5.0	4.3	4.2	4.1	2.8	2.1	2.0	1.9	1.8	1.6	1.3	0.6	0.1					
Australia	12.6	9.7	8.4	7.5	6.8	6.4	6.3	5.3	5.0	5.0	4.3	4.1	4.1	2.7	2.0	1.9	1.8	1.8	1.5	1.2	0.5						
Poland	12.1	9.2	7.8	6.9	6.3	5.9	5.8	4.7	4.5	4.4	3.8	3.6	3.5	2.2	1.5	1.4	1.3	1.2	1.0	0.7							
Canada	11.3	8.4	7.1	6.2	5.6	5.1	5.1	4.0	3.8	3.7	3.0	2.9	2.8	1.5	0.8	0.7	0.6	0.5	0.3								
France	10.9	8.1	6.7	5.8	5.2	4.8	4.7	3.7	3.4	3.4	2.7	2.6	2.5	1.2	0.5	0.4	0.3	0.2									
Ireland	10.7	7.8	6.5	5.6	5.0	4.6	4.5	3.5	3.2	3.1	2.5	2.4	2.3	1.0	0.3	0.2	0.0										
Denmark	10.6	7.8	6.5	5.6	5.0	4.5	4.5	3.4	3.2	3.1	2.4	2.3	2.2	0.9	0.2	0.1											
Italy	10.5	7.7	6.4	5.4	4.8	4.4	4.3	3.3	3.1	3.0	2.3	2.2	2.1	0.8	0.1												
United Kingdom	10.4	7.5	6.2	5.3	4.7	4.3	4.2	3.2	3.0	2.9	2.2	2.1	2.0	0.7													
Sweden	9.6	6.8	5.5	4.6	4.0	3.6	3.5	2.5	2.2	2.1	1.5	1.4	1.3														
United States	8.2	5.4	4.2	3.3	2.7	2.3	2.2	1.2	1.0	0.9	0.2	0.1															
New Zealand	8.2	5.4	4.1	3.2	2.6	2.2	2.1	1.1	0.9	0.8	0.1																
Norway	8.0	5.2	3.9	3.0	2.5	2.1	2.0	1.0	0.7	0.6																	
Germany	7.3	4.6	3.3	2.4	1.8	1.4	1.3	0.3	0.1																		
Estonia	7.2	4.5	3.2	2.3	1.7	1.3	1.2	0.2																			
Finland	7.0	4.2	3.0	2.1	1.5	1.1	1.0																				
Belgium	5.9	3.2	1.9	1.0	0.5	0.1																					
Austria	5.8	3.1	1.8	1.0	0.4																						
Netherlands	5.4	2.7	1.4	0.6																							
Czech Republic	4.8	2.1	0.9																								
Slovak Republic	3.9	1.2																									
Korea	2.6																										

Due to differences in the unobservable literacy score dispersion , domestic value added in gross exports in Korea is 1.2 percent higher than in Slovak Republic in the industry with high skills complementarity relative to those with low skills complementarity .

Note: Estimates come from model described in Box 3.4.

Column countries are ranked in ascending order of the unobservable literacy skills dispersion, while row countries are ranked in descending order of the unobservable literacy skills dispersion. Each estimate (cell) shows the increase in exports in value added terms resulting from the difference in the unobservable skills dispersion between the two countries in industries with high skills complementarity relative to those with low skills complementarity.

The industry with high (low) complementarity is at the 75th (25th) percentile of the industries ranked by degree of complementarity. According to the skills complementarity indicator used in the model, the comparative advantage is in chemical and chemical products relative to electrical machinery and apparatus. The relative comparative advantage in two industries with higher (lower) difference in skills complementarity would be larger (lower) than the results presented in the figure.

TiVA indicators are in 2011 and skills indicators are in 2012 or 2015. Data on skills for Belgium refer only to Flanders and for the United Kingdom – England and Northern Ireland jointly.

Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis*; OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*; OECD Annual National Accounts, SNA93, *http://stats.oecd.org/*; OECD STAN STructural ANalysis Database, *http://stats.oecd.org/*; Mayer and Zignago (2011), "Notes on CEPII's distances measures: the GeoDist Database", *CEPII Working Paper 2011-25*; World Input-Output Database (WIOD), *www.wiod.org/home*.

StatLink *http://dx.doi.org/10.1787/888933474403*

Opportunities for specialisation

Countries vary in their skills endowments – the skills mix of their population and their unobservable skills dispersion, enabling them to have pools of reliable workers. At the same time, industries vary in their skills requirements. The interaction between countries' skills endowment and industries' specificities contributes to countries' comparative advantages and enables countries to perform well in some GVCs.

Comparing countries' potential for specialisation, arising from their skills endowment, with their actual industry specialisation and how it has evolved over the last decade can show how countries can specialise within GVCs by capitalising on their skills. This analysis assumes that all other potential sources of trade comparative advantage are held constant.

Countries' specialisation within GVCs can be observed by looking at revealed comparative advantages (RCAs). The RCA indicates the relative advantage or disadvantage of a country in a certain class of goods or services, as evidenced by trade flows. The TiVA database makes it possible to compute RCAs in terms of value added and to capture countries' specialisation in industries within GVCs. Traditionally, RCA analysis is based on comparing a country's share of world exports of a particular product with its share of overall exports. However, the best way to determine specialisation within GVCs is to calculate RCAs

on the basis of GVC incomes in the production of final goods, rather than exports, since the comparative advantage stems from primary factors of production in the value added and not the imported inputs. An RCA larger than 1 for an industry indicates that the share of the country's overall GVC income that the country derives from adding value in the GVC production of this industry is higher than that of other countries.

Over the last 15 years, OECD countries have been increasingly specialising in services, while their RCAs in resource extracting sectors as well as in many manufacturing sectors have been declining (Table 3.3). Some variation exists, however. East European countries, along with Germany, Ireland, Israel and Korea, have enhanced their integration into high-tech industries, such as electrical and optical, or chemicals. Other countries, including Greece, Japan and the Netherlands, have increased RCA in low-technology sectors such as food products, and wood and paper.

Countries' comparative advantages in GVCs resulting from their skills characteristics can be summarised by observing whether countries' skills characteristics are aligned with industries' skills requirements (Box 3.5). Different skills characteristics can provide comparative advantages in different industries. For instance, in terms of its skills mix, Israel could specialise in all high-tech manufacturing and complex business service industries, but its strong unobservable skills dispersion provides comparative advantages rather in low-tech and medium-tech manufacturing (Table 3.4).

Most OECD countries strive to reach technology frontiers and specialise in technologically sophisticated industries – either medium to high-tech manufacturing industries or in complex business services. Countries differ in the number of specialisation opportunities they may obtain from their skills characteristics (Table 3.5). Some countries (e.g. Estonia, Japan, Korea and New Zealand) could explore a wide spectrum of specialisation opportunities across the different technologically advanced sectors, while others have good skills alignment only in services (e.g. Austria, the Netherlands, Norway, the Slovak Republic and Slovenia) or manufacturing (e.g. Canada, Chile and Finland). Some countries' skills characteristics struggle to meet the requirements of the technologically advanced sectors (Australia, Ireland, Turkey, the United Kingdom and the United States). Table 3.5. Specialisation opportunities in complex business services, high-tech and medium-high-tech manufacturing industries resulting from the alignment for countries' skills characteristics with industries' skills requirements.

Comparing countries' current specialisations in GVCs, as captured by the RCAs, with the specialisation opportunities emerging from countries' skills characteristics leads to a number of findings:

- Several countries have increased their RCAs in industries in which their skills characteristics give them specialisation opportunities (e.g. Japan in the computer industry). This indicates that their skills policies are in line with their specialisation patterns and objectives in GVCs.
- Some countries have increased their RCAs in some industries but this change is not supported by their skills characteristics (e.g. Canada and the United States in most complex business services). The poor alignment of their skills with industry requirements could make it difficult for them to maintain their comparative advantage.
- Other countries have specialisation opportunities in some industries because of their skills characteristics but have seen their RCAs decrease in these industries (e.g. Sweden in electrical machinery). This could be because it is no longer optimal to specialise in

Table 3.3. **Trend in revealed comparative advantages in global value chains, 2000-11**

● Revealed comparative advantage increased
● Revealed comparative advantage decreased
○ 2011 Revealed comparative advantage > 1

Technology category	Industry name	Australia		Austria		Belgium		Canada		Chile		Czech Republic		Denmark		Estonia		Finland		Germany		Greece		Ireland		Israel		Japan		Korea		Netherlands		New Zealand		Norway		Poland		Slovak Republic		Slovenia		Sweden		Turkey		United Kingdom		United States	
		change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1	change in RCA	2011 RCA >1
Low-tech manufacturing	Food products, beverages, tobacco	●		◐		●		●		●	○	●	○	●		●		◐		●		◐	○	◐	○	●		◐	○	●		◐	○	●	○	●		◐	○	●		●		●		●	○	●		●	
	Textiles, leather and footwear	●		●		●		●		●		●		●	○	●		●		●		●		●		●		●		●	○	●		●		●		●	○	●	○	●		◐	○	●		●		●	
	Wood and products of wood and cork	●	○	●	○	●		●	○	●	○	●	○	●		●	○	●		●		●		●		●		●		●		●		●	○	●		●	○	●		◐	○	●	○	◐		●		●	
	Pulp, paper, printing and publishing	◐	○	◐	○	●		●	○	●	○	◐	○	●		◐	○	●		◐		◐		●	○	●		◐	○	◐		◐	○	●		●		●		●		●	○	●	○	●		●	○	◐	○
	Manufacturing n.e.c; recycling	●		●	○	●		●		●		●	○	●		●	○	●		●		◐		●	○	●		●		●		●	○	●		●		◐	○	◐	○	●	○	●		◐	○	●		●	
Medium/low-tech manufacturing	Coke, refined petroleum, nuclear fuel	●		●		●		◐		●		●		◐		◐		●		●		●	○	◐		◐		●	○	●		◐		●		●		●		●		●		◐		●		●		◐	○
	Rubber and plastics products	●		◐	○	◐		●		●		◐	○	●		◐		●		◐	○	●		●		●		◐	○	◐	○	●		●		◐	○	◐	○	●	○	●		◐	○	◐	○	●		●	
	Other non-metallic mineral products	●		●	○	●		●		●		●	○	●		●	○	●		●		●		●		●		●		●	○	●		●		●	○	●	○	●		◐		●	○	●		●		●	
	Basic metals	●		●	○	●		●		◐	○	●		●		◐		●		●		●		●		●		●	○	◐	○	●		●		●		●	○	●		●		●		●		●		●	
	Fabricated metal products	◐		◐	○	●	○	●		◐		◐	○	●	○	◐	○	◐	○	◐	○	◐		●		●		◐		◐	○	◐	○	●		◐		◐	○	◐	○	◐	○	●	○	◐	○	●		●	
Business services (less complex)	Wholesale and retail trade; repairs	●		◐	○	◐	○	◐		●		●	○	◐	○	◐		◐		●		◐	○	◐		◐		●	○	●		●	○	●		●		◐	○	◐	○	◐		◐		◐	○	●		●	
	Hotels and restaurants	●		◐	○	◐		●		◐		●		◐		◐		◐		◐		◐	○	●		●		◐	○	●		◐		◐		◐		◐		◐		◐		◐	○	●	○	◐	○	●	
	Transport and storage	◐	○	●		●	○	●		●	○	●	○	●	○	●	○	●		◐	○	●		●	○	●		◐	○	●		●		●		◐	○	◐	○	◐	○	◐		●	○	◐	○	●		●	
	Post and telecommunications	●		●		●		◐	○	◐		●	○	●	○	●		●		●		◐	○	◐		◐	○	◐		●		●		●		◐		●		●		◐	○	●		●	○	●	○
Medium/high-tech manufacturing	Machinery and equipment n.e.c	●		◐	○	●		●		◐		◐	○	●		●		◐	○	◐	○	●		●		●		●	○	◐	○	◐		◐		●		●	○	◐	○	◐	○	●	○	◐		●		●	
	Electrical machinery, apparatus n.e.c	●		◐	○	●		●		◐	○	◐	○	◐	○	◐	○	◐	○	◐	○	◐		●		◐		●		◐	○	●		◐		◐	○	◐	○	◐	○	●		◐	○	●		●	
	Motor vehicles, trailers, semi-trailers	●		◐		●		●		●		◐	○	●		◐		●		◐	○	●		●		◐		◐	○	●		●		●		◐	○	◐	○	◐	○	●		◐	○	●		●	
High-tech manufacturing	Chemicals and chemical products	●		◐	○	●	○	●		●		●		◐	○	◐		◐		◐	○	●		◐	○	◐	○	●		◐	○	◐	○	●		●		●		◐	○	●	○	●		●		◐	
	Computer, electronic, optical products	◐		●		●		●		◐		●		◐	○	●		◐	○	●		●	○	●	○	●	○	◐	○	◐	○	●		●		◐		◐		●		◐	○	●		◐	○	●		◐	○
	Other transport equipment	●		◐		●		●		●	○	●		●		●		◐	○	◐	○	●		●	○	◐	○	◐		◐		●		◐	○	◐		◐		◐		●		●		◐		●	○	●	○
Business services (more complex)	Finance and insurance	◐	○	●		◐	○	◐	○	◐		◐		◐	○	●		●		◐		●		◐	○	●		◐	○	◐		◐	○	◐		◐		●		●		●		●		◐	○	●	○	◐	○
	Real estate activities	●	○	◐	○	●		◐	○	●		●		◐	○	●	○	◐	○	◐	○	◐	○	●		◐	○	◐	○	●		●		◐	○	●		◐		◐	○	◐	○	◐	○	◐	○	◐	○	◐	○
	Renting of machinery and equipment	●		◐	○	◐	○	◐	○	◐	○	◐		◐	○	◐	○	◐	○	●	○	◐		◐	○	◐	○	◐	○	●		●	○	◐	○	◐	○	◐		◐		◐	○	◐	○	●	○	◐	○	◐	○
	Computer and related activities	◐	○	◐	○	◐	○	◐		◐		◐	○	◐	○	◐	○	◐	○	◐	○	◐		◐	○	◐	○	◐	○	●		●	○	◐	○	◐		◐	○	◐	○	◐	○	●		◐	○	◐	○	◐	○
	Research and development and others	◐	○	◐	○	◐		◐	○	◐		◐	○	◐	○	◐		◐		●		◐		◐	○	◐	○	◐		◐		◐	○	◐		◐		◐		◐	○	◐	○	◐		◐	○	◐	○	◐	○

Source: OECD calculations based on OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*.

Box 3.5. **Deriving the specialisation opportunities stemming jointly from countries' various skills characteristics**

This chapter shows that several characteristics of skills can shape countries' specialisation in GVCs: the skills mix, with a pure skills mix effect and a relative skills endowment effect, and the unobservable skills dispersion. This section consolidates the various results to assess the overall extent to which countries may have opportunities to specialise in complex business and high-tech manufacturing industries. These specialisation opportunities are then compared with the countries' actual specialisations as measured by their RCAs.

According to the models discussed in this chapter, several skills characteristics shape specialisation opportunities: i) unobservable skills dispersion; ii) skills mix in numeracy versus literacy; iii) skills mix in problem solving in technology-rich environments versus literacy; and iv) skills mix in problem solving in technology-rich environments versus numeracy. The skills mix includes two aspects, a pure skills mix effect measured by the correlation between the relative skills advantage and the absolute skills advantage, and a relative skills endowment effect measured by the average ratio of each of two skills. The methodology includes several steps:

1) An overall skills mix effect combining the pure skill mix effect with the relative endowment effect is calculated based on the model specification for each of three pairs of skills (Grundke et al., forthcoming b).

2) An average unobservable skills dispersion for literacy, numeracy and problem solving in technology-rich environments is calculated.

3) A measure of the alignment of countries' skills characteristics with industry' skills requirements is calculated for each country-industry pair, and for each skill characteristic. This is done by ranking countries in terms of the four skills characteristics and industries in terms of their skills requirements and looking at the distance between these ranks. The smaller the distance, the more aligned a country's skills are with this industry' skills requirements. For instance, the country with the lowest unobservable skills dispersion has the lowest distance (strongest alignment) with the industry with the highest intensity in managing and communication tasks, which indicates a strong degree of skills complementarity. The country with the strongest skills mix in numeracy versus literacy (both a high correlation between the relative numeracy skills and the absolute literacy, and high relative numeracy skills) has the lowest distance (strongest alignment) with the industry with the highest relative intensity in marketing and accounting tasks versus managing and communication ones.

4) An overall alignment measure of countries' skills characteristics with the skills requirements of a particular industry is calculated by taking the average of the alignments in terms of the four skills characteristics and industry's skills requirements. This number would measure the joint alignment.

5) A threshold needs to be applied to decide about the minimum degree of alignment that leads to an opportunity to specialise in the industry. Only countries with an alignment that is in the top 25 percentile of the alignment distribution across all countries and industries in the sample are considered to have a specialisation opportunity.

Table 3.5 shows the specialisation opportunities stemming from countries' skills characteristics and countries' current specialisations as reflected by their RCAs.

Source: Grundke, R. et al. (forthcoming b), "Having the right mix: The role of skills bundles for comparative advantage and industry performance in GVCs", *OECD Science, Technology and Industry Working Papers*.

Table 3.4. **Countries' comparative advantages in global value chains in various types of industries stemming from their skills characteristics**

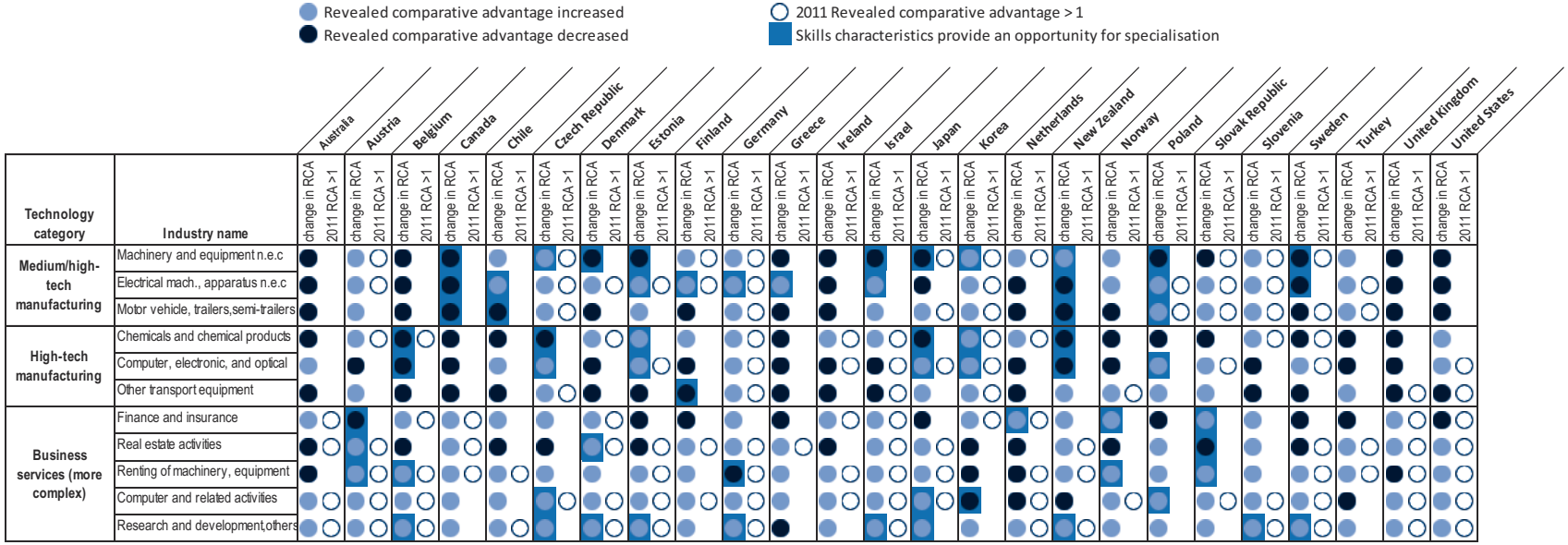
Skills requirements of industries	Complementarity (1)		Intensity of marketing/accounting versus managing/communication skills (2)				Intensity of self-organisation skills versus managing/communication skills (3)				Intensity of self-organisation skills versus marketing/accounting skills (4)			
	High	Low	High		Low		High		Low		High		Low	
Examples of industries	All complex business services and high-tech manufacturing	Most low-tech and medium-tech manufacturing and less complex business services	Most business services and low-tech manufacturing		Most high-tech and medium-tech manufacturing industries		Some complex business services and various manufacturing		All less complex business services and various manufacturing		High-tech and medium-tech manufacturing		Most business services and low-tech manufacturing	
Channel	Unobservable dispersion	Unobservable dispersion	Mix	Endowment	Mix	Endowment	Mix	Endowment	Mix	Endowment	Mix	Endowment	Mix	Endowment
Australia		**	**			**			**	*		**	**	
Austria	**			**	*			**	**				*	*
Belgium	**			**	**		**			**	**			**
Canada		*	*			*	*	*				*	*	
Chile		**			*	**		**	**			**	**	
Czech Republic	**			**	**		**	*			**			*
Denmark		*		**	**		*	**			*			**
Estonia	*			*	**		*			**	**			**
Finland	*			*	**				*	**	*			*
France		*	**			*								
Germany	*		*	**				**	*			*	*	
Greece		**		*	**			*	*		*			*
Ireland		*	**			**			**	*		*	**	
Israel		**	*			*	*	**			*	*		
Italy		*		*	*									
Japan	**				*	*	**			**	**			**
Korea	**		*			*	**			*	*	*		
Netherlands	**			*	*				*	**	*	*		
Norway	*		**	*				*	**			*	**	

Table 3.4. **Countries' comparative advantages in global value chains in various types of industries stemming from their skills characteristics** *(cont.)*

Skills requirements of industries	Complementarity (1)		Intensity of marketing/accounting versus managing/communication skills (2)				Intensity of self-organisation skills versus managing/communication skills (3)				Intensity of self-organisation skills versus marketing/accounting skills (4)			
	High	Low	High		Low		High		Low		High		Low	
Examples of industries	All complex business services and high-tech manufacturing	Most low-tech and medium-tech manufacturing and less complex business services	Most business services and low-tech manufacturing		Most high-tech and medium-tech manufacturing industries		Some complex business services and various manufacturing		All less complex business services and various manufacturing		High-tech and medium-tech manufacturing		Most business services and low-tech manufacturing	
Channel	Unobservable dispersion	Unobservable dispersion	Mix	Endowment	Mix	Endowment	Mix	Endowment	Mix	Endowment	Mix	Endowment	Mix	Endowment
New Zealand	*		*			**	*	*				**	*	
Poland		*			**	*	**			**	**			*
Slovak Republic	**		*	**			*			*			*	**
Slovenia		**	*	**			**	*			**			**
Spain		**			*	*								
Sweden	*			*	*				*	*	*			*
Turkey		**	**			**		**	*			**	*	
United Kingdom		*	**			**		*	**			**	**	
United States	*		**			**	*			*		**	**	

Note: Results come from the models presented in Boxes 3.3 and 3.4. ** and * indicate that countries are among the 75th percentile or 50th percentile of the exporters in value added terms in the selected type of industries given the characteristics of their skills distribution.
(1) GVC comparative advantages are given by countries' unobservable skills dispersions in literacy.
(2) GVC comparative advantages are given by countries' correlations between comparative advantage of individuals in numeracy and absolute advantage in literacy for the skills mix channel and by the average ratio of scores in numeracy and literacy for the skills endowment channel.
(3) GVC comparative advantages are given by countries' correlations between comparative advantage of workers in problem solving in technology-rich environments and absolute advantage in literacy for the skills mix channel and by the average ratio of scores in problem solving in technology-rich environments and literacy for the skills endowment channel.
(4) GVC comparative advantages are given by countries' correlations between comparative advantage of workers in problem solving in technology-rich environments and absolute advantage in numeracy for the skills mix channel and by the average ratio of scores in problem solving in technology-rich environments and numeracy for the skills endowment channel.
Chile, Greece, Israel, New Zealand, Slovenia and Turkey: Year of reference 2015. All other countries: Year of reference 2012. Data on skills for Belgium refer only to Flanders and for the United Kingdom – England and Northern Ireland jointly.
Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis*; OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*; OECD Annual National Accounts, SNA93, *http://stats.oecd.org/*; OECD STAN STructural ANalysis Database, *http://stats.oecd.org/*; Mayer and Zignago (2011), "Notes on CEPII's distances measures: the GeoDist Database", *CEPII Working Paper 2011-25;* World Input-Output Database (WIOD), *www.wiod.org/home*.

Table 3.5. **Specialisation opportunities in complex business services, high-tech and medium-high-tech manufacturing industries resulting from the alignment for countries' skills characteristics with industries' skills requirements**



Note: Estimates of specialisation opportunities are explained in Box 3.5. Specialisation opportunities stemming from countries' skills characteristics are highlighted in blue.
Skills indicators are in 2015 for Chile, Greece, Israel, New Zealand, Slovenia and Turkey and in 2012 for all other countries: Data for Belgium refer only to Flanders and data for the United Kingdom refer to England and Northern Ireland jointly. TiVA indicators are in 2011.
Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis*; OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*; OECD Annual National Accounts, SNA93 *http://stats.oecd.org/*; OECD STAN STructural ANalysis Database, *http://stats.oecd.org/*; Mayer and Zignago (2011), "Notes on CEPII's distances measures: the GeoDist Database", *CEPII Working Paper 2011-25;* World Input-Output Database (WIOD), *www.wiod.org/home*.

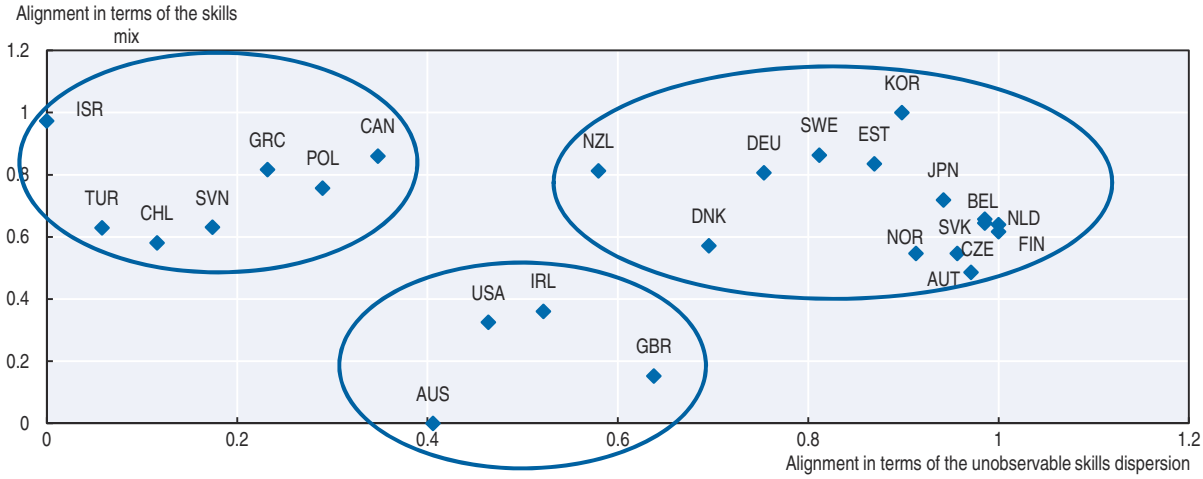
these industries; the countries concerned might be upgrading to other industries. Another explanation could be that factors other than skills prevent these countries from specialising in these industries.

- Finally, in some cases skills characteristics do not provide specialisation opportunities and countries' RCAs have decreased (e.g. Australia, Canada, Norway and the United Kingdom, in several high-tech industries). This could indicate that countries are now specialising in other industries, such as services. But it could also indicate that to specialise in these industries, countries need to upgrade the skills of their population and achieve a better alignment of their populations' skills with the skills requirements of these industries.

A closer look at how well countries' different skills characteristics match the skills requirements of the technologically most advanced industries can indicate what countries could do in terms of skills to achieve specialisation objectives (Figure 3.16). Some patterns emerge:

- A first group of countries have a strong alignment of their skills mixes with the requirements of these industries, but a large unobservable skills dispersion prevents them from having the pools of reliable workers that are required in these industries (Canada, Chile, Greece, Israel, Poland, Slovenia and Turkey). Countries in this group need to narrow their unobservable skills dispersion and improve or maintain a good skills mix to increase or strengthen their specialisation in technologically advanced industries. Israel has the strongest alignment in terms of its skills mix, but the lowest in terms of the unobservable skills dispersion. Countries in this group have different skills mixes, with Israel, Slovenia, Poland and New Zealand having strong skills mixes in problem solving in technology-rich environments: those who have strong problem solving skills relative to other skills also

Figure 3.16. **Alignment of countries' skills characteristics with the skills requirements of high-tech manufacturing and complex business services industries**



Notes: A country's position is determined by the average alignment score of its skills mixes (y-axis) and its skills dispersion (x-axis) with the skills requirements of five complex business services and three high-tech manufacturing industries. Zero indicates a low alignment between countries' skills characteristics and industries' skills requirements and 1 a strong one.
Skills indicators are in 2015 for Chile, Greece, Israel, New Zealand, Slovenia and Turkey and in 2012 for all other countries: Data for Belgium refer only to Flanders and data for the United Kingdom refer to England and Northern Ireland jointly. TiVA indicators are in 2011.
Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis*; OECD Trade in Value Added database (TiVA), *https://stats.oecd.org/index.aspx?queryid=66237*; OECD Annual National Accounts, SNA93, *http://stats.oecd.org/*; OECD STAN STructural ANalysis Database, *http://stats.oecd.org/*; Mayer and Zignago (2011), "Notes on CEPII's distances measures: the GeoDist Database", *CEPII Working Paper 2011-25*; World Input-Output Database (WIOD), *www.wiod.org/home*.

StatLink *http://dx.doi.org/10.1787/888933474410*

have strong numeracy and literacy skills. A strong skills mix in problem solving in technology-rich environments is required by several high-tech manufacturing industries and complex business services.

- A second group of countries (Australia, Ireland, the United Kingdom and the United States) has a poor alignment of their skills characteristics – mainly the skills mix but also to some extent the unobservable skills dispersion – with the requirements of technologically advanced industries. These countries would need to develop stronger skills mixes and narrow the unobservable skills dispersion to increase or maintain comparative advantages in these industries.
- The largest group of countries is characterised by a small unobservable skills dispersion, enabling them to have pools of reliable workers, and skills mixes that broadly correspond to the requirements of technologically advanced industries. This good overall alignment of skills characteristics with skills requirements of technologically advanced industries brings them some opportunities for specialisation in one or several of these industries. However, there are differences among countries. New Zealand would have to narrow its unobservable skills dispersion to increase or strengthen its specialisation in these industries and Austria, Denmark and Norway would have to develop stronger skills mixes.

Policies can help countries to develop strong skills mixes that meet the requirements of technology advanced industries. They can also narrow the unobservable skills dispersion. Large unobservable skills dispersion can reflect various factors. If the quality of education programmes varies widely at the same level of education, individuals can have the same type of formal diploma but different levels of skills. A segmented economy, in which leading firms offer a lot of non-formal training and access to the latest technologies while other firms are lagging behind in terms of knowledge, would also create differences in workers' skills. As a result, individuals with a similar profile do not perform at the same level, creating unwelcome surprises for employers and weakening the efficiency of the production process. Policies can reduce the unobservable skills dispersion, either ex-ante, for instance through an education system with homogenous quality, or ex-post, for instance through measures to better signal individuals' skills. Training policies can help those who do not perform at the expected level to catch up. Chapter 4 discusses these policies.

The results presented above come from models that have been estimated, that rely on a number of assumptions and that are constrained by data availability. They use information from the Survey of Adult Skills to assess the impact of specific skills – literacy, numeracy and problem solving in technology-rich environments – on countries' opportunities to specialise in some industries. However, the results that show the importance of having a strong skills mix and a small dispersion of unobservable skills go beyond the set of skills assessed in the Survey of Adult Skills. A strong skills mix also means having strong cognitive skills and personality traits.

Due to data limitations, this analysis includes a small group of exporting countries, those covered by the Survey of Adult Skills. It shows the extent to which a country from this group can export more in value added terms (to the world) than another country of the same group because of its skills characteristics. The analysis does not enable the comparative advantage stemming from the skills characteristics of one country of this group to be compared with the advantage of a country outside the group, such as China. However, the results on the revealed comparative advantages and their evolutions do include all countries in the world.

Summary

A broad range of skills matter for participation and specialisation in GVCs. They include cognitive skills, personality traits and skills that combine both, such as the capacity to interact and communicate with others. Countries with the highest skills levels also participate and export the most in GVCs.

Countries can shape their specialisation in GVCs by developing skills characteristics that match industries' skills requirements. The results here do not specify which skills characteristics countries should develop to make the most of GVCs. However, the results do illustrate the potential costs of adopting industry specialisation objectives that are misaligned with countries' skills. Policies to support a specific industry can be inefficient if countries' skills do not match the skills requirements of the industry and, by leading to misallocations of skills, they can lower the comparative advantage countries have in other industries.

Many OECD countries strive to excel in technologically advanced sectors, but the specialisation pathways for some countries would require more effort and take longer depending on their current production structure, skills characteristics and other capabilities. The more capabilities two industries share, the more likely it is that a country that successfully creates value in one of these industries will also specialise in the other. Some countries that lack the skills characteristics necessary for high-tech industries and complex business services can specialise first in industries that use available skills, while developing the necessary mix of skills. Other countries have skills characteristics that bring them opportunities to specialise in sophisticated industries. However, other factors might prevent them from specialising in these industries. For specialisation strategies to succeed, skills policies need to be implemented in line with other types of policies.

Industries vary greatly in their skills requirements. However, even industries with a low level of technological sophistication require a broad range of skills. The empirical analysis shows the importance of having the right mix of skills to perform in GVCs. These mixes of skills are specific to industries but they all involve various cognitive skills and "soft skills". Education and training policies, for youth and adults, students, workers and the unemployed, are crucial to develop these skills mixes. The population needs to have skills that match industries' skills requirements, as well as other types of skills that are required at the international level. This finding has implications for the design of educational programmes, especially for those that aim to develop advanced skills in a particular area, such as STEM programmes.

Countries can specialise in technologically advanced industries if they are able to provide pools of reliable workers who perform at the expected level, which requires a narrow dispersion of unobservable skills. Some OECD countries show a large unobservable skills dispersion, however. Ex-ante policies to achieve equal quality across similar educational programmes and ex-post policies to train workers who do not perform at the expected level, or to better signal workers' skills, are crucial to enable countries to specialise in complex services and high-tech manufacturing industries.

Notes

1. Except the readiness to learn indicator.
2. Except for the 25th percentile with backward linkages in terms of exports.
3. For instance, business services industries are intensive in ICT and STEM skills but have on average low backward participation. Likewise, the use of ICT and STEM skills is increasing with the

occupation category, with managers and professionals using these skills the most while their jobs may also be less exposed to offshoring than other jobs.

4. These results are in contrast with the literature, according to which these skills are crucial for performance in a complex global environment. Indeed, globalisation calls for an ever greater ability to adapt to change and absorb shocks. Hence, self-organisational capability and workers' flexibility should correspondingly lead to superior firm performance in GVCs. Marketing skills can also increase firms' ability to participate in GVCs as they are needed to look outside their existing business context, to develop new perspectives on managing products, work with new distributors and suppliers and reach new customers and competitors.
5. Workers may have the skills but not use them in their jobs. This argument could explain why all skills indicators based on the information on the frequency of tasks performed (the so-called task-based skills) show weaker links with GVC variables, as compared with the assessed cognitive skills.
6. Since the intensity in ICT and STEM tasks does not appear to characterise groups of industries, the relative intensities with respect to these two tasks are not shown in Figure 13.
7. On the basis of an article published in *The New York Times* on 17 October 2006, *www.nytimes.com/2006/10/17/world/asia/17india.html*.
8. In Chile and the Turkey, a large share of adults opted out of the computer-based assessment or failed the ICT core or had no computer experience, which might partly explain why those who did the assessment have better problem solving skills in technology-rich environments than literacy or numeracy skills.
9. Literacy is defined in the Survey of Adult Skills as "understanding, evaluating, using and engaging with written text to participate in society, to achieve one's goals, and to develop one's knowledge and potential". As such, compared with the other two assessed skills (numeracy and problem solving in technology-rich environments), literacy can be considered as the universal skill, the major prerequisite to find and maintain a job and contribute to a firm's and a country's performance.

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Chapter 4

How skills policies can make the most of global value chains*

This chapter discusses how countries can make the most of global value chains through effective and well-co-ordinated skills policies. These policies have to develop the skills countries need to participate and specialise in global value chains; use their skills pools effectively and anticipate changing skills needs; enhance international co-operation in education, training and innovation; and deal with the risks and implications of offshoring. A "whole of government" approach is needed to co-ordinate education and training policies with policies such as employment protection legislation, non-compete clauses and migration policies.

*The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Skills play a crucial role in ensuring that participation in global value chains (GVCs) translates into better economic and social outcomes (Chapter 2). They are also vital to enable countries to perform and specialise in the most technologically advanced segments of GVCs (Chapter 3). A broad range of policies can affect the development and use of each country's skills. Education and training policies can develop strong and relevant skills. Labour market policies influence the allocation of skills to industries and occupations. Management policies contribute to the effective use of skills within firms. Policies that attract foreign students and skilled migrants not only increase a country's pool of skills but also tap into their knowledge of other cultures and networks. And policies that connect countries' skills to international innovation networks can help to internationalise the production process.

This chapter shows how countries can design their skills policies to:

- develop the skills they need to participate and specialise in GVCs
- use their skills pools effectively and anticipate changing skills needs
- enhance international co-operation in education, training and innovation
- deal with the risks and implications of offshoring.

Many types of policies outside the skills domain also influence countries' capacity to seize the benefits of GVCs, including trade, competition and infrastructure policies. It is beyond the scope of this publication to discuss such policies in detail, but this chapter gives some insights on the importance of aligning skills policies with other types of policies to make the most of GVCs. A "whole of government" approach is needed to enable such alignment.

The main findings of this chapter are:

- Improving the design and quality of skills policies not only helps countries seize the benefits of GVCs, but also helps countries address youth unemployment challenges. In contrast, policies that target specific industries or aim to attract foreign direct investment are more risky and do not lead to this double dividend.
- To seize the benefits of GVCs, many different kinds of policy need to be aligned. A "whole of government" approach is needed to co-ordinate education and training policies with policies such as employment protection legislation, non-compete clauses and migration policies. For instance, investment in education and training policies may not be able to boost performance in global value chains if migration policies prevent countries from attracting foreign students.
- As tertiary education develops in emerging and developing economies, OECD countries compete within GVCs through the skills of their populations rather than through their level of education. This means each country needs to enhance the quality of its education and training systems. First, as well as focusing strongly on developing cognitive skills, countries need innovative teaching strategies and flexibility in the curriculum choice in tertiary education so that students can also learn social and emotional skills and multidisciplinarity can develop. Second, a uniform quality of education across schools and programmes is crucial. In many countries, learning outcomes are strongly tied to social

background, not only limiting the skills pool but also blurring the signals for employers of the actual skills workers may have.

- Countries' comparative advantages in trade emerge from the interaction between skills characteristics and industry requirements, so countries need to improve co-operation between education and training systems and the private sector. Such co-operation can include vocational education and training with a strong work-based learning component, local initiatives to link education institutions to the private sector, and specific policies to foster interactions between the private sector, universities and research institutions.
- It is vital to ensure that skills are matched to industries as well as possible. This can be achieved by designing employment protection legislation that provides flexibility to firms and security to workers, monitoring the development of non-standard forms of employment, and improving knowledge on the incidence and implication of non-compete clauses that can impede skills mobility.
- Management policies can be a source of comparative advantage in GVCs. Entrepreneurship education can foster awareness and knowledge of best practices for employers and workers.
- GVCs make it harder for countries to recoup their investment in education. To overcome this hurdle, countries that belong to the same value chain can co-operate in designing education programmes and possibly in the financing of education to achieve solutions that distribute equally the benefits of GVCs. Co-operation in designing education programmes is a way to ensure quality, maintain knowledge of the development of skills that have been offshored but could be brought back later, and raise the skills in developing economies.
- Countries have to improve their recognition of skills acquired abroad or informally to facilitate internationalisation of the production process and benefit from it. Recognising skills acquired abroad would attract foreign students and foreign workers who can contribute to research, innovation and performance in an international context. Recognising skills acquired informally would help workers exposed to the risks of offshoring to gain further qualifications and adapt their careers to changing needs.
- To limit the risks and costs of offshoring, countries need to find the right balance between short-term training and labour market programmes for displaced workers, and long-term policies that facilitate the development of skills at various phases of life. Removing the obstacles to adult education means working on various fronts: improving the tax system to provide stronger learning incentives, easing access to formal education for adults, and working with trade partners to enhance flexibility in the sharing of time between work and training.

Developing the skills for participation and specialisation in global value chains

Well-designed policies can develop strong skills, by providing high-quality education at all levels and flexible pathways to success, and by preventing students from dropping out of school (OECD, 2015a). This section examines how policies can develop the skills characteristics that countries need to specialise in the most technologically advanced industries (as evidenced in Chapter 3) and ensure that participation in GVCs benefits the whole economy by including many firms (as discussed in Chapter 2).

Education and training policies to develop strong skills mixes

Rationale

Firms and workers need a wide range of skills to participate and perform successfully in GVCs. Cognitive skills play a leading role, but for countries to specialise in particular

industries they need the right mix of different skills, including social and emotional aspects of skills as well as cognitive aspects (as evidenced in Chapter 3).

Emerging countries are enlarging access to education, improving the quality of their education and training institutions, and developing technical education programmes. In this new international context, tertiary education or science, technology, engineering and mathematics (STEM) skills become less and less a source of comparative advantage. However, when STEM skills are combined with other fields of knowledge, and other types of skills such as communication, teamwork and problem solving, they can be a source of comparative advantage. For instance, a population well equipped with data analysis skills has enabled Singapore to raise its participation in GVCs, but its data specialists generally lack good problem-solving skills, preventing the country from specialising in the most technologically advanced industries (UKCES, 2015).

The task-based skills indicators (Chapter 3, Box 3.1) show that occupations vary in the intensity with which skills are used on the job, which suggests that workers also vary in their ability in these skills depending on their occupation. The frequency of the performance of various tasks decreases progressively from high-skill to low-skill occupations (Figure 4.1). For all skills, there is a declining trend with age, but the trend is more marked for cognitive skills, reflecting the effect of the increase in educational attainment on the cognitive skills of workers (Figure 4.2). Skills involving personality traits, such as marketing and communicating, show a more stable profile with age, suggesting that these skills may be developed first through initial education and then on the job.

Policies

OECD countries have recognised the importance of social and emotional skills for performance at work, and are taking action to develop these skills at all levels of education. Social and emotional skills, such as self-confidence, also affect the capacity to develop and use cognitive skills. In the large majority of countries and economies that participate in the OECD Programme for International Student Assessment (PISA), among high performing students, girls do worse than boys in mathematics (OECD, 2015b). However, when comparing boys and girls who reported similar levels of self-confidence in mathematics or of anxiety about mathematics, the gender gap in performance disappears.

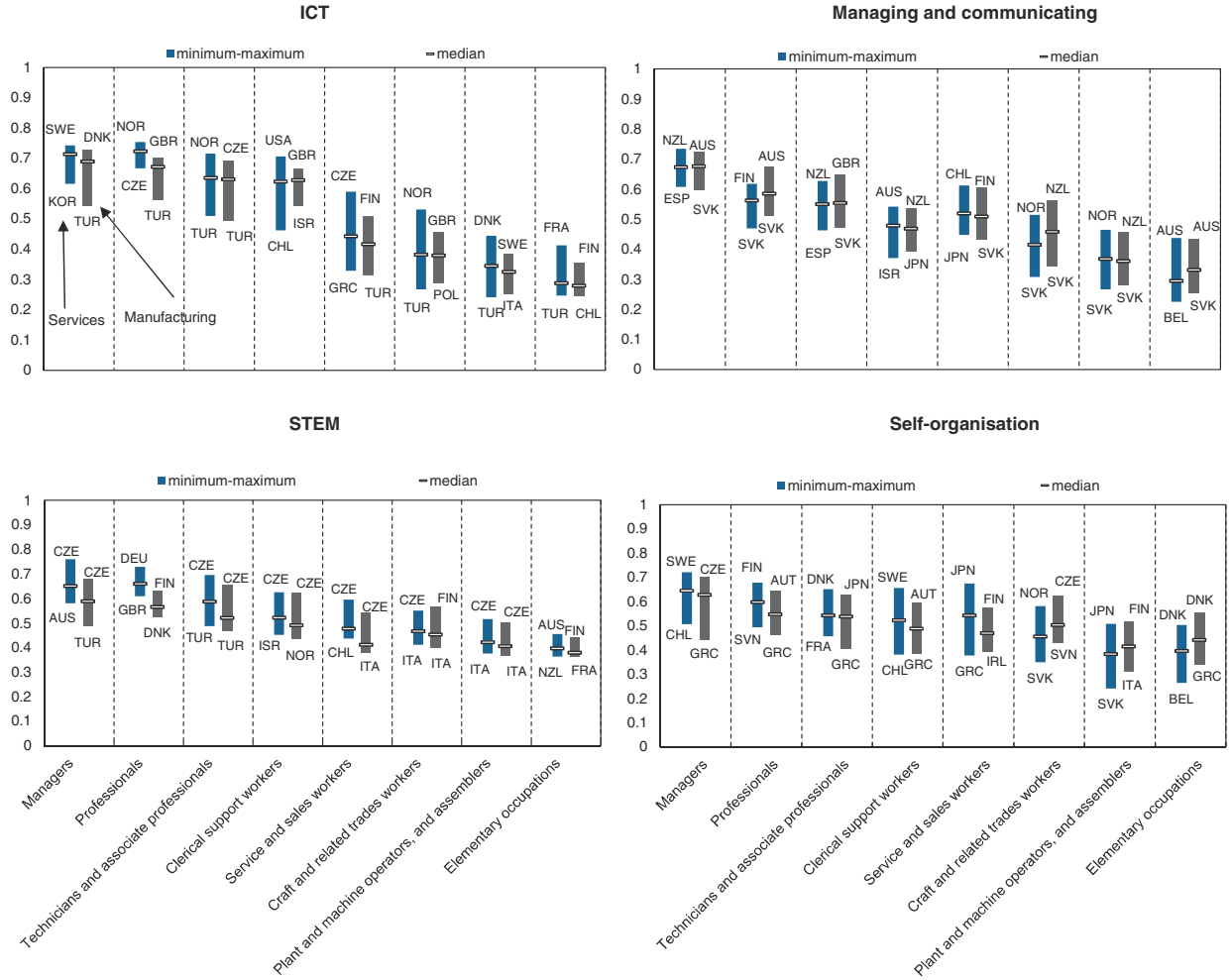
Some intervention programmes, particularly in early childhood, have been consistently successful in improving social and emotional skills (Heckman and Kautz, 2013). These programmes typically include pre-school activities and meetings between parents and teachers. For adolescents and young adults, successful intervention programmes generally have a mentoring component as part of a work-based activity. Early interventions can also aim to develop a combination of social and emotional skills and cognitive skills (Box 4.1).

Promoting social and emotional skills such as self-confidence, self-management and relationship skills demands innovative teaching methods. Strategies that work with students' feelings and relationships, like role-playing, collaborative-based pedagogies, gaming, case-study and social problem-solving pedagogies, are especially important for promoting communication and emotional skills, as well as pro-social attitudes (Le Donné, Fraser and Bousquet, 2016).

Multidisciplinarity and skills mixes can be developed in higher education by promoting students' participation in the design of their degrees (Vincent-Lancrin, 2016). In many OECD countries, students can choose some of their courses, usually in addition to mandatory ones.

Figure 4.1. **Task-based skills indicators varying by occupation**

2012 or 2015



Note: Chile, Greece, Israel, New Zealand, Slovenia and Turkey: Year of reference 2015. All other countries: Year of reference 2012. Data for Belgium refer only to Flanders and data for the United Kingdom refer to England and Northern Ireland jointly.

Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis.*

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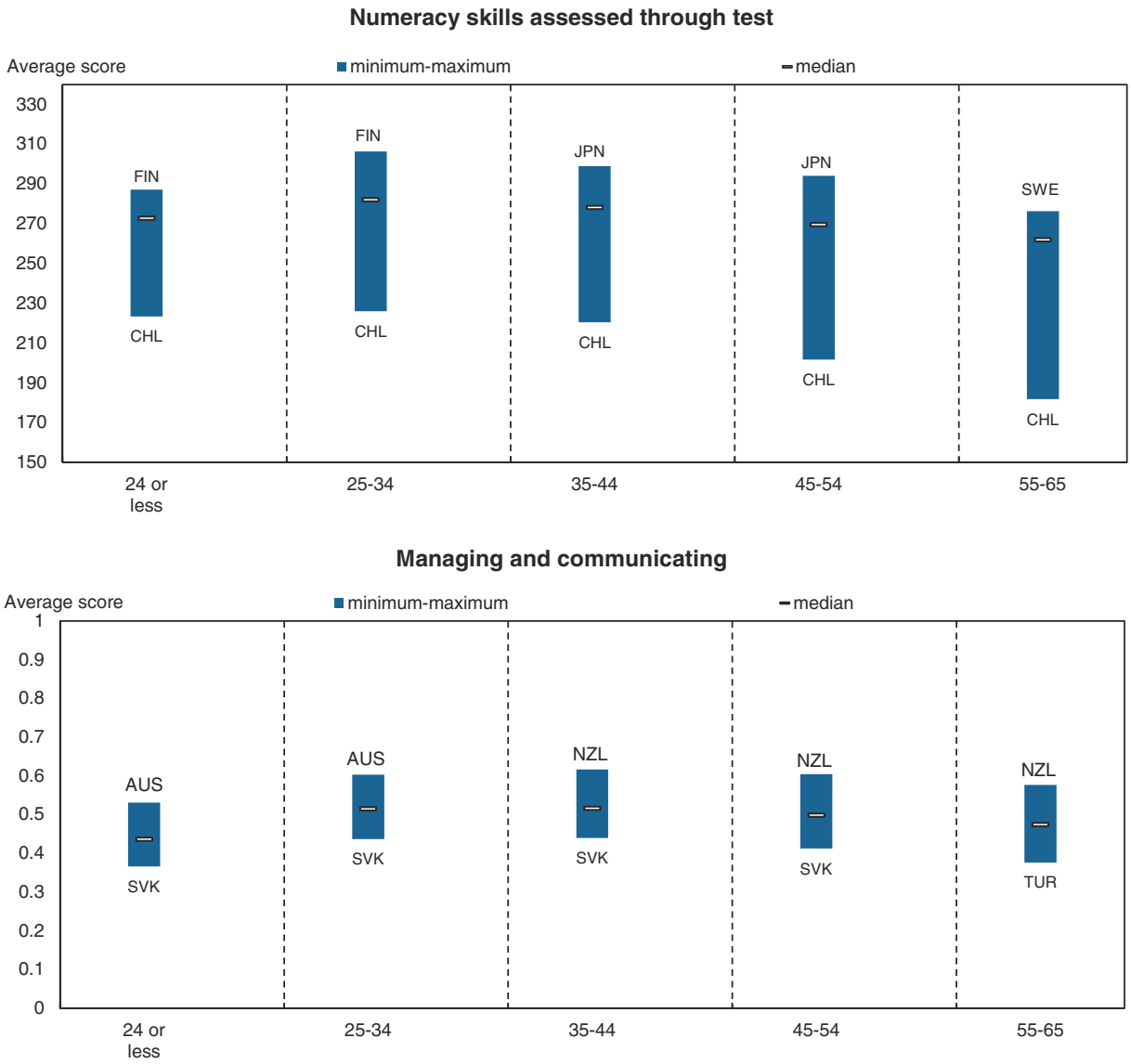
Some countries have gone further by allowing students to take courses in an institution other than the one in which they are enrolled. A modular credit system and partnerships between institutions (for instance, in France and the United Kingdom) allow students to cumulate credits towards a relatively open degree. This openness teaches students to manage themselves and take responsibility by allowing them to study what corresponds best to their professional needs and personal aspirations, while offering them the flexibility to change their study path.

Being able to speak foreign languages is essential to ensure that individuals can move throughout the world and work freely in multi-cultural and multi-lingual business environments. Multilingualism also promotes countries' competitiveness and ensures social cohesion and intercultural dialogue. A population fluent in foreign languages can attract foreign capital and encourage local companies to join multinationals' supplier networks. This can be a source of comparative advantage for trade in GVCs, particularly for emerging and transition economies.

Figure 4.2. **Skills indicators varying by age**

2012 or 2015



Note: Chile, Greece, Israel, New Zealand, Slovenia and Turkey: Year of reference 2015. All other countries: Year of reference 2012. Data for Belgium refer only to Flanders and data for the United Kingdom refer to England and Northern Ireland jointly.

Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis.*

StatLink *http://dx.doi.org/10.1787/888933474438*

Schools and higher educational institutions provide the main opportunities to learn languages. In most EU countries, for instance, a clear majority of pupils learn English from primary level upwards (Figure 4.3). In other countries, teaching of foreign languages begins at secondary level. Sometimes there is inconsistency between different education levels, with the share of pupils learning English as a foreign language dropping remarkably at the lower secondary level (in Bulgaria and Croatia, for instance). The Erasmus Programme of the European Union, which enables pupils and young adults to live and study in another EU country, has been instilling multi-cultural understanding and developing foreign language skills for the last three decades. In addition to improving foreign language skills, Erasmus students increase their soft skills through the programme (European Commission, 2014).

Box 4.1. **Improving STEM skills in combination with social and emotional skills from early childhood**

In recent years, several OECD countries have introduced reforms to improve instruction of science, technology, engineering and mathematics (STEM) programmes at different school levels. They have made the goal of developing STEM skills along with social and emotional skills explicit by introducing new curricula, standards or assessments, as well as new teacher education and training programmes. Some countries have introduced initiatives in the crucial phase of early childhood, like the Little Scientists' House programme in Germany.

The Little Scientists' House initiative was launched to create enthusiasm about science and technology among very young children, following the 2006 Programme for International Student Assessment (PISA) survey which showed that German pupils did not have sufficient skills and knowledge in natural sciences and technology. PISA results also showed that gender differences in attitudes to science were prominent, with boys reporting more positive characteristics than girls on at least five aspects of attitude.

The project is based on three principles:

i) Curiosity and enthusiasm are the gateway to natural sciences and technology for both children and adults. Most children have an inherent interest in natural science subjects, which is driven by curiosity.

ii) Children and teachers design the learning process together (co-construction). Children learn by working with others, but also through individual exploration and shared reflection. The aims of co-constructive education processes are to develop new contents together; solve problems together; exchange ideas; and get to know different perspectives.

iii) Promotion of basic competences: in addition to stimulating curiosity and enthusiasm about natural sciences and technological phenomena, the project also provides children with basic competences such as learning, language and social skills as well as fine motor skills.

The main activities developed by the Little Scientist's House initiative are workshops (involving teachers and children) and promotion days (such as Day of the Little Researchers). Teachers and early childhood educators interested in natural sciences, as well as natural scientists/engineers, have been trained by the Little Scientist's House foundation to teach children and conduct workshops.

The Little Scientist's House initiative has also set up local networks co-ordinated by a wide variety of partners, such as day care supporters, communities, museums and universities of natural sciences. These networks offer activities and educational programmes for day-care organisations to encourage children to get closer to natural sciences.

During the pilot phase in 2006, the initiative was implemented in 50 preschools in Berlin. Since 2007, it has been extended to the whole of Germany. So far, more than 20 000 preschools, day-care centres and primary schools have been involved. The project plans to expand activities to 47 000 institutions. All educators receive training, information materials and ideas through its local networks.

Source: European Union (2009), " The little scientist's house", Compilation of good practice on fostering creativity and innovation in the fields of learning and cultural awareness, *www.create2009.europa.eu/fileadmin/Content/Downloads/PDF/Projects/National_projects/DE_The_Little_Scientist_s_House.pdf*; Siemens Stiftung (n.d.), "Little scientists' house: Discovering the world with scientific passion", Siemens Stiftung website, *www.siemens-stiftung.org/en/projects/little-scientists-house/*.

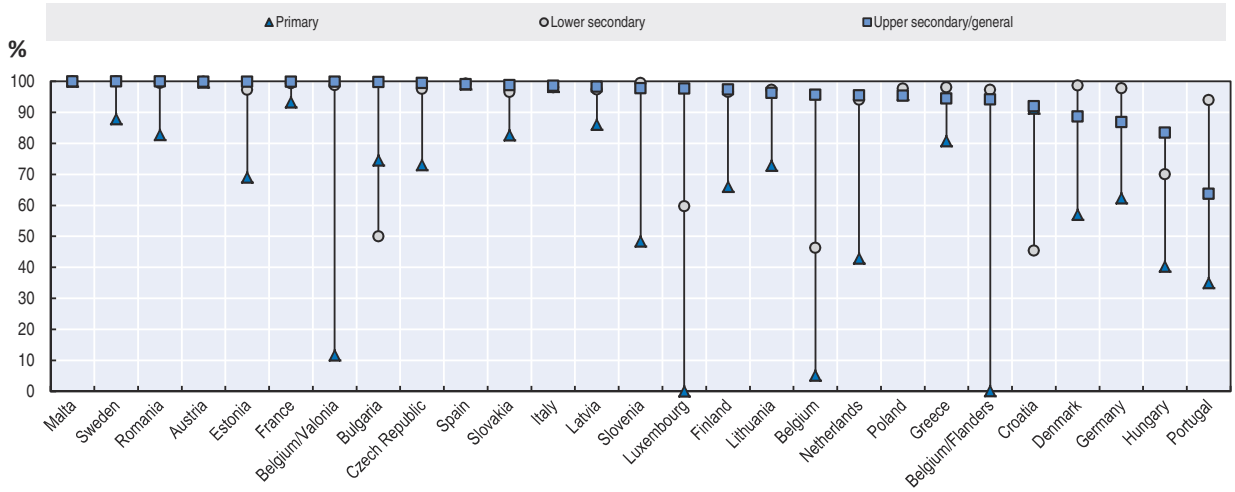
Achieving more equity in learning outcomes and more transparency in the population's skills

Rationale

To specialise in technologically advanced industries, countries need to have pools of workers who perform at the expected level, as these industries have long production chains and poor performance at any single stage greatly reduces the value of output (Chapter 3).

Figure 4.3. **Share of pupils in the European Union learning English as a foreign language**

Across different education levels, 2015



Note: Data on the number of pupils studying foreign languages are related to the corresponding numbers of students enrolled in each country at each school level.

Source: Eurostat Database, *http://ec.europa.eu/eurostat/data/database*.

StatLink http://dx.doi.org/10.1787/888933474444

Pools of workers who perform at the expected level can emerge in countries in which the skills dispersion across individuals with similar characteristics – the unobservable skills distribution – is narrow.

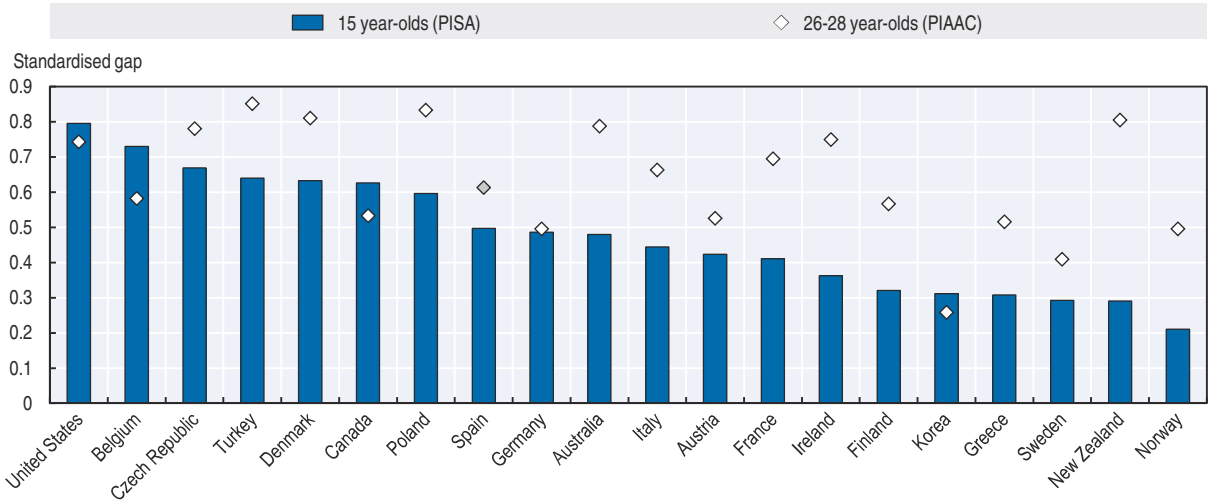
A large skills dispersion across individuals with similar characteristics may result from a variety of factors:

- Individuals with similar levels of education do not always have the same level of skills within countries, as the acquisition of skills depends on the quality of schools and education programmes.
- Work-based learning and training programmes are critical to strengthening the links between the education system and industries, and raising the skills of workers, but the quality of these programmes also varies.
- There are differences in cognitive skills for the same level of educational outcomes particularly between vocational education and training (VET) programmes and general programmes. According to the Survey of Adult Skills, a much larger share of VET students are low-skilled than of academic students who have spent the same number of years in school but have pursued a general programme (OECD, 2015a).
- Students from some social and migration backgrounds do not have equal access to opportunities. This also generate differences in skills between individuals with similar education level, for instance between natives with an immigrant background and other natives.

Disparities in learning outcomes start early in the education process and accumulate over life. Educational institutions tend to reinforce existing socio-economic advantage rather than share learning opportunities more equitably (OECD, 2013a; 2016a). PISA results show that 15-year-old students from socio-economically disadvantaged households tend to underperform in the different skills domains surveyed. Differences persist and often increase for young adults, as measured by the Survey of Adult Skills (Figure 4.4). Students

Figure 4.4. **Disparities in literacy between individuals with and without tertiary educated parents at the age of 15 and for 26-28 year-olds**

PISA 2000 (15-year-olds) and PIAAC 2012 or 2015 (26-28 year-olds)



Note: The standardised gap refers to the difference in the mean scores of individuals with at least one parent educated at the tertiary level and individuals without tertiary educated level parents divided by the average standard deviation of countries participating in the study. Countries are ranked in descending order of the gap in PISA. Diamonds highlighted in a darker shade, as in Spain, represent groups for which the gap is statistically insignificant at the 5% level. For Greece, New Zealand and Turkey the year of reference is 2015 for the 26-28 year-olds and 2003 for the 15-year-olds.

Source: Borgonovi et al. (2017), "Youth in transition: How do some of the cohorts participating in PISA fare in PIAAC?", *OECD Education Working Paper*, No. 155, *http://dx.doi.org/10.1787/51479ec2-en*.

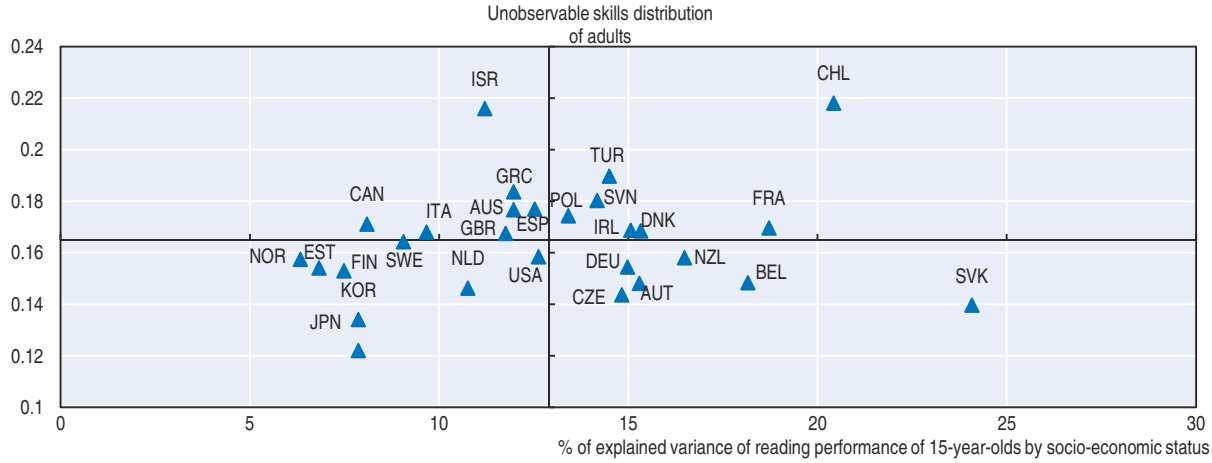
StatLink *http://dx.doi.org/10.1787/888933474454*

and young adults, neither of whose parents has attained a tertiary degree, score in literacy proficiency below their peers with tertiary educated parents.

Disparities in learning outcomes resulting from socio-economic disadvantage are closely linked with countries' unobservable skills dispersion (Figure 4.5). Countries with the smallest score differences in literacy proficiency between 15-year-olds from contrasting socio-economic backgrounds, such as Estonia, Finland, Japan, Korea and Norway (bottom left quadrant), have also the most narrow unobservable skills dispersion. In comparison, countries in the upper right quadrant (including Chile and France, among others), which are characterised by a strong relationship between reading performance and socio-economic status, show an above average skills dispersion for the adult population with similar characteristics. Providing equal learning opportunities to youth disadvantaged by their educational, migration and minority background would ensure that they leave education with stronger skills.

Some countries with large socio-economic disparities among 15-year-olds do not have wide unobservable skills dispersions, notably Austria, Germany, New Zealand and the Slovak Republic (in the bottom right quadrant of Figure 4.5). This means other factors are in play. High-quality VET programmes and multiple pathways within the education system, as in Austria and Germany, may provide greater opportunities for success at school and beyond, and thus neutralise the relationship between parental educational background and skills dispersion at earlier stages of education. Having a large share of students enrolled in VET programmes, however, cannot be automatically associated with a narrow unobservable skills dispersion (Figure 4.6); the quality of these programmes and particularly of their work-based learning components needs to be high.

Figure 4.5. **Correlation between the unobservable dispersion of literacy proficiency of adults and the impact of socio-economic status on reading performance of 15-year-olds**



Notes: Countries on the y-axis are ranked by their unobservable skills dispersion of literacy proficiency as measured by the Survey of Adult Skills in an ascending order. The unobservable dispersion is plotted against the percentage of explained variance of reading performance of 15-year-olds by socio-economic status, which measures the strength of the relationship between reading performance and the PISA Index of social, economic and cultural status as estimated in a single-level bivariate regression model.
Chile, Greece, Israel, New Zealand, Slovenia and Turkey: Year of reference 2015. All other countries: Year of reference 2012. Adults' data for Belgium refer only to Flanders and adults' data for the United Kingdom refer to England and Northern Ireland jointly.
Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012 and 2015), *www.oecd.org/skills/piaac/publicdataandanalysis*, and PISA database (2012), *www.oecd.org/pisa/pisaproducts/pisa2012database-downloadabledata.htm*.

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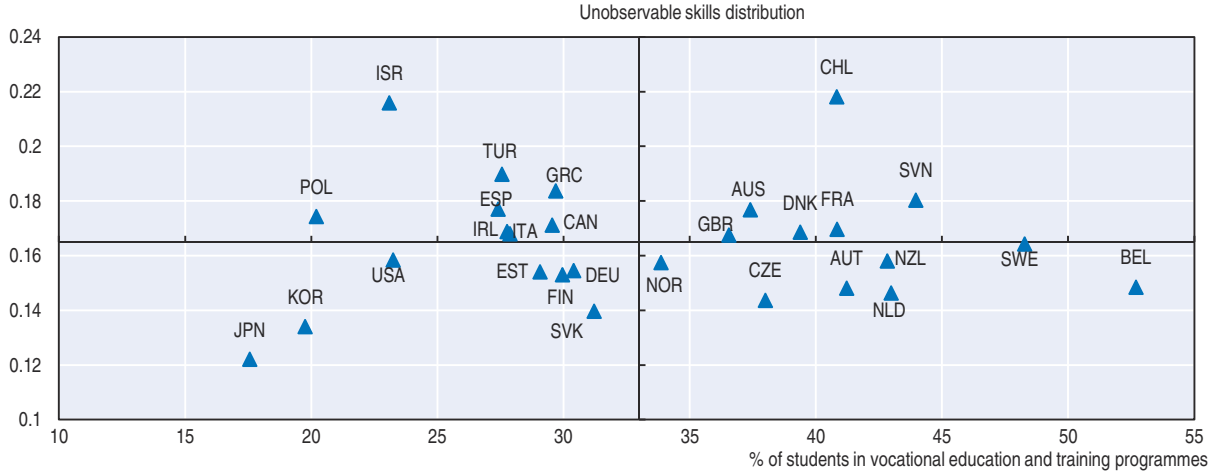
Figure 4.6. **Correlation between the unobservable skills dispersion and the share of students in vocational education and training programmes**



Notes: Countries on the y-axis are ranked by their unobservable skills dispersion in an ascending order. The unobservable dispersion is plotted against the share of students in vocational education and training programmes.
Chile, Greece, Israel, New Zealand, Slovenia and Turkey: Year of reference for adults is 2015. All other countries: Year of reference 2012. Data for Belgium refer only to Flanders and data for the United Kingdom refer to England and Northern Ireland jointly.
Source: OECD compilation based on the Survey of Adult Skills (PIAAC) (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis*.

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Policies

In countries where social background has a stronger influence on student performance, differences in performance between schools are larger (OECD, 2016a). Policies should aim to reduce inequalities of opportunity among schools. One option is to try to lessen the

concentration of disadvantaged and low-performing students in particular schools. This can require policies outside the skills domain, such as housing policies. Another option is to allocate more resources, including better teachers, to schools with larger concentrations of low-performing students and to disadvantaged schools. The design of the school funding system can not only reduce inequalities among schools but also enhance the quality of education (OECD, forthcoming a).

To ensure equity in learning outcomes, it is also vital to achieve more uniform quality across VET programmes by:

- Ensuring that the provision of VET responds to labour market needs. This requires good information on labour market needs, mechanisms to link provision more directly to those needs, a diversity of offerings and pathways through education and training systems, and engagement of employers and unions in designing the system.
- Increasing the quality of VET programmes, by: i) providing comprehensive skills development for employability; ii) integrating high-quality, work-based learning into all programmes; iii) ensuring that there are sufficient teachers and trainers, and that they have both good pedagogical skills and up-to-date technical expertise; and iv) providing adequate quality assurance and monitoring of the labour market outcomes of education and training providers.
- Providing more support to work-based learning, including i) active and ongoing engagement of employers and unions at all levels; ii) robust, easy-to-understand, competency-based qualifications; iii) more information on costs and benefits; iv) well-aligned policies beyond work-based learning programmes (e.g. employment regulation); and v) well-targeted financial support.

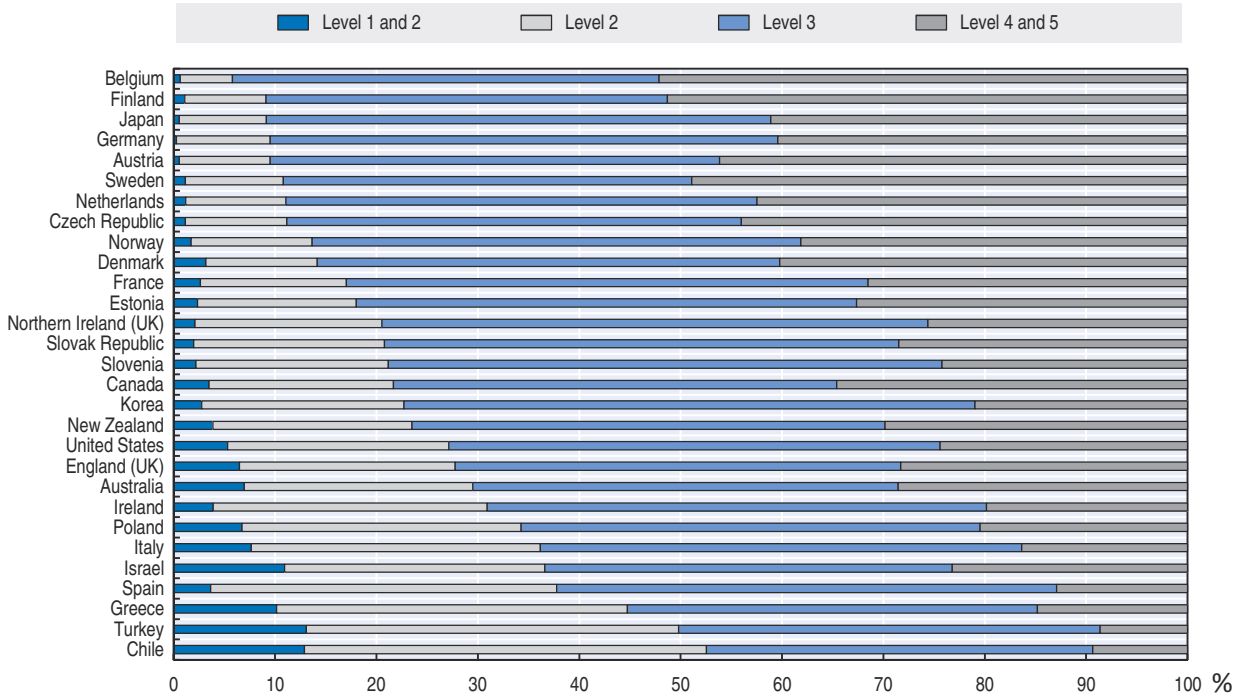
In higher education, the funding system can play a key role in achieving homogeneity in the quality of programmes. Providing sufficient and stable resources to tertiary education, while ensuring equal access and strong outcomes, are central objectives in all countries. To achieve these objectives, direct public transfers to higher education institutions can be linked to their performance using broad performance indicators (Dougherty and Reddy, 2011). In addition, to admit students from disadvantaged backgrounds, performance indicators may be used to account for the characteristics of students. If tuition fees are in place or introduced, they need to be accompanied by measures that remove financial barriers to undertaking higher education in the first place (Johnstone, 2004; Johnstone and Marcucci, 2010).

Degrees and qualifications have to provide clear signals to the labour market about graduates' skills. With higher education expanding massively, these signals are needed more than ever, but qualifications' reliability as a guide to graduates' learning outcomes has been questioned. Attainment does not always translate into skill proficiency: the Survey of Adult Skills found that around 20% of OECD young higher education graduates have numeracy proficiency below level 2 (Figure 4.7).

Equipping graduates of vocational and university education programmes with reliable, competency-based qualifications requires the engagement of government, employers, unions, students and all other relevant stakeholders (OECD, 2014a). They need to: i) develop qualifications together to reflect labour market needs; ii) provide diversification of qualifications without too much fragmentation; iii) incorporate high-quality assessments into qualifications, including competency-based approaches; and iv) better link competency-based qualifications to the labour market.

Figure 4.7. **Numeracy skills of young university graduates**

Percentage of young graduates scoring at each proficiency level, Tertiary-type A only, 20-34 years-old



Notes: Countries are ranked in ascending order of the percentage of graduates with literacy or numeracy at or below level 2. In Austria, the Czech Republic, Estonia, Finland, Flanders (Belgium), Germany, Japan, Korea, Northern Ireland, the Netherlands, Sweden and the United States, the estimated percentage of graduates performing at level 1 or below on literacy is not different from zero. Adults who obtained their highest qualification outside the host country – those with foreign qualifications and first generation migrants, who obtined their highest qualification prior to entering the host country – are excluded.

Chile, Greece, Israel, New Zealand, Slovenia and Turkey: Year of reference for adults is 2015. All other countries: Year of reference 2012. Data for Belgium refer only to Flanders.

Source: OECD calculations based on the Survey of Adult Skills (2012, 2015), *www.oecd.org/skills/piaac/publicdataandanalysis*; Kuczera, Field and Windisch (2016), *Building Skills for All: A Review of England*, *www.oecd.org/unitedkingdom/building-skills-for-all-review-of-england.pdf*.

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Entrepreneurship education and start-up support in higher education institutions

Rationale

In recent years, higher education institutions have been increasingly supporting entrepreneurship among their students. So far, the emphasis has been on activities aimed at developing attitudes, knowledge and skills that allow students to identify opportunities and turn them into successful ventures. Higher education institutions can also become environments conducive for nascent entrepreneurs. Over the last two decades, some have been introducing key complementary support services such as mentoring, active involvement of students in research activities, co-working spaces and incubation facilities. Institutions have also been helping students to manage intellectual property rights and to access public and private financing. Often, the demand for introducing these services comes directly from students and staff.

According to a recent international student survey on entrepreneurship, entering global markets quickly is a key growth objective for many university-based start-ups.[1] The number of international students signing up for entrepreneurship education activities is rising, but far fewer are taking the next step of starting a business (OECD, forthcoming b). In some

countries this gap has been noticed first by regional and local governments that want to see an increase in outward-looking and growth-oriented start-ups in their jurisdictions.

Multinational corporations and large established firms often expect to boost their innovation activities by collaborating with start-ups from higher education institutions, particularly in niche areas that require high levels of flexibility and creativity. Identifying start-up teams and their business ideas early is thus a strategic priority when large innovator firms collaborate with higher education institutions.

Policies

Governments in most OECD countries see higher education institutions as having a key role in promoting entrepreneurship. Policy support frameworks, however, vary substantially. When a sustainable support system is established, with long-term funding for strategic initiatives, training programmes and higher education networks, institutions are more likely to expand and sustain their entrepreneurship support. In parallel, graduate entrepreneurship education can be included in the performance contracts between education ministries and higher education institutions. To provide quality support for nascent entrepreneurs, it is vital that these institutions rely on partnerships with the business support organisations. Government can encourage and facilitate this co-operation.

As higher education becomes more international, some countries have introduced support mechanisms to retain students with entrepreneurial intentions. In the Netherlands, for example, a residence permit scheme for start-ups gives ambitious entrepreneurs one year after graduation to launch an innovative business. Mentoring by an experienced entrepreneur or researcher based in the Netherlands is a criterion for eligibility. Many higher education institutions have seized this new opportunity to launch and support international start-ups.

Strengthening skills in small and medium-sized enterprises (SMEs)

Rationale

Local small and medium-sized enterprises (SMEs) that are connected to inward foreign direct investment (FDI) and to GVCs as domestic suppliers of exporters can benefit from knowledge spillovers and transfer of technologies from multinationals, which are generally more innovating and productive than other firms (Chapter 2; OECD/World Bank Group, 2015). Links to supply chains can enable SMEs not only to enhance their access to international markets but also to improve their skills, for example through direct support from multinationals to meet requirements for quality, efficiency and speed of delivery. Improvements can spread further down the supply chain as first tier suppliers seek improvements in their own supplier base. SMEs' integration into GVCs is a key condition for the transfer to the whole economy of the benefits of GVCs in terms of knowledge development, productivity and growth.

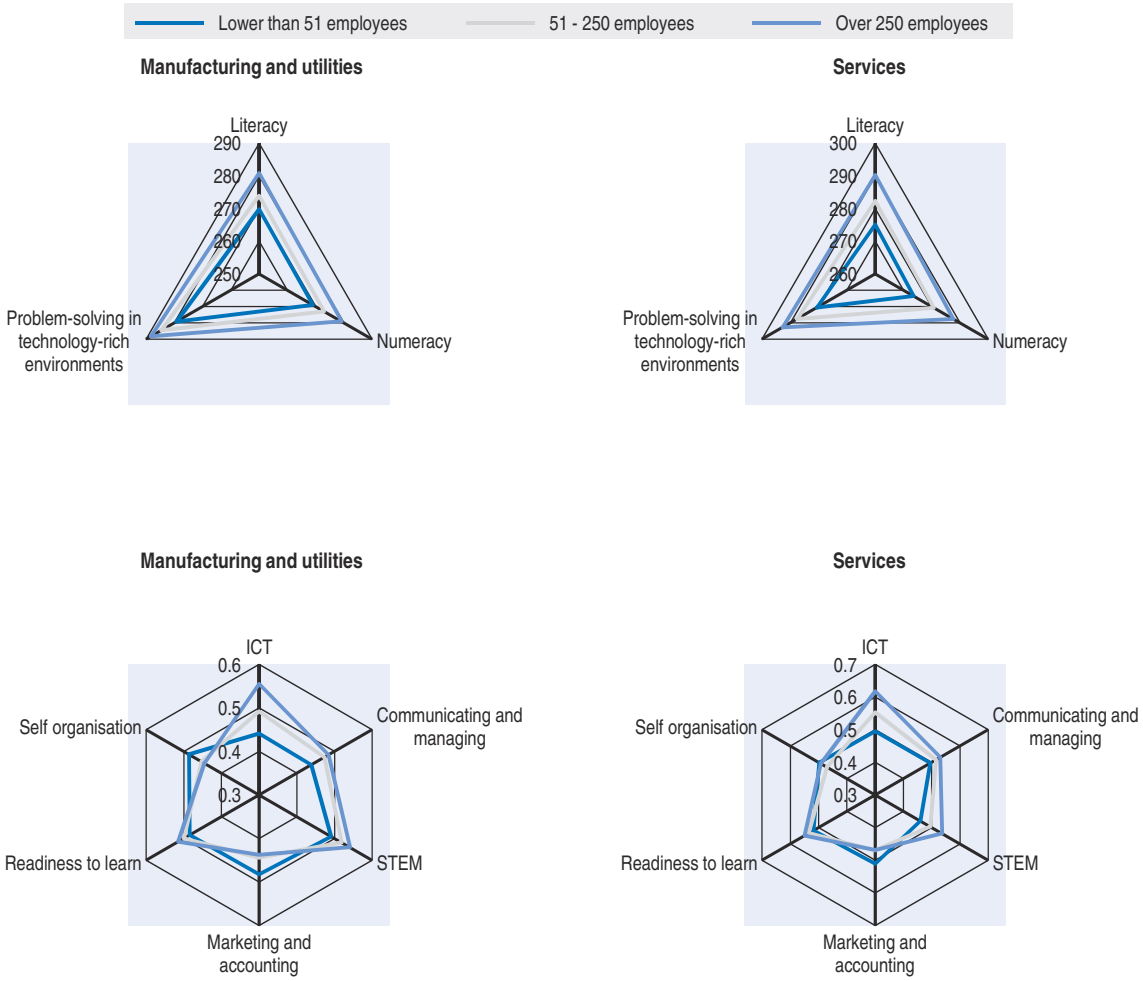
However, FDI and links to GVCs do not automatically enable SMEs to improve their skills, as investing multinationals may prefer to use skills from their home countries or from third countries. Countries' skills have an impact on the ability of SMEs to compete and to exploit the opportunities represented by FDIs. Host countries can benefit from a GVC-skills virtuous circle: countries' skills foster participation in GVCs and attracting FDI contributes to skills development, which results in higher value-added FDI and better skills. SMEs and entrepreneurs largely rely on local labour markets and institutions to find and develop skills. However, local labour markets vary widely in how well they put skills to good use. Many local

economies are stuck in a low-skill trap and may lack opportunities to connect their companies to GVCs. Where the demand for skills among employers is low, and people's skills are not fully utilised, productivity is undermined. Such a situation can also reduce the quality of local jobs in terms of salaries, job security and the possibility for career progression.

SMEs tend to have lower skills than larger firms in manufacturing and services industries, especially for cognitive skills (Figure 4.8). Smaller firms also make lower use of information and communications technologies (ICT), managing and communicating, and STEM skills than larger firms, suggesting that these skills might be less developed for workers in these firms.

Figure 4.8. **Skills by industry and firm size**

Average across countries, 2012



Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012), *www.oecd.org/skills/piaac/publicdataandanalysis.*

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Policies

Targeted management training for SMEs that are involved in GVCs, or have the potential to establish connections, can help improve their understanding of procedures used by international companies (specifically tendering and associated processes) and ways of approaching international business, while developing some of the skills that companies need to join GVCs.

To enable multinationals to select local suppliers, it is vital that VET systems produce certifiable skills that correspond to international levels and the requirements of foreign investors. Language skills are especially important. In emerging economies and developing countries, the lack of English-speaking SME owners and employees with appropriate management and technical skills often prevents multinationals from involving local small businesses (OECD/World Bank Group, 2015).

Local leaders need infrastructures and networks that help them develop innovative employment and skills strategies to connect companies to GVCs. Partnerships are being used across the OECD to link local leaders to other firms and to multinationals. They generally involve a wide range of partners, including employment and training agencies, local colleges and universities, and economic development agencies (Box 4.2) (OECD, 2014b). Vocational education institutions can play an important role in such local development (OECD, 2014a).

Box 4.2. **In the United States and Canada, innovative initiatives connect the private sector with education and training institutions**

In the United States, federal economic development policy has fostered "industry clusters" as a way to drive regional economic growth (OECD, 2014b). The Jobs and Innovation Accelerator Challenge supported numerous regional efforts to strengthen and develop regionally based industry clusters, drawing in funding and technical assistance from several agencies.

In 2011, the United States launched the National Network for Manufacturing Innovation, also known as Manufacturing USA, a network of research institutes that support innovation, education and collaboration in manufacturing. These institutes are public-private partnerships, each with a distinct technology focus area, that work towards this common goal. Industry, academia and government partners are taking advantage of existing resources, collaborating and co-investing to nurture manufacturing innovation and accelerate commercialisation.

The institutes aim at connecting people, ideas and technology to solve industry-relevant advanced manufacturing challenges, restore and enhance industrial competitiveness, increase economic growth and strengthen U.S. national security. They focus on transforming promising, early-stage research into proven capabilities that are ready for adoption by US manufacturers. The institutes provide members with access to state-of-the-art facilities and equipment, as well as workforce training and skills development customised to support new technology areas.

Michigan's InnoState project seeks to promote new product manufacturing capability within existing contract manufacturing firms, enabling them to better connect with GVCs. Working through the Pure Michigan Business Connect Site, the Michigan team provides marketing and other tools for outreach and branding.

The project is comprised of several regional partners, including:

- the Workforce Intelligence Network, which provides labour market information and serves as a resource hub for local businesses and other stakeholders;
- the Detroit Regional Chamber, which has several economic development programmes aimed at encouraging local businesses to diversify their customer base;
- the Michigan Manufacturing Technology Center, which helps manufacturing companies with training, consulting and management mentoring;
- the National Centre for Manufacturing Sciences, which seeks to drive innovation in manufacturing businesses; and

Box 4.2. **In the United States and Canada, innovative initiatives connect the private sector with education and training institutions** *(cont.)*

- the Southeast Michigan Community Alliance, one of seven Michigan Works Agencies in Southeast Michigan that provide a wide range of workforce development services. Michigan Works Agencies help job seekers look for jobs and develop their employability and technical skills, and help employers recruit and retain qualified employees. The agencies also provide access to funding to train new hires through their On-the-Job Training programmes, and train employees through their Incumbent Worker Training and Customized Training programmes.

In Ontario, Canada, local community colleges and universities help employers to develop product market strategies locally and to better connect to GVCs (OECD, 2014b). Niagara College, for example, has not only geared its curriculum towards meeting local industrial demands in horticulture and wine making, but has also set up an applied research unit that helps local firms to upgrade their products and business strategies. It collaborates with firms in areas such as product and process applied research, engineering design, technology development, product testing, proof of concept, piloting and problem solving.

Source: http://innostatemi.com/about-us/.

OECD (forthcoming b), *Engaging employers in putting talents to better use in the workplace.*

OECD (2014b), *Employment and Skills Strategies in the United States*, *http://dx.doi.org/10.1787/9789264209398-en*.

Closing the gap between education institutions and the private sector

Rationale

A close match between countries' skills and industry requirements leads to international comparative advantages in these industries (Chapter 3). Closer links between education institutions and the private sector are needed to achieve such a match and ensure that education and training systems are capable of adapting to changes in the demand for skills.

Fostering co-operation between education and training providers, employers and other stakeholders can enhance the quality and market relevance of VET and higher education programmes. Such co-operation can help individuals develop the strong mixes of skills that are necessary in industries with higher potential for value creation. Many occupation-specific skills, as well as skills needed in business, such as teamwork and communication, can be best learned in the workplace. Work experience can thus signal the demand for different types and combinations of skills, smooth the education to work transition and enhance recruitment.

Governments and education systems can work with companies to understand their skills needs, so that more multinationals rely on domestic skills. This is particularly important for emerging economies, which often try to build whole industries to serve the local operations of a large foreign company. Work-based learning experience in the supplier network of such a company, in the company itself or abroad would offer multiple benefits, such as providing exposure to up-to-date equipment and expertise, and enhancing social and emotional skills necessary to succeed on the job.

Policies

Public-private partnerships between higher education institutions, research centres and the business sector can help further close the gap between the education system and the labour market by transforming research into innovation through collaboration (Box 4.2).

Exposure to the business world can link skills development to labour market needs and help companies create value. However, work-based learning is still under-utilised in many countries – even for traditional VET programmes – and a range of obstacles stand in the way of its broader use. A work-based learning component could be integrated into different levels and types of education and could be compulsory for VET programmes. Introducing such a requirement could streamline many programmes, as those which are of little interest to employers may not be able to fulfil the requirement. In some cases, financial support might be needed.

Making the best use of the skills pool and anticipating changing skills needs

The interaction between a country's skills characteristics and industries' requirements contribute to countries' performance in GVCs in many ways: the allocation of skills to industries, the match between workers' skills and the tasks performed on the job, the way skills are used on the job, and the capacity of education and training systems to adjust to changing needs.

On average, around one-quarter of workers report a mismatch between their existing skills and those required for their job, with significant differences between countries (OECD, 2013b). Being overskilled for the job is more widespread than being underskilled. A skills mismatch is associated with lower labour productivity as it reflects less efficient resource allocation (Adalet McGowan and Andrews, 2015). However, a pool of workers with skills that are not fully used can offer a potential for firms to introduce new technologies or working methods, and to become more productive in the long run.

Management policies can make the best use of skills

Rationale

Management policies, which make a key contribution to performance and productivity in general, are a powerful tool for making the best use of skills assets, adjusting them to new needs, and thereby giving a country a comparative advantage in GVCs (Box 4.3).

Global value chains increase the development of culturally diverse teams, making it even more important for firms to develop good management policies. Cultural diversity enhances productivity and innovation by increasing the level of relevant knowledge and the ability to solve problems, thanks to the diversity of experiences and perspectives (Horwitz and Horwitz, 2007). However, business performance is higher for teams with higher ethnic diversity only up to a certain threshold, beyond which the costs of communication, co-ordination and cohesion become too high (Hoogendoorn and van Praag, 2014). Good management policies can push forward this threshold.

The World Management Survey gives information on the management practices used by firms in a large range of countries (Bloom and Van Reenen, 2007). Best management practices are defined as those that organise and explain the production process, monitor and analyse individual performance, set challenging and interlinked short and long-run targets, reward high performers develop workers' skills and retain talents.

The use and development of management practices by firms varies widely between countries, with the United States, Germany, Japan, Sweden and Canada making the best use of them and several emerging economies using them much less (Figure 4.9). In the top-performing countries, dispersions across firms in the use of best management practices are not large. Where such differences are large, this suggests there is scope to expand best

Box 4.3. **How management policies can give countries a comparative advantage in global value chains**

A study in Denmark points to organisational performance as a source of economic and trade performance (Danish Agency for Science Technology and Innovation, 2013). The study compares "hidden champions" – firms in the manufacturing sector that are export leaders in their respective export markets – with other firms in the same sectors (core firms).

One difference regards formal education qualifications: the export leaders were found to have a higher share than core firms of workers with a general tertiary qualification or a tertiary vocational qualification. The major difference, however, comes from work organisation practices. Of the hidden champions, 58% have work organisation practices characterised by employee involvement to a very great extent or a great extent, against 37% for core firms. Almost all of the hidden champions have a management philosophy based on employee involvement and the delegation of responsibilities.

In India, an experiment was conducted on large multi-plant textile firms to assess the impact of management practices on firms' productivity (Bloom et al., 2013). A group of firms (the treatment group, randomly chosen) received five months of extensive management consulting from a large international consulting firm. In the first month, the consulting firm identified opportunities for improvement in a set of management practices and then supported firms in the following four months in the implementation of recommendations. Another group of firms (the control group) only received the one month of diagnostic consulting.

The development of good management practices increased productivity by 17% in the five following years. The firms having received the treatment grew faster, with evidence suggesting that better management allowed them to delegate more and open more production plants in the three years following the start of the experiment. Firms had not previously adopted these methods because they were unaware of the benefits of practices such as daily factory meetings, standardised operating procedures and inventory control norms.

Source: Bloom, N. et al. (2013), "Does management matter? Evidence from India", *Quarterly Journal of Economics*, Vol. 128/1.

Danish Agency for Science Technology and Innovation (2013), *The Hidden Champions – Danish Industrial Export Successes*, Copenhagen.

management practices to firms lagging behind in their use. Countries with the lowest average management practices scores are also those with the largest variation across firms in the use of these practices.

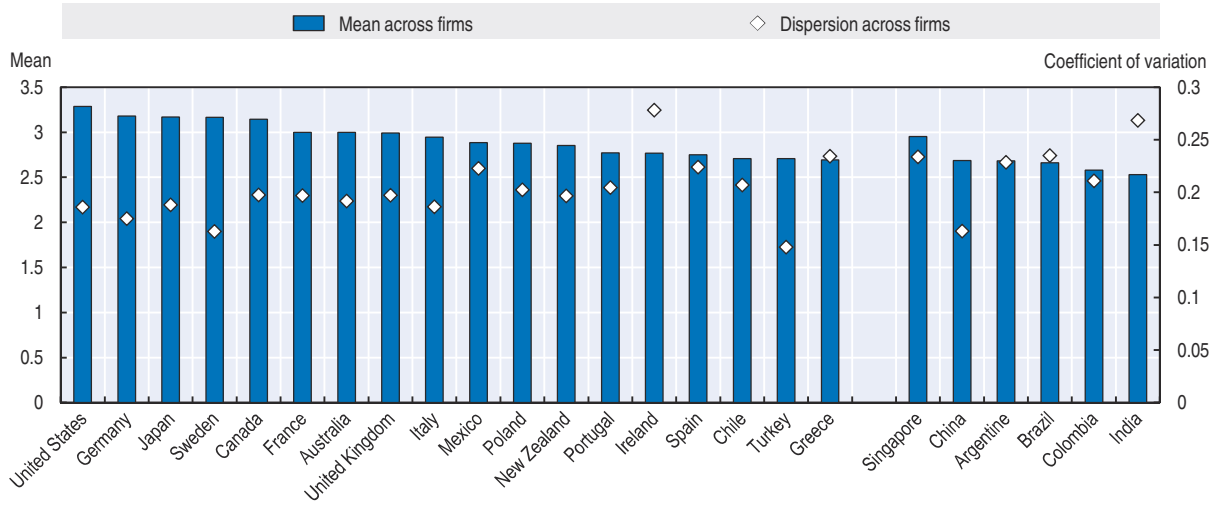
Policies

Various types of policies affect the use of management practices. The level of education of both managers and non-managers is strongly linked to better management practices (Bloom et al., 2012). Hence, policies to develop skills in general but also entrepreneurship and management skills can help to diffuse best management practices. Flexible employment protection legislation generally makes it easier to implement best management practices. Policies not related to skills also play an important role. Those that impede product market competition, including tariffs, are linked with poor management practices, as are policies that favour family ownership of firms, such as tax incentives for these types of firms.

These findings illustrate how achieving strong performance in GVCs requires avoiding misalignments between policies. Education polices to develop a set of strong skills could

Figure 4.9. **The use of best management practices by countries**

2004-14



Note: Mean and coefficient of variation of the management practices scores across firms. A higher score (mean) indicates better management practices. A higher coefficient of variation indicates a larger dispersion across firms in the scores of management practices.
Source: OECD calculations based on Bloom et al. (2012), "Management practices across firms and countries", *NBER Working Papers*, No. 17850.

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stimulate the adoption of good management practices, which could in turn be a source of trade comparative advantage. But this investment would be partly lost if other measures prevented competition, possibly with the objective of favouring domestic firms, as they would create an environment that in the end does not stimulate the adoption of best management practices.

In emerging and developing economies, growth in the industrial sector is often regarded as a critical step for broad-scale development and long-term poverty reduction. However, these economies could enhance the transformative power of these labour market opportunities by guaranteeing sufficient job quality. In some of these countries, low wages combined with health and safety hazards in industrial jobs deter skilled workers, who prefer to turn to self-employment in the informal sector (Blattman and Dercon, 2016).

Multinational firms could play a key role in improving working conditions and employment patterns, especially in developing and emerging economies where social regulations are often less developed. Raising the skills of domestic workers and developing knowledge about best management practices can lead to virtuous cycles in which multinationals improve job quality in the country. This requires co-operation between multinationals, their governments and emerging countries. One example is the Bangladesh Accord on Fire and Building Safety, chaired and facilitated by the International Labour Organisation, a unique agreement between lead firms and trade unions to promote respect for labour rights in the Bangladeshi clothing industry.

Employment protection legislation can ease reallocations and adaptation

Rationale

Employment protection legislation affects countries' capacity to perform in GVCs and adapt to their consequences. Flexible legislation can ease structural adjustment and enhance countries' capacity to change their positioning in GVCs. Overly rigid labour market policies can

prevent firms from adopting risky technologies and realising high productivity gains because such policies make it more costly to shed workers (Bartelsman, Pieter and De Wind, 2010).

At the same time, employment protection raises workers' incentives to acquire firm-specific skills, which can be a source of trade comparative advantage (Tang, 2012). Countries with more protective labour laws tend to export more in firm-specific, skill-intensive sectors. Legislation must balance employers' need for flexibility in a competitive environment with workers' needs for possibilities and incentives to develop firm-specific skills.

Similarly, rigid legislation might reduce or delay the risk of unemployment of workers exposed to offshoring but be an obstacle to finding a new job. Overall, there is a broad agreement that employment protection legislation must balance workers' needs for income, skills development and job security with employers' need to adjust the workforce in an increasingly changing world of work (ILO, 2015; OECD, 2014c).

In recent decades, non-standard employment – which does not benefit from the same degree of protection against contract termination that permanent employees enjoy – has developed, even if permanent employment remains the most prevalent form of contract (OECD, 2014c). Globalisation and technological change, which increase the need for flexibility, are considered the main reasons for the development of non-regular employment (Eurofound, 2010; ILO, 2015). Non-standard employment includes fixed-term contracts, hiring through temporary employment agencies, and part-time work, but also more atypical contracts such as very short fixed-term and part-time work contracts, freelance contracts, non-contract work, zero-hours contracts and on-call work.

There is no international data on atypical contracts. Data covering major high-income countries show that the share of workers under a permanent contract has declined, while a category has emerged of employees engaged without a contract, which stood at 1.1 per cent in 2012, alongside a modest increase in the share of own-account workers (ILO, 2015). These trends point to a decline in employment security across the workforce in high-income economies between the pre- and post-crisis periods. Zero-hours contracts, which do not offer any guarantee to the employee about how much work is entailed, have developed in some countries. In the United Kingdom they have reached 2.9% of total employment (UK Office for National Statistics, 2016). However, they are mainly found in sectors not exposed to GVCs, such as accommodation, food, health and social work.

As the group of workers under non-standard forms of employment has become more heterogeneous, it is difficult to grasp the overall status of employment protection for these workers. Temporary and part-time contracts do not give access to the same level of rights and protections as standard contracts, but these rights and protections have increased over time and are well established. Nonetheless, pay increases, participation in the representative process, unemployment subsidies, pension rights and vocational training systems are linked to job tenure (ILO, 2015). Most reforms of employment protection legislation in developed and EU countries between 2008 and 2014 have consisted in increasing regulations on atypical forms of work so as to rebalance them with regulations on standard forms of work (Adascalitei and Pignatti Morano, 2016).

Policies

Participation and performance in GVCs requires employment protection legislation that provides flexibility to firms and security to workers. This can be achieved by attaching employment protection and social insurance to workers rather than to jobs, and by

delinking these entitlements from job tenure, either by linking them to work experience or making them independent from these criteria. Some countries are considering the introduction of a single contract and of a guaranteed minimum income.

A better understanding of the incidence of atypical forms of work, and of social protection entitlements of workers under atypical forms of work, would help countries to design better employment protection legislation and ensure that duality, with a group of workers facing the cost of offshoring, is not increasing. Workers in all types of employment need adequate protection. In several countries, atypical forms of work are not the main employment but a way to get additional income (Eurofound, 2010).[2] It is important to better understand this issue to allocate the funding of social protection correspondingly to various employers.

Non-compete clauses that do not hinder skills mobility

Rationale

Non-compete clauses, under which employees agree not to use information learned during employment in subsequent jobs for a set period of time, are intended to protect employers' intangible investment. By restricting workers' mobility, they enable employers to benefit from their investment in training and R&D. At the same time, they limit workers' opportunities to find new jobs after voluntary or involuntary job termination. They can be an obstacle to structural adjustments, and can be used to prevent competition. Non-compete clauses particularly affect employees with technology-specific skills, who have difficulties finding new jobs beyond firms that are direct competitors (Garber, 2013). These workers are less likely to change jobs when subject to non-compete clauses (Marx, Strumsky, and Fleming, 2009). Non-compete clauses can also limit the diffusion of knowledge and hinder innovation (Samila and Sorenson, 2009).

Differences in the legislation and enforcement of non-compete clauses may influence countries' capacity to attract FDI and firms' choice of location for offshoring (Garber, 2013). India differs from China and Brazil, for example, in that there is no enforcement of non-compete clauses. This could be a barrier to foreign investment from firms with high-value trade secrets. Nonetheless, India has attracted significant foreign R&D investment; multinationals might benefit from the lack of enforcement of non-compete clauses, as it allows them to tap into a broader set of workers with firm-specific knowledge, and other factors also matter in offshoring decisions.

Policies

It is important to have a better understanding of the incidence of non-compete clauses in OECD countries to assess more thoroughly their impact. There is no broad assessment of the prevalence of non-compete clauses. A study in the United States found that 38% of the workers had been submitted to non-compete clauses during their working experience and that 18% were under such an agreement in 2014 (Figure 4.10; Starr, Bishara and Prescott, 2016).

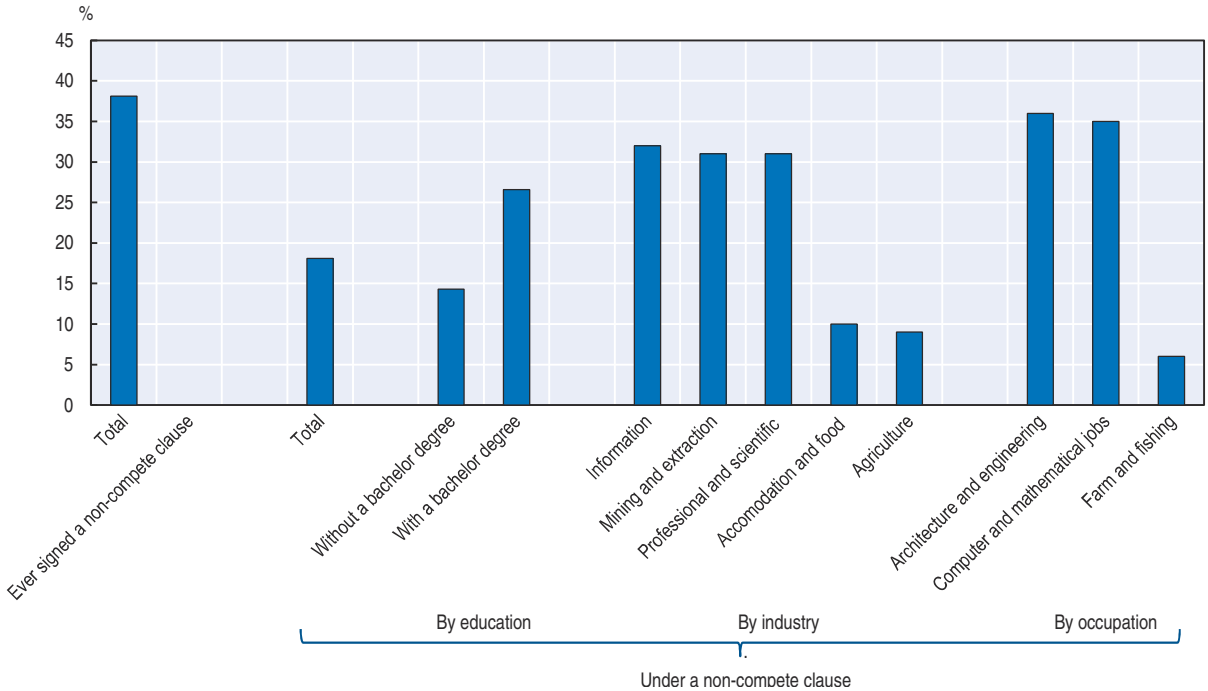
Policies can anticipate changes in skills needs

Rationale

Policy intervention can help to address skills mismatches and skill shortages in the labour market. Doing so successfully, however, relies on having good information on

Figure 4.10. **Workers under a non-compete clause in the United States, by characteristics**

Percentage, 2014



Note: Total numbers are expressed as a percentage of the US labour force. Other numbers are expressed as a percentage of workers in the respective group.

Source: Starr, Bishara and Prescott (2016), "Noncompetes in the U.S. labor force", *https://ssrn.com/abstract=2625714*.

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current and future skills needs. Systems and tools for assessing and anticipating skills needs exist in all OECD countries, but approaches vary significantly in terms of how skills are defined, the time span, frequency, methodology and scope (OECD, 2016b).

In terms of methodology, most exercises rely on more than one source of information, thus reducing potential biases. In most cases these are quantitative sources of information (e.g. employer surveys, surveys of workers or graduates, quantitative forecasting models, sector studies and labour market information) but a few countries systematically incorporate qualitative information as well. Many countries carry out multiple exercises. For instance, Canada combines analyses of existing skill shortages with medium to long-run forecasts of skill needs. This enables the government to tailor immediate policy interventions, such as those targeted at new immigrants with needed skills or short-term training schemes for displaced workers, while also guiding longer-term policy development, for instance building new course curricula or apprenticeships (Box 4.4).

Policies

To be successful, skills assessment and anticipation exercises must be well aligned with potential policy uses. For instance, skills needs should be defined so that they map easily to policy-making variables, like field of study or occupation. To be accessible and useful to policy makers, output should not be too technical, and should be sufficiently disaggregated at the regional, sub-regional or industry levels.

Box 4.4. **How countries use skills needs assessment to steer policy**

Governments of OECD countries use skills assessment and anticipation exercises to guide policy development in employment, education and migration. In terms of employment policy, skills needs information is commonly used to update occupational standards, and to design apprenticeship, retraining and on-the-job training programmes. For example, in Australia, Belgium and New Zealand, skills needs information feeds into the National Occupation Standards, to facilitate the rapid development of standards in new occupations or in occupations with changing skill requirements. Turkey uses skills exercises to design apprenticeships in occupations and industries where shortages are identified.

In France, Hungary, Ireland and Italy, skills needs information is used to help in the transition to a greener and digital economy.

Skills needs information is also commonly used in education policy to inform curriculum development and set the number of student places at all levels of education, including technical and vocational education and training programmes. It is also made available to prospective students and career guidance counsellors to inform decisions about which education level and field of study to pursue. For instance, Finland recently launched a web-based tool, ForeAmmatti, which allows users to browse information on vacancies, regional supply and demand of labour, and skills needed for particular occupations.

In migration policy, skills needs information is used to fast-track entry of immigrants with skills that are in high demand. For example, in Australia, job vacancy data and interviews with employers inform lists of current and future skills shortages, which facilitate migration of workers with relevant skills. Similarly, the United Kingdom's Migration Advisory Committee uses general labour market information to identify occupations with shortages and to advise the government on immediate skills needs.

Source: OECD (2016b), *Getting Skills Right: Assessing and Anticipating Changing Skill Needs*, *http://dx.doi.org/10.1787/9789264252073-en*.

The engagement of key stakeholders in the design of skills assessment and anticipation exercises can ensure that they understand the outputs and use them for policy making. For instance, the strength of Norway's skills assessment and anticipation system lies in the joint involvement of employment and education authorities in the design and development of forecasts carried out by Statistics Norway. This type of stakeholder engagement requires strong co-ordination. A variety of mechanisms have proven successful in promoting consensus among stakeholders, including working groups (e.g. the inter-ministerial skills working groups in the United States), round tables (e.g. the round tables in the Netherlands enhance collaboration among regional/sub-regional administrative levels), sector skills councils (e.g. in Canada, the Czech Republic and the United Kingdom) and independent national skills advisory groups (e.g. in Denmark, Finland and Germany).

Finally, it is generally seen as good practice to adopt a holistic approach to the assessment of skills needs that incorporates quantitative and qualitative information. For instance, the United Kingdom's sector-specific holistic approach to forecasting relies on econometric models, surveys of employers' opinions, skills audits, Delphi methods,[3] case studies, focus groups, scenario development, and consultation with experts and employers (CEDEFOP, 2008; UKCES, 2010).

International co-operation for education, training and innovation

Investment, education, research and innovation have globalised along with the production process. Rather than embark in a race for talent and investment, countries can co-operate on policies that affect the capacity to innovate, the mobility of students and workers and the funding of education (Box 4.5 and Figure 4.11). This co-operation is an important step to ensure that GVCs are not delinked from the local context and that governments can influence the impact of GVCs on their countries (Taglioni and Winkler, 2016).

Box 4.5. **Capturing countries' potential to be part of global education, innovation and research networks**

The OECD has developed several indicators to capture various aspects of countries' connections to global education, innovation and research networks (OECD, 2014d; OECD, 2015c). It is possible to summarise this information to get a single indicator that captures three dimensions of co-operation, each of them measured by a number of indicators:

1) International co-operation for research and innovation, measured by international co-authorship, international co-inventions, and the international mobility of scientific authors.

2) Foreign/international students and high-skilled workers, measured by the share of international and foreign students enrolled in tertiary education and the share of foreign-born doctorate holders.

3) Funding incentives for international co-operation, measured by government expenditure on R&D, the share of government R&D expenditure financed from abroad, and the share of business R&D expenditure financed from abroad. The overall budget for R&D, as a signal of countries' overall support for R&D activities, can trigger investment from abroad or attract multinationals. The share of this investment coming from abroad, either from the foreign private sector or from foreign governments, reflects a country's capacity to attract R&D investment from abroad. Receiving funding from abroad encourages research organisations to work with other countries.

All indicators are normalised and a summary indicator is calculated for each dimension as the average of the normalised indicators (Figure 4.11). The indicator reflects the extent to which countries have framework conditions, policies and characteristics that can foster participation in global education, innovation and research networks.

Source: OECD Patent Database, OECD Main Science, Technology and Industry Indicators Database, OECD Education at a Glance Database; OECD (2015c), *OECD Science, Technology and Industry Scoreboard 2015: Innovation for growth and society*, *http://dx.doi.org/10.1787/sti_scoreboard-2015-en*.

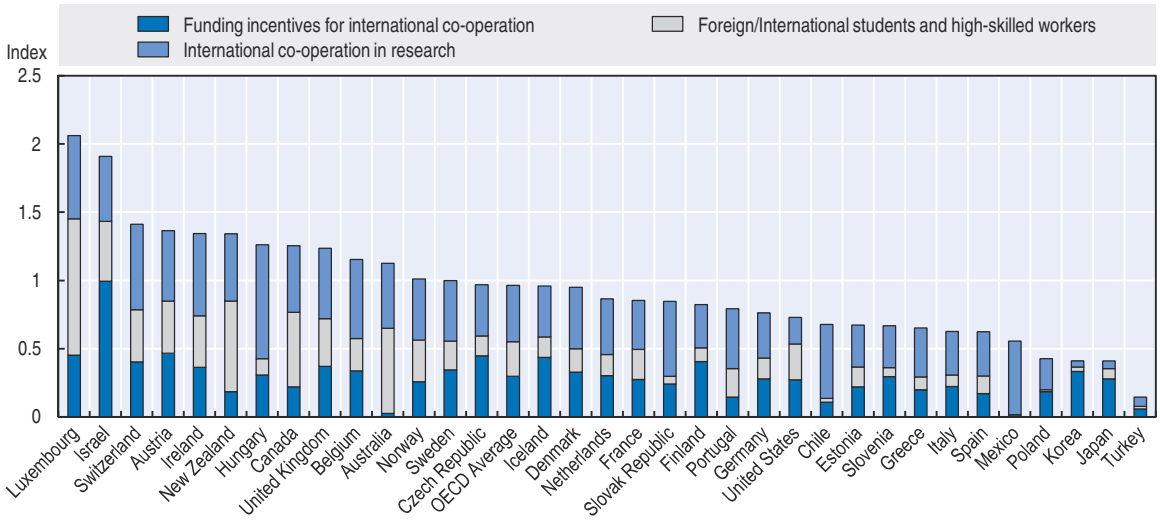
Participating in global education, research and innovation networks

Rationale

Innovation activities have become increasingly internationalised. Although the majority of R&D investments are still concentrated in companies' home country, near headquarters, companies have also started to offshore R&D activities (de Backer and Destefano, forthcoming). Offshoring of R&D was initially intended to adapt products and processes to local market demands but companies then sought to use it to tap into foreign knowledge, technology and human capital.

In addition, co-operation for innovation has developed, through collaborative arrangements with external partners and suppliers, as can be seen from the rise in patents

Figure 4.11. **Countries' potential to be part of global education, innovation and research network, a synthetic indicator**



Source: OECD calculations based on the OECD Patent Database, *http://stats.oecd.org/*; OECD Main Science, Technology and Industry Indicators Database, *https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB*; OECD Education at a Glance Database, *http://stats.oecd.org/*; OECD (2015b), *OECD Science, Technology and Industry Scoreboard 2015: Innovation for growth and society*.

StatLink *http://dx.doi.org/10.1787/888933474524*

with co-inventors from different countries. Firms, universities, research institutions and government agencies are connected in global innovation and research networks.

Countries have to belong to global innovation networks to ensure that their investments in skills pay off within the context of GVCs. Having a pool of good researchers in a specific area may not be enough; their research needs to be relevant to the international market. Although innovation co-operation between countries, measured by patents involving inventors from different countries, is less developed than trade with GVCs, there is a significant geographic overlap between global innovation networks and GVCs (de Backer and Destefano, forthcoming).

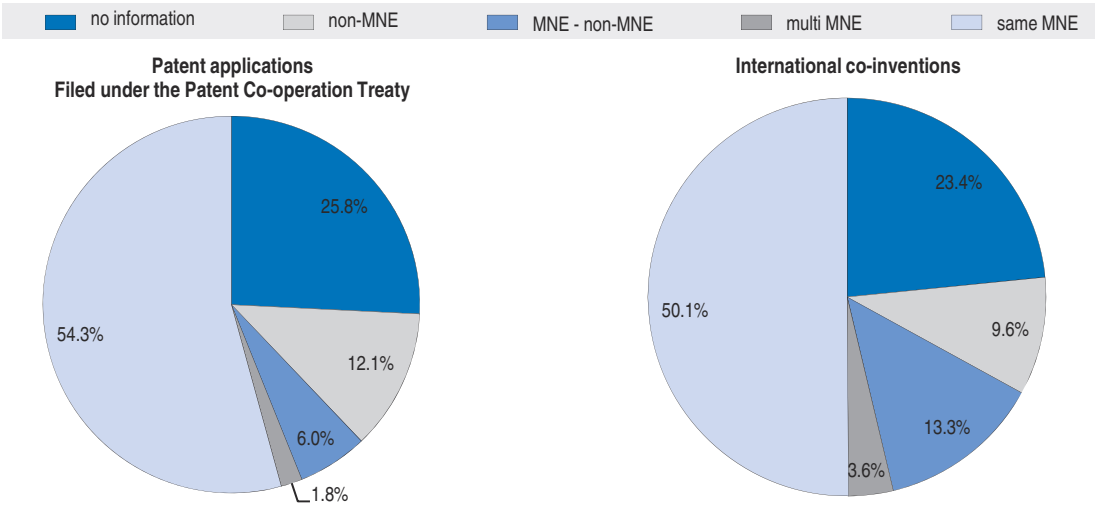
The links between GVCs and global innovation networks are reflected in the leading role of multinationals in patenting. More than 60% of all patent applications and two-thirds of co-inventions are related to multinationals' activities (Figure 4.12). Of co-inventions, more than 50% concern co-inventors in different countries but with the same multinational as applicant (i.e. headquarters and/or affiliates).

Collaboration on scientific research among institutions in different countries, for instance through international co-authorship, improves networking and enhances the likelihood that research will be recognised or adopted by the private sector (OECD, 2015c). Scientific collaboration can enable small countries to reach higher value-added segments of GVCs and attract foreign direct investment. Estimates suggest a positive relationship between measures of scientific research collaboration and citation impact, especially for in countries with lower levels of scientific production (OECD, 2015c). Knowledge may also spread more rapidly when interpersonal links through joint work and co-operation create opportunities for learning that go beyond the exchange of codified information (OECD, 2016c).

Global education networks are just as vital as innovation and research links. Competition to attract international students is rising. Some countries have less success in attracting international students and researchers, which hinders their competitiveness in

Figure 4.12. **The importance of multinational enterprises (MNEs) in patenting and international co-invention**

1995-2013



Note: The left-hand chart shows the shares of patent applications that can be allocated to one multinational (same MNE), several multinationals (multi-MNE), multinationals and non-multinationals (MNE-non-MNE), non-multinationals (non-MNE) and those for which no information is available. The right-hand chart measures international co-invention by focusing on patents with multiple inventors who reside in different countries. It shows the share of co-inventions that can be attributed to same multinational (headquarters and/or affiliates), several multinationals, multinationals and non-multinationals, non-multinationals (non-MNE) and those for which no information is available.

Source: de Backer and Destefano (forthcoming), "The links between global value chains and global innovation network: An exploration", *OECD Science, Technology and Industry Working Papers*.

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the search for talent and the economic impact of their higher education systems. It also diminishes the exposure of home students to international students, and thus their capacity to operate in global environments later on. Students in higher education who study and spend time in a foreign tertiary institution build links with others and gain experience that will be beneficial for their professional careers. In a group of countries, more than 30% of students at a doctoral level come from abroad (Figure 4.13).

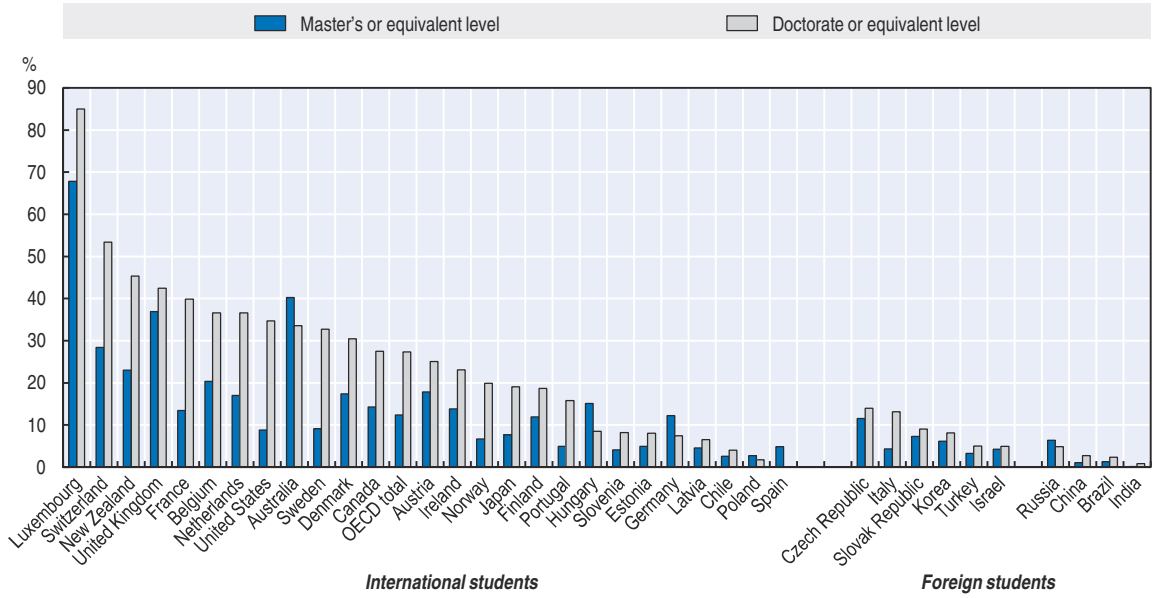
Policies

Countries increasingly compete to attract international investment through policies outside the skills domain (OECD, 2014d). These policies, including subsidies and tax breaks, can be costly and do not ensure that spillovers from multinationals to SMEs will occur. Even if they succeed in attracting investment, the benefits might be volatile and transitory as such incentives generally divert investments from one country to another within a geographic region.

Policies to develop strong skills through high-quality education and training systems also help to foster international co-operation for innovation and research. High-quality education systems, especially at the tertiary level, attract students from abroad who might be more involved in research co-operation. Specific policies to foster interactions between the private sector, universities and research institutions, such as clusters and hubs (Box 4.2), can facilitate the transfer of knowledge but this requires that members have the skills to benefit from these interactions, develop real exchanges of information, and work together.

Figure 4.13. **Share of international or foreign students by level of tertiary education**

2014



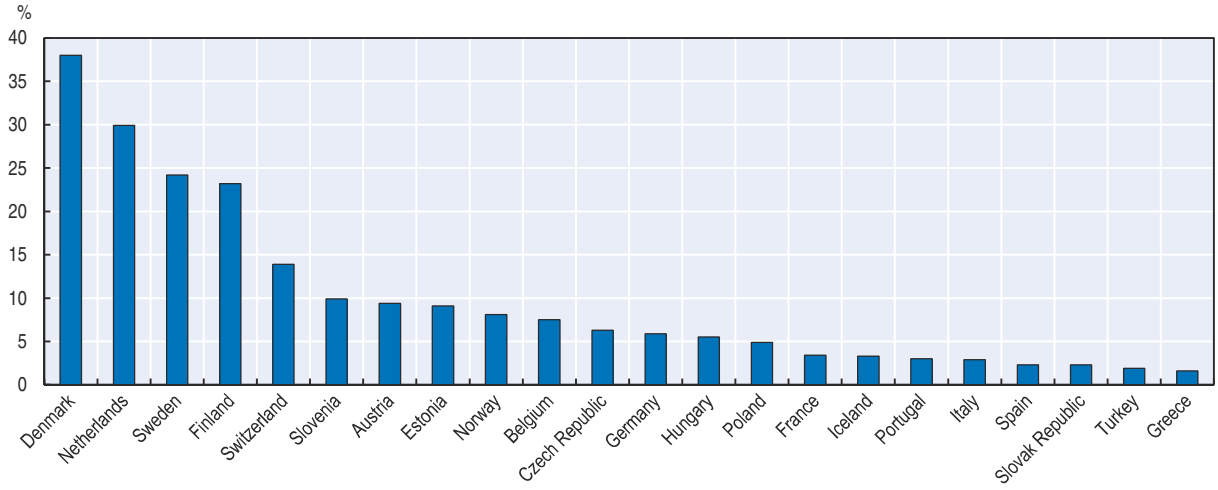
Source: OECD (2016d), *Education at a Glance 2016: OECD Indicators*, *http://dx.doi.org/10.1787/eag-2016-en*.

StatLink http://dx.doi.org/10.1787/888933474544

In addition, some specific policies can foster the internationalisation of education and research systems and encourage research co-operation. The provision of education and training programmes in English can help to attract students from abroad and enable other countries to compete with English-speaking countries. They are unevenly developed in EU countries (Figure 4.14).

Figure 4.14. **Proportion of tertiary education programmes provided in English**

2013-14



Note: At ISCED levels 5 or 6.

Source: Wächter and Maiworm (2014), "English-taught programmes in European higher education: The state of play in 2014".

StatLink http://dx.doi.org/10.1787/888933474558

Other policies in tertiary education that can ease students' mobility include adopting common standards in higher education, recognising foreign diplomas and skills acquired abroad, and enabling students to transfer credits acquired abroad. In Europe, as part of the Bologna process, countries have made efforts to harmonise their qualification frameworks and to make them more transparent. Most of the OECD EU countries have fulfilled all the steps of the European qualification framework (European Commission/EACEA/Eurydice, 2015a). Nevertheless, in most EU countries, higher education institutions make the final decision on recognition of foreign qualifications, while recognition of credits gained abroad is fully in the hands of higher education institutions. Improving international recognition of skills acquired abroad would help students move abroad at different points in their academic development and thereby acquire a diverse set of experiences and connections.

Funding skills development when the social returns are increasingly global

Rationale

Countries benefit in several ways from the internationalisation of education. Some countries attract a large share of international students, enlarging the domestic pool. International students are attractive for OECD host countries beyond the economic benefits of their skills and ideas. In 2011, half of the OECD countries for which the data are available charged higher fees for international students (OECD, 2016d).

Some developing and emerging economies see a large share of their most talented students leave to study abroad, where they can benefit from high-quality programmes. If these students do not return, their countries lose part of their initial education investment. Nonetheless, the possibility of studying abroad may increase people's incentive to invest in education at home, as it opens a prospect of higher expected return on education. More people may decide to enrol in tertiary education, even though not all of them will pursue education abroad, increasing the supply of tertiary educated people in the origin country.

This "return on migration" for the origin country is possible if the probability of emigration for students with tertiary education is sufficiently low. However, the incentive to study abroad could encourage students to choose a field of study that responds to migration prospects. When foreign and domestic needs for skills differ, the mismatch between the supply and demand for skills in the origin country can become large and induce what is called "brain waste" (Docquier and Rapoport, 2012).

The development of GVCs benefits from and contributes to the internationalisation of tertiary education. Offshoring activities shift the skills demand across industries and across countries (Chapter 2), altering the efficiency of educational investment. In the country where multinationals are located, three main changes are likely to happen. First, the offshoring of activities means that some investment in education, typically in specific vocational skills, is lost if the corresponding jobs are offshored. Second, education and training policies may be needed to help the workers who lose their jobs to develop skills that will help them to move to another industry. Third, the increase in demand for skills induced by the new distribution of production – usually skills associated with more complex tasks – may raise demand for other or new education programmes. In contrast, in countries to which activities are offshored, the need for some education programmes increases, but these countries may not have the capacity to develop such programmes.

Policies

Countries aim at gaining comparative advantages through the skills of their population but GVCs make the production process less dependent on local skills. In this context, the social returns of education to countries are more uncertain while the private returns of education may increase. This uncertainty can affect the governments' education finance strategies as well as people's educational decisions. Countries can co-operate to design arrangements that benefit both sides.

An agreement to jointly design and finance education programmes needs to build on mutual recognition of the distribution of benefits and costs arising from the internationalisation of tertiary education and of the production process. First, the financial resources collected by universities in OECD member countries from international students are large whereas the cost of education in non-OECD countries is usually lower. Second, the internationalisation of tertiary education and of the production process generates opportunities in developing and emerging economies but can also lead to costs, especially if skills in these countries are downgraded. Third, the productivity gains of offshoring can be higher for offshoring countries if they can rely on a skilled labour force in countries to which activities are offshored.

Co-operation arrangements can take various forms. They can involve discussions between governments and firms from various countries on the specific skills needs implied by offshoring, and how they can be met. They can also entail more formal agreements in which the costs of education programmes are shared and offshoring countries are involved in designing education programmes in countries to which activities are offshored. Some studies have proposed to create a Global Skill Partnership under which two countries can agree on sharing the costs and benefits of creating skills for both countries' needs, while preserving workers' freedom of movement (Clemens, 2015).

A formal agreement on co-operation for education has to build on a partnership between different stakeholders that have complementary roles in GVCs. Partnership between public and private entities is vital because each can improve the quality of training. A dialogue between private-sector partners and public institutions is also important to guarantee that the educational programmes are portable. Moreover, private-sector partners play an important role in identifying the skills mix they need whereas public institutions (in particular in countries to which activities will be offshored) should ensure that students are not tied to the employers. Such an agreement should guarantee successful placement for students in the global labour market. There are several examples of international co-operation in VET, for instance the German-Thai Dual Excellence Education programme (European Commission, 2015).

Education institutions can learn from each other, enhancing the quality of education in both institutions. Being involved in education programmes in countries to which activities are offshored can be a way to maintain knowhow in this type of programme, especially for VET programmes. In addition, some activities and skills may be offshored today but onshored – brought back to the domestic market – tomorrow. And if know-how in VET programmes is retained, it is easier to fulfil needs for related education programmes that may emerge in the future.

For emerging and developing economies, the loss of talented students can be partly offset by remittances, especially if they flow towards education. The country of origin could inform students about opportunities, once they are working, to send money home. Filipino migrants have been found to be more willing to remit to beneficiaries in their origin

country when the money is "labelled" to be used for educational expenses (De Arcangelis et al., 2014). The country of origin could also foster intangible remittances, such as ideas and knowledge, by maintaining strong ties with students abroad.

Aligning migration policies with international competitiveness objectives

Rationale

Migrants are increasing the supply of skills in many destination countries. The number of migrants with tertiary education living in OECD countries almost doubled between 2000 and 2010, an increase much larger than that in the native-born population (Arslan et al., 2016).

People born in the same country who each move to different countries develop networks that help to spread ideas, knowledge and technology. Networks between migrants from the same country of birth, in particular skilled migrants, stimulate trade and foreign direct investment by removing informational and cultural barriers (Javorcik et al., 2011; Foley and Kerr, 2013). Migrants also increase cultural diversity in firms, which can boost productivity (Alesina, Harnoss and Rapoport, 2016; Ottaviano and Peri, 2005).

Migrants are more entrepreneurial than native-born citizens so they can boost innovation, spurring economic growth. Immigrant groups are more engaged in self-employed enterprises than natives in many OECD countries, including Australia, Canada, the United Kingdom and the United States (Kerr and Kerr, 2016). This trend has strengthened over time. In the United States, immigrants' share of entrepreneurship rose from 17% in 1995 to 27% in 2008 (Fairlie and Lofstrom, 2013).[4] Migrant entrepreneurship is often driven by a lack of other employment opportunities, particularly for low-skilled migrants, but also by migrants' social networks, which provide information, financial support and a customer base (Kerr and Mandorff, 2016). Thanks to their knowledge of global markets, migrant entrepreneurs orient their sales to international customers. A study of 7 600 firms in London showed that companies with foreign-born owners (including those with some UK-born owners) are more likely to introduce new products and services and to sell to the international market than firms with only UK-born owners (Nathan and Lee, 2013).

Policies

It is important to avoid misalignment between migration policies and international competitiveness objectives. In recent years, some OECD countries have revised their policy frameworks for skilled workers and international students (OECD, 2016e). In particular, there has been a clear trend to make it easier for international students to remain in the country after graduation. Labour migration schemes have been adjusted, generally to favour skilled workers. Changes have gone in various directions for less skilled labour.

Facing the risks and implications of offshoring

Participation in GVCs includes the offshoring of activities, which lowers the demand for some skills. GVCs also increase the interconnections between countries and thereby the uncertainty surrounding the demand for skills. Skills policy changes in a country affect its skills endowment and, in turn, its comparative advantages in GVCs but also those of its trading partners. Overall, the development of GVCs leads to structural changes that can be costly for some groups of workers, especially in the short term. Well-designed policies have a vital role to play in reducing these costs.

Finding a balance between preventive and curative policies to support workers at risk of displacement

Rationale

Some workers face a greater risk than others that their jobs will be shifted offshore, either because of the type of tasks they perform on the job (Chapter 2) or because of workers' own characteristics.

Older workers and those with low education levels face a higher risk of displacement, take longer to get back into work and suffer greater and more persistent earnings losses (OECD, 2013c). While young people also face a higher risk of displacement than prime-aged workers, they generally find work quickly after displacement, often in jobs with greater skills requirements than their previous jobs.

Women are generally no more likely to be displaced than men, once other factors are taken into account, such as the type of contract they hold before displacement. However, women are more likely than men to become disconnected from the labour market and experience longer spells of inactivity after displacement.

Very often workers' characteristics and the type of task they perform on the job are mutually reinforcing factors: low-skilled older workers perform routine intensive tasks that can be offshored and face difficulties finding a new job because of their low skills.

Displaced workers tend to have longer unemployment spells and higher earning losses than the other unemployed workers. The duration of the subsequent unemployment spell increases with job tenure, because workers with high tenure have a higher level of specific human capital investment in their firms and in their industry or occupational sectors (OECD, 2013c; Cavaco, Fougère and Pouget, 2009).

Policies

Well-designed policies can help displaced workers find a new job but it is also crucial to provide organised learning opportunities, beyond initial formal education, to help vulnerable workers to adapt and change job if needed, as the social cost of job losses for these workers can be high. Both types of policies are discussed in this section.

Most OECD countries have policies to support displaced workers and some have been beneficial. In France, several programmes that target displaced workers have been gradually introduced. The initial programme increased the likelihood of finding a job with a permanent contract (Cavaco, Fougère and Pouget, 2009).[5] The programme provided immediate, individual support to displaced workers for six to eight months, beginning just after dismissal, including retraining, often vocational training, and help in looking for a new job. In the United States, the focus has been on limiting the risk that displaced workers experience a loss in earnings, as some of their skills are not transferable to emerging industries. The government has allocated grants to community colleges to train displaced workers for in-demand jobs. These programmes have increased re-employment earnings of participants (Jacobson, Lalonde and Sullivan, 2005).

Labour market policies can help displaced workers find a new job if they are well designed. Some important elements include an obligation to look for a job, access to high-quality job search counselling, and strong and modern public employment services. When specific programmes are proposed, they should include some work experience and labour market training (OECD, 2015d).

Workers who are displaced because their industry or occupation is exposed to offshoring need to develop new skills to raise their employability. In some cases, short training programmes can be sufficient to improve workers' skills. In other cases, workers may need to go back to education, such as upper secondary or post-secondary VET. It is crucial to provide organised learning opportunities for adults beyond initial formal education. Workers in high-technology sectors need to keep pace with rapidly changing techniques. Workers in low-technology industries and those performing low-skilled tasks must learn to be adaptable.

VET programmes can better develop a broad range of skills – including foundation literacy and numeracy skills, and vocational skills – than short-term labour market programmes, so they can be an important policy for some groups of displaced workers. In most EU countries, upper secondary VET is available for adult learners, either through the general VET system or through programmes dedicated to them (European Commission/EACEA/Eurydice, 2015b). Several countries have also a specific upper secondary programme for youth who have left school early, such as the second chance schools in France (OECD, 2015a).

Overcoming obstacles to adult education and training

Rationale

In most countries, workers whose skills levels are already high participate the most in adult education (OECD, 2013b). Participation in adult learning increases with the use of reading activities in everyday life (Figure 4.15). Those who use their reading skills a lot in everyday life are 2.5 times more likely to participate in adult learning than those with low use of reading skills. In addition, participation in adult learning is predominantly job-related – driven by motivation to improve career prospects and get or change a job – and as such is closely linked to employment status, among other factors. Participation rates for the employed are higher than for the unemployed and for adults who are not in the labour force (Figure 4.16).

There is a virtuous cycle for high-skilled workers: they have the skills to learn more and by learning more, they raise their skills. In contrast, low-skilled workers or the non-employed face a vicious cycle. They are trapped in situations in which they do not benefit from training and therefore their skills remain weak or may even deteriorate.

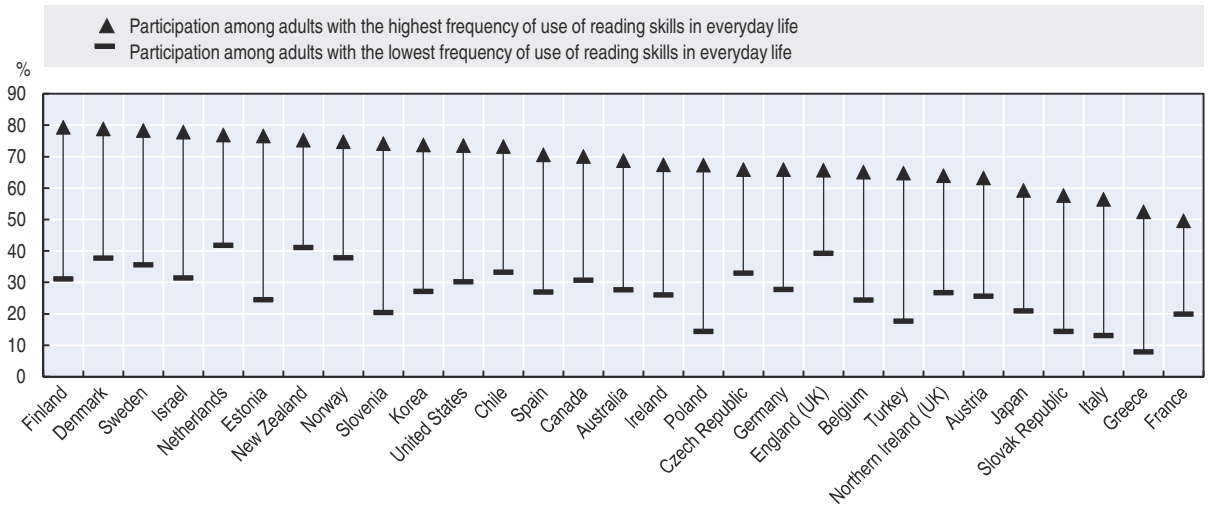
Policies

Policies to support workers at risk of displacement have to break the vicious cycle that keeps low-skilled workers out of adult learning. Data for EU countries show that work and family responsibilities are important barriers to adult participation in lifelong learning (European Commission/EACEA/Eurydice, 2015b). Distance learning programmes can offer solutions to those with work and family responsibilities. Another important step is to develop agreement between employers and unions, as is done in the Nordic countries, to offer more flexibility for undertaking lifelong learning on the side of both employers and adult education and training providers.

To facilitate employment and career transitions, it is also crucial to offer opportunities to start or continue higher education later in life, which requires adapting the requirements to enter higher education. The validation of non-formal and formal learning is vital, not only to ease the access of adult learners to higher education but also to ensure that they have the skills needed to succeed in their learning programme.

Figure 4.15. **Adult participation in education and training by frequency of use of reading skills in everyday life**

Percentage of adults, 25-64 year-olds, 2012 or 2015



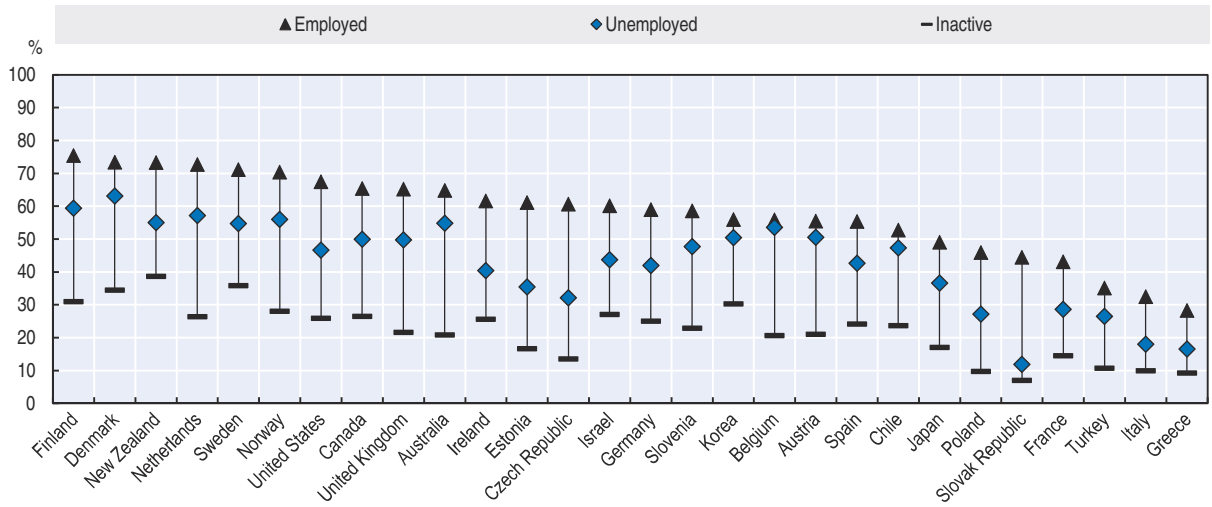
Note: Chile, Greece, Israel, New Zealand, Slovenia and Turkey: Year of reference 2015. All other countries: Year of reference 2012. Data for Belgium refer only to Flanders. Highest frequency refers to reading daily or weekly and the lowest frequency refers to no reading, or reading rarely or less than once a month.

Source: OECD (2016d), *Education at a Glance 2016: OECD Indicators*, Table C6.1, *http://dx.doi.org/10.1787/eag-2016-en*.

StatLink http://dx.doi.org/10.1787/888933474565

Figure 4.16. **Adult participation in education and training by employment status**

Percentage of adults, 25-64 year-olds, 2012 or 2015



Note: Chile, Greece, Israel, New Zealand, Slovenia and Turkey: Year of reference 2015. All other countries: Year of reference 2012. Data for Belgium refer only to Flanders and data for the United Kingdom refer to England and Northern Ireland jointly.

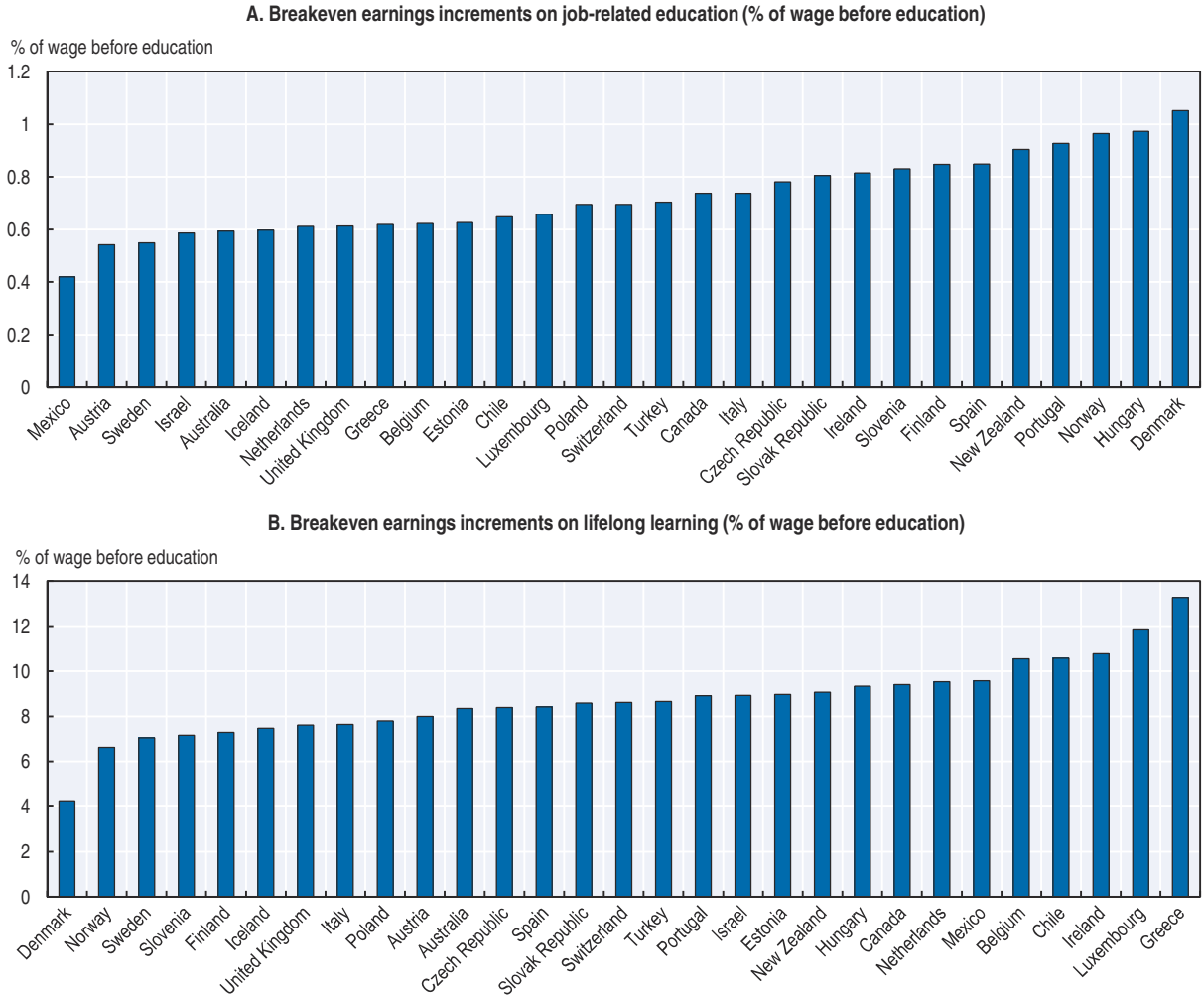
Source: OECD calculations based on the Survey of Adult Skills (2012, 2015), *http://www.oecd.org/pisa/data/2015database*; OECD (2014e), *Education at a Glance 2014: OECD Indicators*, *http://dx.doi.org/10.1787/eag-2014-en*.

StatLink http://dx.doi.org/10.1787/888933474573

Financing is often an impediment to adult education and training. Investing in skills involves a range of costs, including not only lost earnings and tuition fees but also potentially higher future taxes. These costs need to be balanced by higher future wages, tax credits to undertake education, and education grants.

An OECD study has formulated several indicators that measure the impact of tax and spending policy on people's incentives to invest in skills (OECD, 2017). In particular, the Breakeven Earnings Increment indicator measures how much earnings need to increase so that people earn back the costs of an investment in skills over their remaining years in the workforce. A 50-year-old worker reskilling in later life through a one-year course of study to change career needs to achieve much higher earnings gains than a 27-year-old taking a similar one-year course of education or a 32-year-old undertaking a short course of job-related training (Figure 4.17). This is because training to change career is less frequently eligible for tax deductions than job-related training and because a 50-year-old worker has fewer years in which to recoup the cost of education.

Figure 4.17. **Financial incentives to invest in job-related education and lifelong learning**



Note: Data on job-related education are for a 32-year-old single taxpayer with no children, who undertakes a short course of job-related education, earning 95% of the average wage over the year while they study. Data on lifelong learning are for a 50-year-old single taxpayer with no children, who undertakes a one-year course of non-job-related education, earning 25% of the average wage during schooling. This figure shows results that incorporate tax deductions and tax credits for direct costs, tax exemptions for scholarship income, and reduced taxes on student wage income. Tax incentives in the personal income tax system are incorporated, but not the social security contribution system. They do not incorporate skills tax expenditures that subsidise parental spending on education or that subsidise firm spending on education. It is assumed that the skills investment is financed wholly with savings: students do not incur any debt to make a skill investment.
Source: OECD (2017), *Taxation and Skills*, *http://dx.doi.org/10.1787/9789264269385-en*.

StatLink *http://dx.doi.org/10.1787/888933474587*

As governments provide many tax measures to support investment in skills – such as tax deductions of skills expenses, or tax exemptions for scholarship income – good design of these provisions is vital in ensuring their effectiveness (OECD, 2017). Existing skills tax expenditures are often only available for training connected to a workers' current employment, and may be ineffective in assisting workers who need or want to change careers. These tax provisions may reduce labour market flexibility and exacerbate skills mismatches. Skills tax expenditures often provide larger benefits to those with larger taxable incomes, and may provide more benefits to those in secure employment than to those in casual employment. Ensuring access to skills investment for those who have difficulty borrowing is crucial. Income-contingent loans may be an efficient and equitable policy instrument to achieve this aim.

Summary

Countries can shape their performance in GVCs through effective and well-co-ordinated skills policies. The risks of misalignment between skills policies and international competitiveness objectives are large, however: GVCs and trade issues pertain to ministries with their own set of policies outside the skills area, while education, research and labour ministries in charge of most skills policies generally focus on employment and innovation outcomes. To make the most of GVCs, a "whole of government" approach is needed in which stakeholders collaborate to take into account the country's current positioning in GVCs, the strengths and weaknesses of skills policies, other types of policies that affect the country's performance in GVCs, and the opportunities for further specialisation.

While countries compete against one another within GVCs, the fragmentation of the production process enables them to specialise and find niches in which they are competitive. Co-operation on the design and financing of education and training programmes can lead to solutions that benefit both sides: countries that play a leading role in GVCs benefit from the quality of skills in other countries and from maintaining their expertise in the teaching of technical skills that might have been offshored; countries to which activities are offshored benefit from education programmes of higher quality, which can help them improve their position in GVCs. In addition, co-operation between multinationals, governments and emerging countries to develop social standards and obligations can lead to better job quality in countries to which activities are offshored. Co-operation on education and training programmes, as well as on social standards, can ensure a more equal distribution of the gains generated by GVCs.

The development of GVCs exposes some workers to the risk of lower wages and displacement, which can have political repercussions. While the effect of GVCs on inequalities within countries is not clear-cut (Chapter 2), rising trade integration can lead to polarisation of politics (Autor et al., 2016). Adverse economic shocks related to international trade may cause voters to support positions that lean towards political extremes on the left or right. This can put huge challenges on education systems and skills policies. This chapter shows that more needs to be done to strengthen the quality and co-ordination of skills policies. At the same time, several innovative and well-designed policies are already in place that target specific groups or on a small-scale basis. For many countries, the challenge is to raise the quality of these policies on a broader scale.

Notes

1. Global University Entrepreneurial Spirit Students' Survey is a global survey of students' entrepreneurial intentions and activities immediately after graduation and five years later. It started in 2003 and is undertaken by the Swiss Research Institute of Small Business and Entrepreneurship at the University of St. Gallen. In the 2016 edition, 122 509 students from 1 082 HEIs from more than 50 countries participated (Sieger, Fueglistaller, and Zellweger, 2016).
2. According to this study, in Austria for example, 50% of so-called marginal workers are estimated to be unemployed people, retirees or students. Moreover, studies in Austria have found that nearly half of all marginally employed people have more than one employer and that 4.3% have as many as three employers at the same time.
3. The Delphi method entails a group of experts who anonymously reply to questionnaires and subsequently receive feedback in the form of a statistical representation of the "group response", after which the process repeats itself. The goal is to reduce the range of responses and arrive at something closer to expert consensus. The Delphi Method has been widely adopted and is still in use today.
4. This increase in share has been partly driven by the decrease in business creation by natives from the Great Recession starting in 2007 in the United States (Fairlie and Lofstrom, 2013).
5. The initial programme was the "convention de conversion". It has been changed into a "convention de reclassement personnalisé", which includes a social benefit in addition to retraining and job search actions.

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ANNEX 1

List of countries ISO codes

Australia	AUS	Japan	JPN
Austria	AUT	Korea	KOR
Belgium	BEL	Latvia	LVA
Canada	CAN	Luxembourg	LUX
Chile	CHL	Mexico	MEX
China (People's Republic of)	CHN	Netherlands	NLD
Czech Republic	CZE	New Zealand	NZL
Denmark	DNK	Norway	NOR
Estonia	EST	Poland	POL
Finland	FIN	Portugal	PRT
France	FRA	Russian Federation	RUS
Germany	DEU	Slovak Republic	SVK
Greece	GRC	Slovenia	SVN
Hungary	HUN	Spain	ESP
Iceland	ISL	Sweden	SWE
Ireland	IRL	Switzerland	CHE
India	IND	Turkey	TUR
Indonesia	IDN	United Kingdom	GBR
Israel	ISR	United States	USA
Italy	ITA		

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OECD Skills Outlook 2017

SKILLS AND GLOBAL VALUE CHAINS

Since the 1990s, the world has entered a new phase of globalisation. Information and communication technology, trade liberalisation and lower transport costs have enabled firms and countries to fragment the production process into global value chains (GVCs). Many products are now designed in one country and assembled in another country from parts manufactured in several countries. Thirty percent of the value of exports of OECD countries comes from abroad. In this new context, GVCs and skills are more closely interrelated than ever. Skills play a key role in determining countries' comparative advantages in GVCs. A lot of the opportunities and challenges brought about by GVCs are being affected by countries' skills.

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