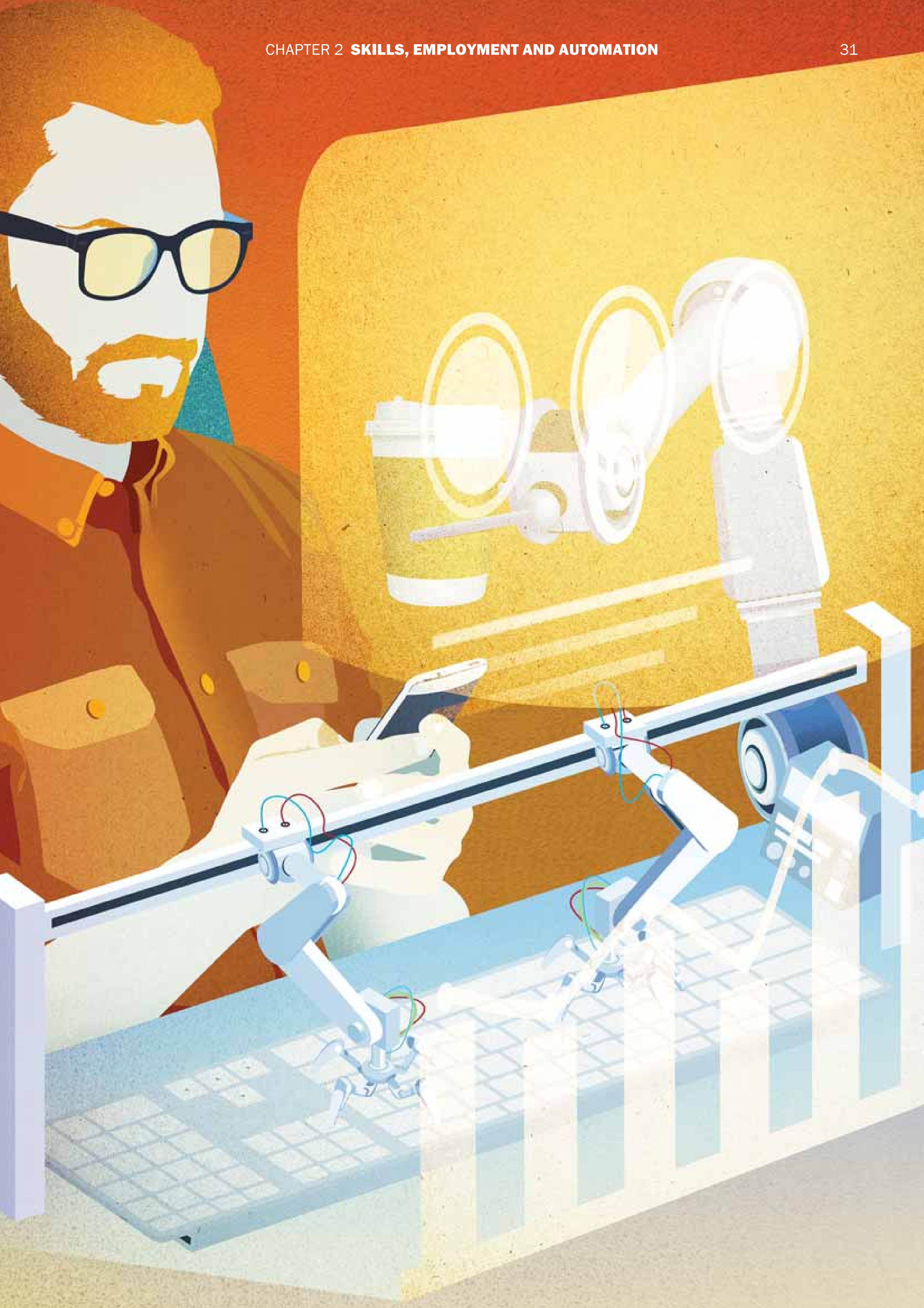
2

SKILLS, EMPLOYMENT AND AUTOMATION

Over the past 25 years, the economies of the EBRD regions have created an average of 1.5 million jobs per year. However, the nature of work is changing, with automation on the rise. Many economies where the EBRD invests have experienced deindustrialisation, as well as the polarisation of employment – a decline in the number of medium-skilled jobs. While technological change is resulting in increased demand for skilled labour, many of these economies face significant gaps in terms of the quality of education, as well as substantial emigration by skilled workers. In the short term, the emigration of skilled workers reduces the productivity of firms in the country of origin. In the longer term, however, emigration has boosted the transfer of knowledge to the EBRD regions and supported innovation.



Introduction

Rapid technological change is having a profound impact on the nature of work and the types of skill that are in demand in the workplace.[1] One example of this is the advent of financial technology (fintech), which has brought about the rise of online banking and resulted in a reduction in the number of traditional high-street bank branches. In some cases, economic policy has struggled to keep pace with such developments (see, for instance, Annex 2.1 for a discussion of regulatory frameworks governing crowdfunding). The EBRD regions have not been immune to these trends. Indeed, the demographic pressures in emerging Europe have created particularly strong incentives for automation (as discussed in Chapter 1).

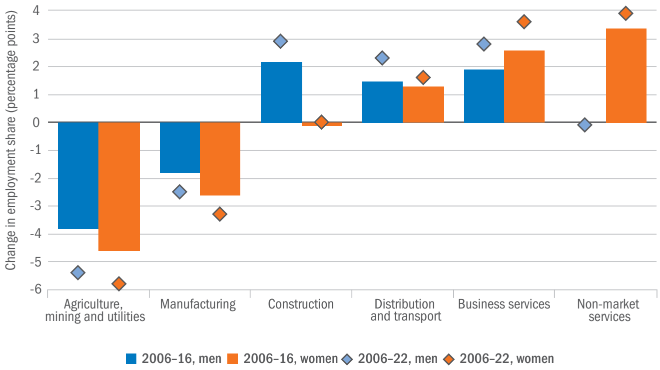
This chapter examines recent trends in labour markets across the EBRD regions, looking at the types of job that have been destroyed and created, future trends in job creation, the skills mix in the various economies and the economic impact of emigration by skilled workers. On the basis of the available evidence, it also discusses policies that can help to mitigate the disruptive effects of technological change and emigration by skilled workers.

The chapter starts by looking at skills from a supply and demand perspective. Like advanced economies, most countries in the EBRD regions have been experiencing deindustrialisation (a decline in industrial employment) and job polarisation (a decline in medium-skilled occupations as a percentage of total jobs). Educational attainment has improved, but mismatches between the supply of skills and the demands of employers persist.

The second section examines the ways in which automation alters demand for labour and skills. On average, workers in the EBRD regions face a significantly higher risk of job automation than their counterparts in advanced economies. For example, the mean probability of a job being automated in the foreseeable future is 57 per cent in the Slovak Republic and 55 per cent in Turkey, compared with around 40 per cent in the United States of America and the United Kingdom.[2]

The third section looks at the impact that the emigration of skilled workers has had on innovation and the productivity of firms in the EBRD regions. Following the accession to the EU of various countries in central and south-eastern Europe in 2004 and 2007, emigration from that region has increased considerably. Emigrants tend to be young and highly skilled, with Eurostat data indicating that more than 20 per cent have university degrees and another 40 per cent are educated to secondary level. The analysis in this section shows that although skilled emigration has been associated with a decline in firms' total factor productivity (TFP) – the efficiency with which capital, labour and material inputs are combined to produce final products – emigration has, in the medium term, boosted "knowledge remittances" to those migrants' countries of origin and contributed to higher rates of innovation.

CHART 2.1. Past and projected changes in employment shares of particular industries



Source: ILO and authors' calculations.
Note: Averages weighted by size of labour force. "Business services" comprise ISIC sectors I (accommodation and food services), K (financial and insurance activities), L, M and N (real estate, business and administrative activities). "Non-market services" comprise ISIC sectors O (public administration and defence), P (education), Q (healthcare and social work), R, S, T and U (other services).

Demand for and supply of skills

Deindustrialisation

It is difficult to assess demand for specific skills at a particular point in time. However, the employment shares of specific occupations can provide a useful approximation of such demand, as skills used at work tend to be specific to a particular industry or occupation.[3] Changes in employment shares over time provide important insights into the creation and disruption of jobs as a result of technological change.

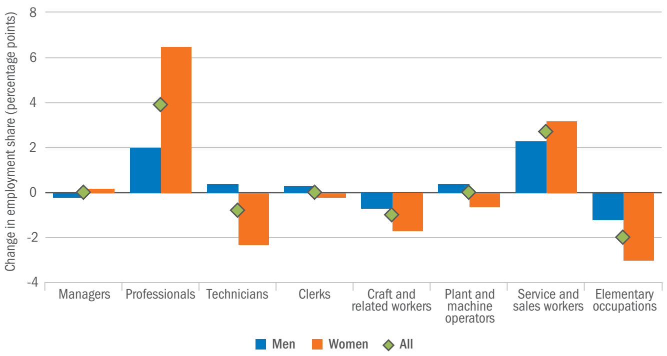
The EBRD regions have been undergoing deindustrialisation. Indeed, the combined employment share of agriculture, mining and utilities declined by 4 percentage points between 2006 and 2016, while that of manufacturing declined by more than 2 percentage points over the same period (see Chart 2.1). These trends are projected to continue (see Box 2.2 for a discussion of expected changes in sectoral employment and working conditions). Male workers leaving the agriculture and manufacturing industries have typically found employment in construction, while women have mainly switched to non-market services such as public administration or education.

As a result, gender segregation in employment has increased further, with men accounting for 92 per cent of all employees in the construction industry in 2016 (up from 90 per cent in 2006) and women accounting for 59 per cent of all employees in non-market services (up from 57 per cent in 2006). See Box 2.1 for a discussion of gender imbalances in unpaid care work.

The speed of such structural shifts varies across economies. Indeed, additional analysis suggests that the economies of Central Asia and the southern and eastern Mediterranean (SEMED) region have tended to see the strongest declines in the

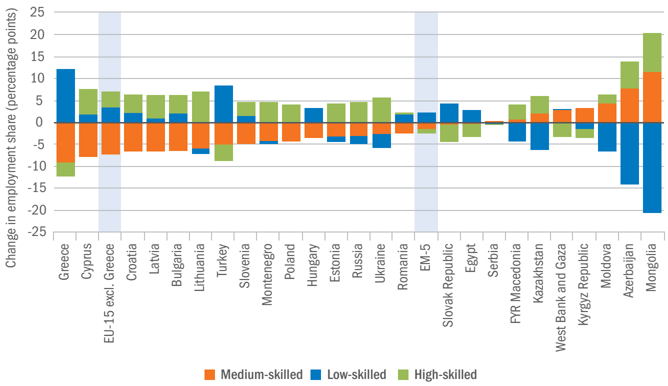
[1] See Acemoğlu and Restrepo (2017), Chiacchio et al. (2018), Dauth et al. (2017) and Graetz and Michaels (2018).
[2] See Nedelkoska and Quintini (2018).
[3] See Handel (2012), Parent (2000) and Gathmann and Schönberg (2010).

CHART 2.2. Changes in employment shares by occupation and gender, 2006-16



Source: ILO modelled estimates and authors' calculations.
Note: Weighted averages across 25 economies. Occupations are based on the International Standard Classification of Occupations' ISCO-08 classification and are ranked from left to right in declining order of skill-intensity. "Professionals" include engineering, healthcare, teaching, business and IT professionals. "Clerks" include keyboard clerks, service clerks and numerical or material recording clerks. "Craft workers" include construction workers, metal or machinery workers, handicraft or printing workers, electrical workers and food processing workers. "Service and sales workers" include personal services workers, sales workers, personal care workers and protective services workers. "Elementary occupations" include cleaners and helpers, agricultural labourers, food preparation assistants and refuse workers.

CHART 2.3. The employment share of medium-skilled occupations declined in most economies over the period 2006-16



Source: ILO modelled estimates and authors' calculations.
Note: Based on methodology in OECD (2017) and ISCO-88 classifications. "EM-5" comprises Argentina, Brazil, Malaysia, South Africa and Thailand. High-skilled occupations comprise legislators, senior officials and managers (group 1), professionals (group 2) and technicians and associate professionals (group 3). Medium-skilled occupations comprise clerks (group 4), craft workers and related tradespersons (group 7), and plant and machine operators and assemblers (group 8). Low-skilled occupations comprise service and sales workers (group 5) and elementary occupations (group 9). Data for Kazakhstan relate to the period 2006-15 and data for Montenegro relate to the period 2006-17.

OVER THE LAST 25 YEARS, ECONOMIES WHERE THE EBRD INVESTS HAVE CREATED AN AVERAGE OF
1.5 MILLION
JOBS PER YEAR

THE COMBINED EMPLOYMENT SHARE OF AGRICULTURE, MINING AND UTILITIES FELL BY
4 PERCENTAGE POINTS
IN THE EBRD REGIONS BETWEEN 2006 AND 2016

primary sector, while manufacturing has tended to decline most strongly in eastern Europe and the Caucasus (EEC) and Russia. Meanwhile, Turkey has seen a 6 percentage point increase in the employment share of business services.

In line with those sectoral shifts from agriculture and manufacturing to services, the employment shares of service-sector professionals and sales workers have risen by between 2 and 4 percentage points (see Chart 2.2). At the same time, the employment shares of elementary occupations (such as agricultural labourers), craft workers and technicians have fallen by between 0.8 and 2 percentage points. Occupational shifts have been more pronounced among women than among men.

Job polarisation

Automation has reduced demand for certain routine cognitive tasks. Since the early 1990s, job creation has been concentrated mainly in low-skilled occupations (such as catering, construction and cleaning) that are harder to automate than computational tasks, as well as high-skilled occupations (such as professional services and research and development).[4] Highly paid skilled work, in turn, raises demand for relatively poorly paid personal services (such as cleaning or catering), reinforcing the polarisation of occupations into what Goos and Manning (2007) called "lovely" and "lousy" jobs.

In line with these global trends, the total employment share of medium-skilled occupations (such as clerks, craft workers, and plant and machine operators) has been declining in the EBRD regions (see Chart 2.3),[5] while those of high-skilled occupations and low-skilled occupations have both been rising. The extent of

[4] See Autor and Dorn (2013).
[5] See OECD (2017) for a classification of occupations.

such job polarisation has, on average, been greater in higher-income economies (see Annex 2.2). In Bulgaria, Croatia, Cyprus, Greece and Latvia, levels of job polarisation have been similar to those observed in advanced economies and higher than the levels seen in most emerging markets.

However, economies with large primary sectors have seen continued declines in the employment share of low-skilled occupations (with the largest declines being observed in agriculture) and increases in the shares of both medium-skilled and high-skilled jobs. This includes economies such as Azerbaijan, Moldova and Mongolia, where agriculture, mining and utilities still account for more than 35 per cent of total employment.

Quantity of education versus quality of skills

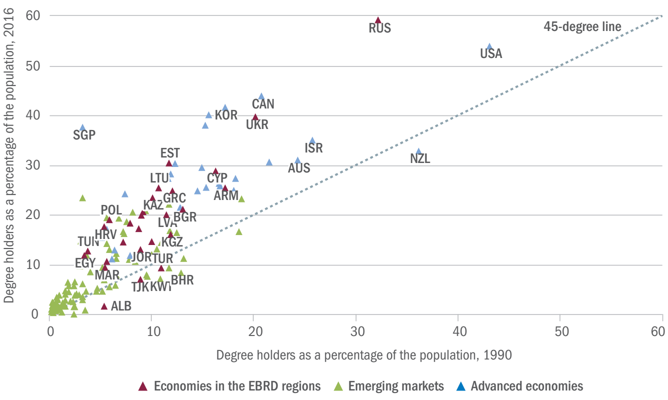
The supply of skills has also been evolving. Indeed, the percentage of workers with university degrees has continued to rise across the EBRD regions, with the exception of Albania, Tajikistan and Turkey (see Chart 2.4). Levels of educational attainment in the EBRD regions are relatively high. In Russia, for example, 59 per cent of adults have university degrees, compared with an average of 28 per cent in advanced economies. In Ukraine, the figure is 40 per cent; and in Estonia, it is 30 per cent. The average number of years of education in the EBRD regions exceeds the equivalent figure for advanced economies.

However, a large quantity of education does not automatically translate into a high-quality education. The quality of education can be measured using the OECD's PISA study, which tests the numeracy, science skills and analytical reading of 15-year-old students in OECD member countries and a number of emerging markets. Economies in the EBRD regions tend to perform fairly poorly in PISA studies relative to their large numbers of years of education (see Chart 2.5). Indeed, the EBRD economies that participated in the 2015 PISA study achieved an average score of 440 across all subjects, compared with an average of 496 in advanced economies.

Lack of ICT skills in the age of automation

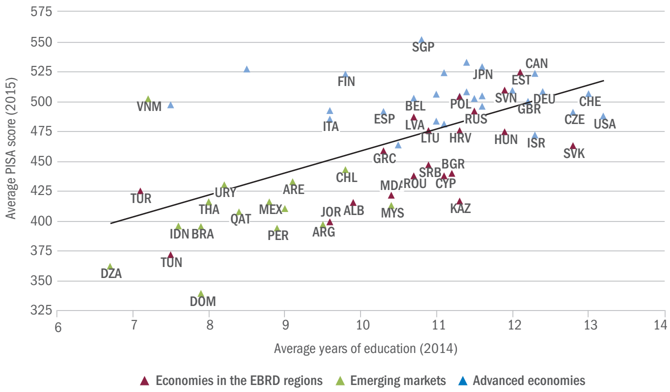
This gap between the quantity and quality of education is even more apparent if we look at information and communication technology (ICT) skills, which are becoming increasingly important in light of technological change. While economies in the EBRD regions generally performed strongly in the OECD's PIAAC surveys in 2011-14, which looked at adult skills (see Chapter 1), their performance was weaker when it came to advanced ICT and cognitive skills that were needed to solve technical problems and accomplish complex tasks (see Chart 2.6). The percentage of the population who are considered to have good ICT skills ranges from 10 per cent in Turkey to 33 per cent in Estonia. Box 2.3 looks at skills mismatches in the SEMED region, which was not covered by those PIAAC surveys.

CHART 2.4. Degree holders increased as a percentage of the population between 1990 and 2016



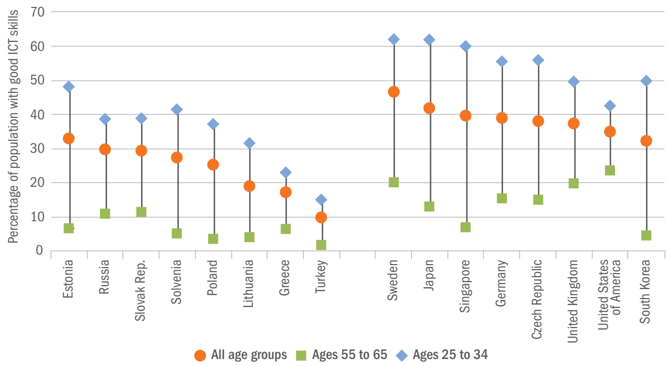
Source: Barro and Lee (2013) and authors' calculations.

CHART 2.5. The quantity and quality of education are correlated, but not very strongly



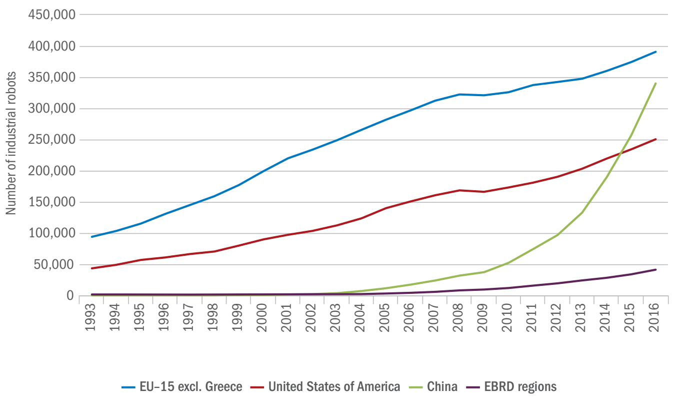
Source: OECD and Barro and Lee (2013).
Note: PISA scores for Argentina, Kazakhstan, Malaysia and Serbia relate to 2012.

CHART 2.6. Percentage of population with good ICT skills, by age group



Source: OECD and authors' calculations.
Note: "Good ICT skills" correspond to level 2 or 3 in the OECD's PIAAC tests.

CHART 2.7. The stock of industrial robots has been increasing around the world



Source: International Federation of Robotics (IFR) and authors' calculations.

How automation is reshaping labour markets

Technological innovations are quickly shifting the balance between activities performed by humans and tasks performed by machines. Indeed, recent research suggests that nearly 50 per cent of all jobs in the United States of America face a high risk of being automated in the foreseeable future.[6] In developing countries, the risk of automation may be even higher, with up to 70 per cent of jobs at risk.[7] In manufacturing, the percentage of jobs that are at risk of automation may be particularly high.

While technological change inevitably gives rise to anxieties, history suggests that although some jobs will be destroyed, others will be created. Indeed, such innovations can help to shift labour from sectors with low levels of productivity (such as agriculture) to higher-productivity sectors (primarily manufacturing and services). This section revisits the subject of automation, looking at the impact that technological change has had on employment in the EBRD regions.

Use of robots in the EBRD regions

A useful measure of the extent of automation is the total stock of operational industrial robots, which are defined by the International Organization for Standardization (ISO) as "automatically controlled, reprogrammable, multipurpose manipulators that are programmable in three or more axes".

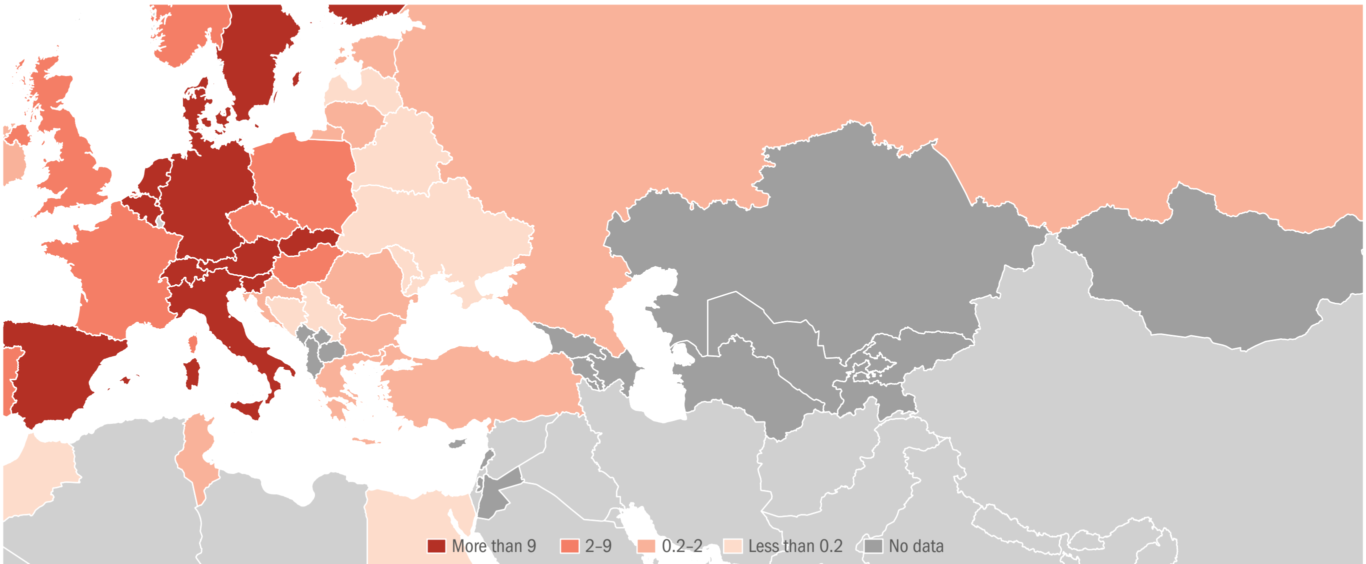
The number of industrial robots is on the rise around the world (see Chart 2.7), both in absolute terms and as a percentage of the number of workers employed. Indeed, the total global stock of industrial robots is projected to increase by 14 per cent a year, reaching 3 million by 2020.[8] The number of industrial robots in use in the EBRD regions stood at 41,000 in 2016, up from 1,500 in 1993 (on the basis of available data for 22 EBRD countries). The vast majority of robots are deployed in manufacturing (particularly in the automotive sectors), although they have also begun to be used more widely in the production of plastic, chemicals and metals.

THE EMPLOYMENT SHARE OF PROFESSIONALS INCREASED BY
4 PERCENTAGE POINTS
IN THE EBRD REGIONS BETWEEN 2006 AND 2016

THE EMPLOYMENT SHARE OF MANUFACTURING DECLINED BY MORE THAN
2 PERCENTAGE POINTS
IN THE EBRD REGIONS BETWEEN 2006 AND 2016

[6] See Frey and Osborne (2017).
[7] See World Bank (2016), Nedelkoska and Quintini (2018), Chiacchio et al. (2018) and Manyika et al. (2017).
[8] See IFR (2017).

CHART 2.8. Number of robots per 1,000 manufacturing workers



Source: IFR, ILO and authors' calculations.
Note: Data relate to 2016.

The extent to which robots are used in manufacturing varies greatly from country to country (see Chart 2.8). The levels seen in the Slovak Republic and Slovenia (where there are more than 93 robots for every 10,000 manufacturing workers) are comparable to those observed in advanced economies and higher than those seen in Brazil, China, India and South Africa. Hungary, Poland, Turkey and Romania have also seen rapid increases in the ratio of robots to manufacturing workers (see Chart 2.9). In contrast, Moldova, Morocco and Serbia have fewer than 2 robots for every 10,000 workers.

Differences across countries and sectors in terms of the use of robots are strongly linked to differences in FDI. Indeed, regression analysis (available on request) suggests that a 1 per cent increase in FDI in a given sector of a given country is associated with a 12 per cent increase in the use of industrial robots.

TABLE 2.1. The impact of robotisation on employment

Dependent variable	Change in employment rate, 2010-16			
	(1)	(2)	(3)	(4)
Increase in exposure to robots, 2010-16	-0.0077** (0.0037)	-0.0079** (0.0036)	-0.0075** (0.0035)	-0.0072** (0.0035)
Increase in ICT-intensity, 2010-16				-0.1653*** (0.0542)
Country dummies	No	No	Yes	Yes
Country-level controls	No	Yes	No	No
Number of observations	471	471	471	471

Source: Eurostat, IFR and authors' calculations.
Note: See Annex 2.4 for details of this instrumental variables (IV) estimation. Robust standard errors are reported in parentheses, and *, ** and *** denote values that are statistically significant at the 10, 5 and 1 per cent levels respectively.

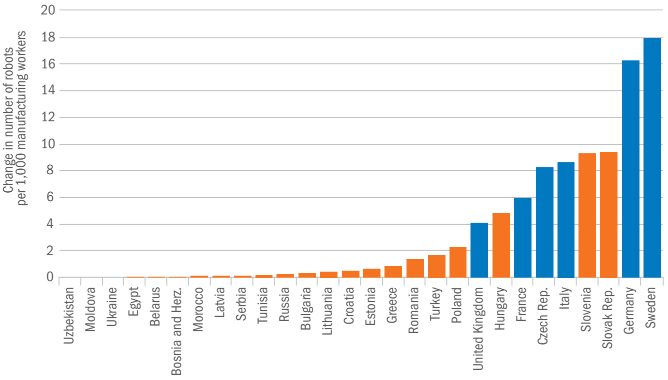
Impact of robots on employment

Automation affects employment in two different ways. In some instances, robots may directly replace workers. However, firms that experience increases in productivity as a result of automation may also increase their demand for labour where it is complementary to the use of robots. In the 11 EBRD economies included in analysis of this issue (see Annex 2.3 for a description of the relevant data), the average employment rate (defined as the percentage of the labour force that is in employment) declined by 1.5 percentage points between 2010 and 2016, while the average number of robots increased by 0.3 per 1,000 workers over the same period.

In order to assess the extent to which the decline in employment can be attributed to the increase in robotisation, regression analysis can be used to explain the causal relationship between the employment rate and the level of robotisation (see Annex 2.4 for a description of the methodology used). That analysis points to a substantial displacement effect: every additional robot per 1,000 workers reduces the employment rate by 0.7 percentage point (see column 4 of Table 2.1).

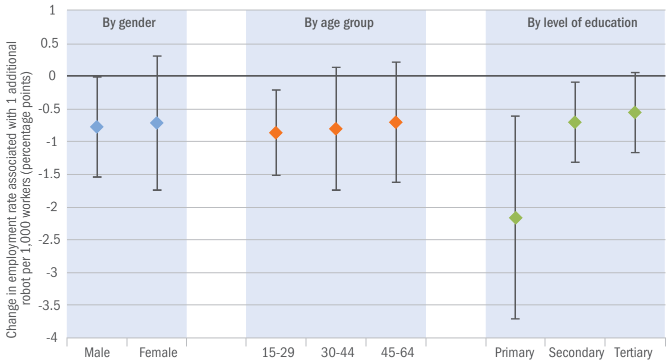
This suggests that robotisation can explain 13 per cent of the total decline that was seen in the employment rate between 2010 and 2016 in the 11 EBRD economies included in this analysis. Although it is not fully comparable owing to differences

CHART 2.9. Change in the number of robots per 1,000 manufacturing workers, 1993-2016



Source: IFR, ILO and authors' calculations.

CHART 2.10. Impact of robotisation by gender, age group and level of education



Source: Eurostat, IFR and authors' calculations.
Note: Based on regression analysis for individual demographic groups (see Annex 2.4 for details). Lines correspond to the 95 per cent confidence intervals associated with these estimates.

in the outcomes used and the time period covered, this estimated impact appears to be somewhat larger than the figures obtained for the United States of America and advanced European economies.[9] Increases in the ICT-intensity of production also have a statistically significant negative impact on the employment rate, but the effect of a 1 standard deviation increase in ICT-intensity is half the size of that of a 1 standard deviation increase in the use of robots.

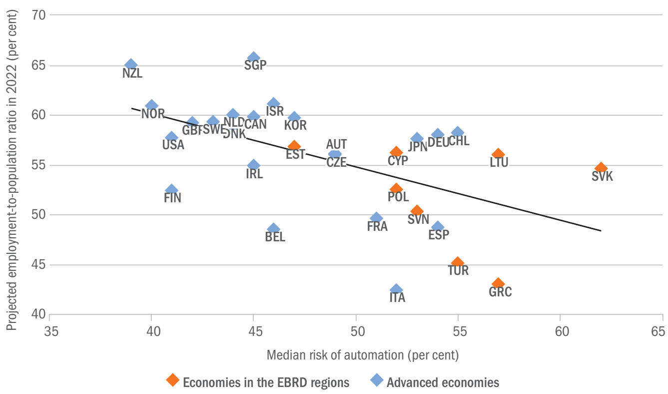
The effect of exposure to robots is strongest for people with low levels of education (see Chart 2.10). This may, however, change as technology evolves. There are no statistically significant differences between men and women or between younger and older workers in terms of the impact of robotisation.

Probability of jobs being automated varies across economies

The probability of a typical (median) job being automated in the near future varies from country to country (see Chart 2.11). A job is considered to be at risk of being automated if most of the tasks involved could be performed by state-of-the-art computer-controlled equipment based on the availability of big data needed to complete such tasks.[10]

In nearly all of the EBRD economies included in Chart 2.11, the probability of the median job being automated is higher than the OECD average of 48 per cent, with Estonia being the only exception. In the Slovak Republic, the median probability of automation is as high as 62 per cent. Meanwhile, a higher probability of automation is associated with a lower projected employment-to-population ratio in 2022.[11]

CHART 2.11. Median risk of automation and expected employment-to-population ratio

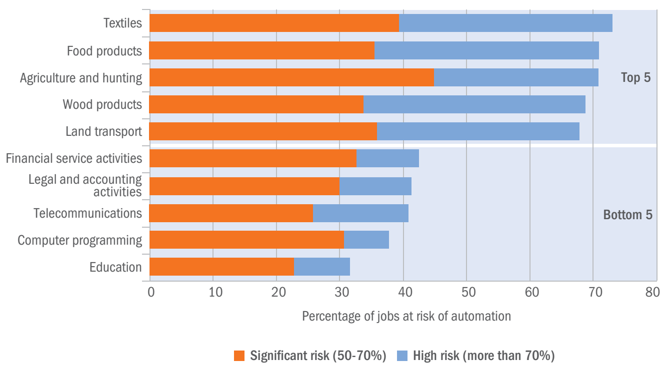


Source: ILO and authors' calculations based on Nedelkoska and Quintini (2018).

IN 2016, ABOUT
41,000
INDUSTRIAL ROBOTS
WERE IN USE IN THE EBRD REGIONS – UP FROM 1,500 IN 1993

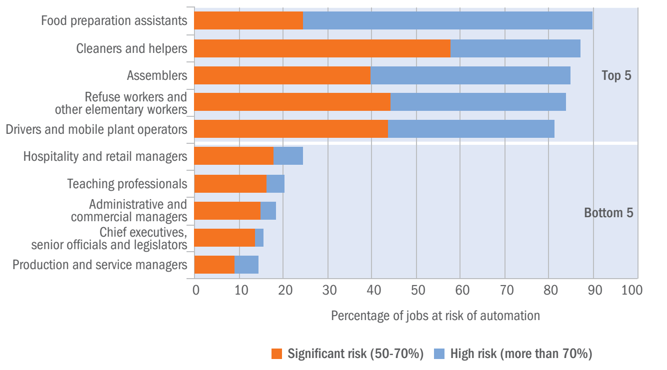
[9] See Acemoğlu and Restrepo (2017) and Chiacchio et al. (2018).
[10] See Frey and Osborne (2017).
[11] The employment-to-population ratio is defined as the percentage of a country's working-age population (rather than its labour force) that is in employment.

CHART 2.12. Industries expected to be most and least affected by automation in the EBRD regions



Source: Nedelkoska and Quintini (2018) and authors' calculations.
Note: Based on two-digit ISIC classification (rev. 4). Jobs are at high risk of automation if at least 70 per cent of the tasks involved are at risk of being automated. Jobs are at significant risk of automation if between 50 and 70 per cent of tasks are at risk of being automated. Estimates are simple averages across Cyprus, Estonia, Greece, Lithuania, Poland, the Slovak Republic, Slovenia and Turkey. Industries with fewer than 10 observations in four countries or more have been excluded.

CHART 2.13. Occupations expected to be most and least affected by automation in the EBRD regions



Source: Nedelkoska and Quintini (2018) and authors' calculations.
Note: Based on two-digit ISCO-08 classification. Jobs are at high risk of automation if at least 70 per cent of the tasks involved are at risk of being automated. Jobs are at significant risk of automation if between 50 and 70 per cent of tasks are at risk of being automated. Estimates are simple averages across Cyprus, Estonia, Greece, Lithuania, Poland, the Slovak Republic, Slovenia and Turkey. Occupations with fewer than 10 observations in four countries or more have been excluded.

Probability of automation also varies across industries

In the EBRD regions, jobs in textile manufacturing, agriculture, food processing, the manufacturing of wood products and land transport are expected to be most affected by automation (see Chart 2.12). At the other end of the scale, fewer than 43 per cent of all jobs in financial, legal and accounting services, telecommunications, computer programming and education are expected to be significantly affected by automation. More generally, automation is expected to affect primary-sector jobs most and services least.

Repeating this analysis at the level of individual occupations shows that food preparation assistants, cleaners and helpers, assemblers, refuse workers, drivers and mobile plant operators face the highest risk of automation (see Chart 2.13). Occupations that require significant analytical skills and high levels of social interaction (such as managers, professionals and senior officials) are among those least likely to be automated.

The impact of emigration on firms' performance and innovation

This section looks at the economic implications of the large-scale emigration that is being experienced by many economies where the EBRD invests. Its empirical analysis focuses on the experiences of EU member states in the EBRD regions, but its findings are applicable to other countries as well. For example, several economies in the EBRD regions are seeking EU membership, while others (such as Ukraine) are not involved in the accession process but are experiencing high rates of emigration among people of working age. For example, Poland issued nearly one million work permits to Ukrainian citizens between 2014 and 2017.

Labour market access for new EU member states

When the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, the Slovak Republic and Slovenia joined the EU in 2004, followed by Bulgaria and Romania in 2007, those new EU member states experienced significant increases in the numbers of workers emigrating to the EU-15 and the four European Free Trade Association (EFTA) countries (namely, Iceland, Liechtenstein, Norway and Switzerland). By 2014, when all restrictions on migration from those new member states had been lifted, the number of migrants who had travelled to those 19 countries stood at four million, compared with 900,000 in 2003 (see Annex 2.5 for more details).

Eurostat data indicate that around 40 per cent of migrants leaving countries that joined the EU in 2004 had medium-skilled or high-skilled occupations in their countries of origin. In the case of Bulgaria and Romania, the corresponding figure was 35 per cent.[12] Emigration can raise wages in countries of origin, increase incentives for young people to invest in education, and foster cross-border flows of trade, capital and ideas.[13] However, concerns are often raised about "brain drain" and its adverse impact on economic development, and it is noticeable that

[12] For the purposes of this analysis, ISCO codes 11-35 are regarded as high-skilled occupations, and ISCO codes 41-83 are regarded as medium-skilled occupations.
[13] See Dustmann et al. (2015), Elsner (2013), Mayr and Peri (2009), Felbermayr and Jung (2009), Kerr (2008) and Choudhury (2016).

many of the migrants leaving those new EU member states are highly skilled.[14]

Firms often complain that they cannot find skilled labour to replace employees who have emigrated. Indeed, the percentage of firms reporting that a lack of skills was a major constraint on their business rose from 12 per cent in 2005 to almost 30 per cent in 2008-09 in the new EU member states, according to the representative Business Environment and Enterprise Performance Survey (BEEPS) conducted by the EBRD and the World Bank. Consequently, some scholars have argued that emigration has the potential to hinder the economic development of those countries, given the record-high labour shortages that they have experienced.

The effects of emigration on firms' performance

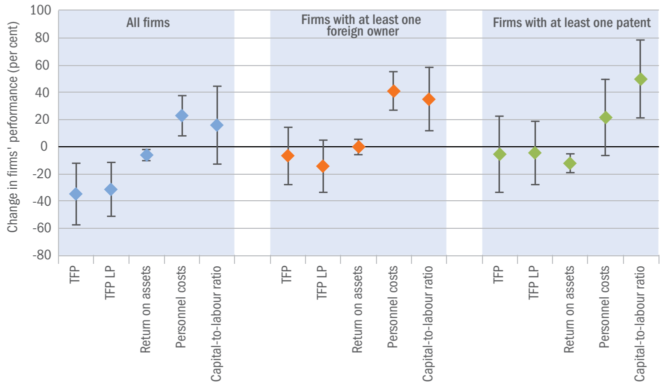
When emigration opportunities for economically active members of the population increase, firms in the countries of origin of potential migrants face more intense competition for labour. As a result, they may have to offer higher wages in order to retain or attract skilled employees. Alternatively, firms can make production more capital-intensive by replacing highly qualified labour with capital and less-skilled workers or choose a different product mix (see also Box 3.5 which discusses firms' responses to the opposite trend, namely an increase in low-skilled immigration). However, such adjustments are costly and may not be feasible for all firms. They may also have an impact on firms' TFP.

Emigration can affect firms' TFP via three main channels. First of all, firms that are unable to fill a vacancy promptly may be forced to leave capital equipment idle for extended periods of time. Second, a lack of skilled employees may reduce knowledge sharing, thereby slowing firms' accumulation of knowledge and hampering improvements in TFP. And third, when experienced employees leave a firm, specialist knowledge about production processes and relationships with suppliers and customers will be lost. Firms may also need to dedicate more resources to training newly hired employees. At the same time, higher rates of labour turnover may actually discourage firms from investing in training, further hampering productivity. On the other hand, an increase in labour market competition may incentivise firms to improve the quality of management and achieve higher levels of TFP.[15]

The emigration opportunities that were available to workers in those new EU member states post-accession varied by country of origin and sector, with the EU-15 and the four EFTA countries able to impose restrictions on such migrants for up to seven years. Those differences are captured by a labour mobility index ranging from 0 to 1, where higher values correspond to greater opportunities for emigration from a given country in a given year for workers in a specific sector (with 0 denoting a complete absence of freedom of movement for workers and 1 indicating full freedom of movement across the EU; see Annex 2.5 for details).

The regression analysis described in Annex 2.5 finds that increases in emigration opportunities had a negative impact on the TFP of firms in new member states (see Chart 2.14). Indeed, that analysis suggests that, on average, a maximum increase

CHART 2.14. The effect of increased emigration opportunities on the performance of firms in the new EU member states



Source: Amadeus and authors' calculations.
Note: See Annex 2.5 for details of this regression analysis. Lines show the 95 per cent confidence interval for each estimate. "TFP LP" is TFP as estimated in Levinsohn and Petrin (2003).

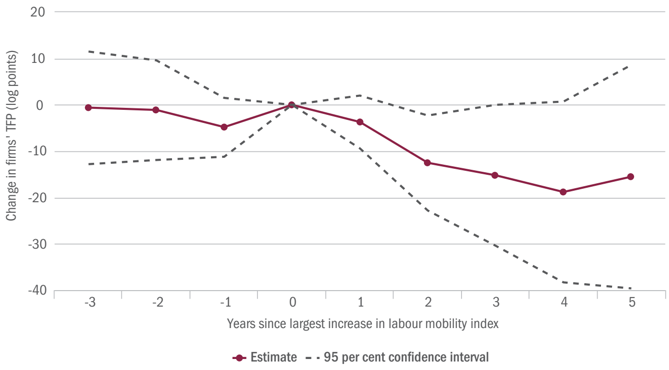
AGRICULTURE, MINING AND UTILITIES STILL ACCOUNT FOR MORE THAN **35%** OF TOTAL EMPLOYMENT IN AZERBAIJAN, MOLDOVA AND MONGOLIA

THE GLOBAL STOCK OF OPERATIONAL INDUSTRIAL ROBOTS IS PROJECTED TO REACH **3 MILLION** BY 2020

IN RUSSIA, **59%** OF ADULTS HAVE UNIVERSITY DEGREES

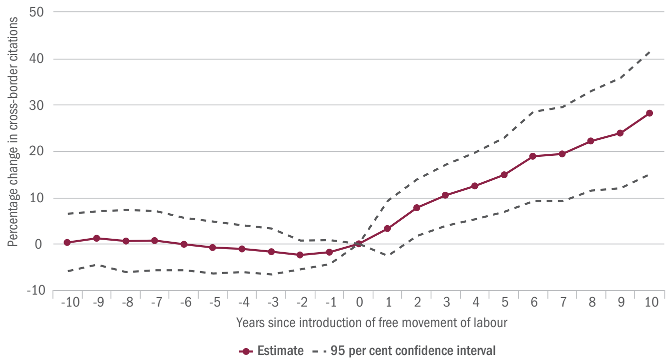
[14] See Batsaikhan et al. (2018).
[15] See, for instance, Bloom et al. (2015) for evidence of increases in TFP in response to more intense product market competition.

CHART 2.15. Evolution of the impact of increased emigration opportunities on the TFP of firms in the new EU member states



Source: Amadeus and authors' calculations.
Note: Estimated using the Levinsohn-Petrin procedure. See Annex 2.5 for details.

CHART 2.16. Increase in cross-border patent citations following the introduction of free movement of labour



Source: European Patent Office's Worldwide Patent Statistical Database (PATSTAT) and authors' calculations.
Note: See Annex 2.5 for details of this regression analysis.

in emigration opportunities for workers in a firm's country and sector (which corresponds, on average, to an increase of 0.25 in the labour mobility index) resulted in that firm's TFP one year later being around 7.5 percentage points lower than it would have been in the absence of emigration.[16]

The cumulative negative impact that emigration has on productivity increases for a number of years following the year with the largest increase in the labour mobility index (which is termed "year zero" in Chart 2.15). It is worth noting that, prior to year zero, firms subsequently exposed to increased emigration were no different from other firms in terms of their productivity trends.

Firms also adjust to increased emigration opportunities for current and potential future employees by increasing personnel costs (which include wages and other employee-related costs, such as hiring and training expenses). An annual increase of 0.25 in the labour mobility index will lead to a 5 per cent increase in personnel costs per employee (resulting in an average rise of €400 per worker per year; see Chart 2.14). The impact on the capital-to-labour ratio is also positive, but not statistically significant. These results are robust to the use of alternative measures of productivity, provided that the 1 per cent of firms that are most and least productive are excluded, firms established after 2002 are excluded and the sample is restricted to the period before the 2008-09 global financial crisis.

The impact on the TFP of firms with at least one foreign owner and firms with at least one patent is smaller and statistically insignificant (see Chart 2.14). This may be because these firms are able to spend significantly more on personnel. In addition, innovative firms (those holding patents) increase their capital-to-labour ratios to a significantly greater extent. Innovative firms may also be in a better position to offer their employees a stimulating working environment, as well as financial incentives conditional on innovations paying off. In the longer term, innovative firms may also benefit from inflows of knowledge facilitated by emigrants working abroad in advanced economies, as discussed in the next subsection.

The impact that emigration has on innovation

Emigration by skilled workers can potentially leave countries lacking the skills that are necessary to support innovation. However, emigrants often maintain close ties with their country of origin. Not only do they send remittances to family members, they also share acquired knowledge with former colleagues and employers, and the resulting cross-border knowledge flows have the potential to offset the negative impact on innovation.[17] In addition, migrants can also facilitate trade and FDI links. Moreover, migrants who return to their country of origin after a number of years abroad will bring with them any knowledge acquired abroad and may, in some cases, establish new firms. This may have a further indirect effect on innovation.[18]

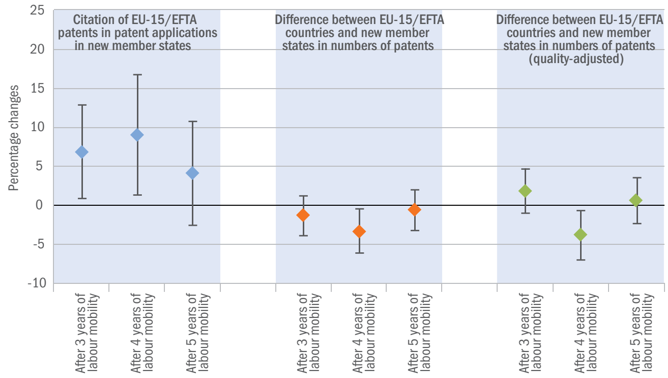
In order to see which of those two opposing effects of emigration dominates, the analysis below looks at links between emigration and the frequency with which patents filed in migrants' countries of origin cite patents filed by inventors in migrants' destination countries, with such cross-

[16] This figure is obtained by multiplying the estimated coefficient (0.316) by the average maximum increase in the labour mobility index per year (0.25).

[17] See Kerr (2008) and Choudhury (2016) for a discussion of cross-country knowledge flows.

[18] See Felbermayr and Jung (2009), Bahar and Rapoport (2018), Javorcik et al. (2011) and Saxenian (2006).

CHART 2.17. Cross-border patent citations and patenting asymmetries between new EU member states and EU-15 and EFTA countries



Source: PATSTAT and authors' calculations.
Note: See Annex 2.5 for details of this regression analysis. Lines show the 95 per cent confidence interval for each estimate.

13%

OF THE DECLINE OBSERVED IN EMPLOYMENT IN 11 EBRD ECONOMIES IN CENTRAL AND SOUTH-EASTERN EUROPE BETWEEN 2010 AND 2016 CAN BE ATTRIBUTED TO ROBOTISATION.

ABOUT

40%

OF ALL MIGRANTS WHO HAVE LEFT COUNTRIES THAT JOINED THE EU IN 2004 HAD HIGH OR MEDIUM-SKILLED OCCUPATIONS IN THEIR HOME COUNTRIES

border patent citations representing a useful measure of knowledge flows between countries. In addition, that analysis also looks at rates of convergence in terms of the numbers of patents that are filed by inventors in countries of origin and destination countries.

It is noticeable, for example, that the number of cross-border citations in patent applications increased significantly following the introduction of free movement of labour between new EU member states and the EU-15 and the four EFTA countries (see Chart 2.16).

Furthermore, Chart 2.17 shows that the frequency with which patents filed in new EU member states cite patents filed in EU-15 and EFTA countries increases three to four years after the introduction of free movement of labour. At the same time, only a small part of that increase is driven by direct communication between migrant inventors and their former colleagues. If we exclude citations where an inventor cites a patent filed by someone with whom he or she has already filed one or more patents, the estimated impact declines slightly, but remains statistically significant, pointing to the importance of broader spillover effects within individual industries.

Importantly, migration from new EU member states to advanced European economies is also associated with a subsequent convergence in the numbers of patents filed by the two groups of countries. On average, firms in advanced European economies file more than three times the number of patents filed by firms operating in the same industries in new member states. Patents filed in advanced economies are also cited more in other patents and can therefore be regarded as being of higher quality. Migration has, on average, contributed to a narrowing of this gap, both in terms of the total number of patents filed and in terms of quality-adjusted measures of patenting (see Chart 2.17). This analysis suggests, therefore, that migration from new EU member states to advanced European economies has, on balance, resulted in a strengthening, rather than a weakening, of innovation in migrants' countries of origin.

Conclusion

Over the last decade, many economies in the EBRD regions have experienced deindustrialisation and increased polarisation of jobs. The employment shares of the agriculture and manufacturing sectors have declined substantially, with professionals and service or sales workers now accounting for larger percentages of the labour force.

With a few exceptions, economies where the EBRD invests have tended to see improvements in educational attainment. At the same time, however, economies in the EBRD regions are lagging behind advanced comparators in terms of ICT-related skills, and the OECD's PISA tests point to wider challenges in terms of the quality – as opposed to the quantity – of education. Closing the gap in terms of ICT-related skills will help the regions' economies to leverage the benefits of future technological change while minimising the disruptive impact that digitalisation has on the labour market.[19] This may also help to leverage the full potential of online training courses and distance learning.

THE PERCENTAGE OF FIRMS CITING A LACK OF SKILLS AS A MAJOR CONSTRAINT ON THEIR OPERATIONS WAS ALMOST

30%

IN 2008-09, UP FROM

12%

IN 2005

A MAXIMUM INCREASE IN EMIGRATION OPPORTUNITIES FOR A FIRM'S WORKFORCE WILL RESULT IN ITS TFP A YEAR LATER BEING ABOUT

7.5 PERCENTAGE POINTS

LOWER THAN IT WOULD HAVE BEEN IN THE ABSENCE OF EMIGRATION

These economies have also seen profound technological change, as reflected in the rapidly rising numbers of industrial robots in operation. This increase in automation is estimated to account for 13 per cent of the total decline in employment in these economies. This effect is particularly pronounced among workers who are only educated to primary level. Policy responses to technological change need to do more to align the supply of skills with the demands of industry, as well as reducing barriers to education and increasing training opportunities for the most disadvantaged workers (as discussed in Chapter 1).

In many countries where the EBRD invests, skills shortages have been exacerbated by the emigration of skilled workers. The analysis in this chapter shows that the TFP of firms whose workers have had increased opportunities to emigrate following their countries' accession to the EU has been significantly lower than it would have been in the absence of emigration. On the other hand, foreign-owned and innovative firms have not experienced a negative impact on productivity, as they have been able to adjust to the changing environment by increasing personnel-related spending. Policies that support training and the upgrading of local skills, such as subsidies for training newly hired workers, can help firms to deal with increased employee turnover and minimise the adverse effects of emigration.

In the longer term, innovative firms in migrants' countries of origin benefit from larger inflows of knowledge on the back of higher levels of emigration. Indeed, an increase in knowledge transfers attributable to emigration has, over time, helped new EU member states to narrow the gap relative to advanced European economies in terms of numbers of patents and the quality of those patents. The positive impact that emigration has on innovation can be leveraged further by means of special programmes aimed at encouraging highly skilled emigrants to return to their country of origin. Conferences that put emigrants in contact with local inventors and firms can also help to increase cross-border knowledge flows.

[19] See OECD (2017).

BOX 2.1. Enabling women to work more productively

The lack of availability or declining quality of public services is a major concern in many countries. In many post-communist countries, women bear the brunt of inadequate public services, as responsibility for caring for children, the elderly and the disabled has shifted back from the state to individuals.[20] In other regions (for instance, in some SEMED economies), such services were never really part of countries' social infrastructure in the first place.

Unpaid care work by women is often regarded as a cost-free alternative to the provision of care services by the state or the private sector. Care work is broadly defined as activities involved in meeting the physical, psychological and emotional needs of children, the elderly and the disabled.[21] Unpaid care and domestic work comprises basic household activities (such as cooking, fetching water and cleaning), plus unremunerated direct care for family and community members.

In the EBRD regions, women spend, on average, 3 hours more per day on unpaid work than men. In SEMED economies, women spend more than 5 hours per day on unpaid work (almost 5.5 hours in the case of Tunisia). Consequently, women's total working hours (including both paid and unpaid work) far exceed men's. Effectively, women have less time to dedicate to paid work.

When women do enter the labour market, it is rare for their care-related responsibilities to be sufficiently redistributed. As a means of reconciling unpaid care work and paid employment, women may accept part-time, informal, home-based work, which may be less well-paid. Women also tend to reduce their hours of paid work with each additional child, and mothers are overrepresented in part-time jobs. Data from the 2010 Labour Force Survey, which was conducted in 27 EU countries, indicate that 36 per cent of women with children work part-time, compared with 21 per cent of women without children.[22]

Part-time work can help women to combine paid work with care-related responsibilities, but this comes at a cost. Mothers who work part-time are much less likely to have managerial or professional occupations and more likely to have elementary occupations or be employed in the service industry. The fact that women are overrepresented in certain sectors and occupations contributes to gender wage gaps that undervalue women's labour and inflate the numbers of working poor.[23] Globally, the gender pay gap is estimated at around 20 per cent, and it is higher for workers with childcare responsibilities.[24]

Better public care services will allow more women to enter the labour force or increase the number of hours they work. This, in turn, will have a positive effect on economic growth through increased consumption in two-earner households, as well as through job creation in the care sector. Two studies in Australia have found that if the price of childcare is reduced by 50 per cent, labour supplied by young mothers rises by between 6.5 and 10 per cent.[25] Similarly, an increase in the subsidised provision of childcare, including public pre-primary school facilities, has been shown to have a positive and statistically significant impact on mothers' labour supply in Canada and Argentina.[26] In the same vein, a programme that increased free public childcare facilities in low-income neighbourhoods of Rio de Janeiro resulted in use of care increasing from 51 to 94 per cent, maternal employment rising from 36 to 46 per cent and employment rates almost doubling among mothers who did not work before giving birth.[27] Moreover, ILO analysis indicates that countries which invest more in care enjoy labour force participation rates of 70 per cent or more among women – significantly higher than the global average of 55 per cent.[28]

If women withdrew from unpaid care work, there would be a significant impact on both the labour market and GDP through the hiring of new care workers and through the new jobs performed by women (who had previously performed such tasks free of charge within their households). One way of estimating that impact is to calculate the number of hours that men and women in each age group spend on unpaid work each year and multiply that figure by an hourly wage rate that is assumed to be equal for men and women.

When estimated in this way, the size of the care economy ranges from 32 per cent of GDP in Bulgaria to 47 per cent of GDP in the Kyrgyz Republic. The care economy tends to be smaller where the labour force participation rate of women is higher, as women who stay at home tend to devote more time to care work. Thus, estimates of GDP would be substantially higher if the care economy was fully accounted for.

Recognising and valuing unpaid care work is central to addressing gender gaps in the labour market and closing the gender wage gap.

IN THE EBRD REGIONS, WOMEN SPEND, ON AVERAGE,

3

HOURS MORE PER DAY ON UNPAID WORK THAN MEN

THE SIZE OF THE CARE ECONOMY RANGES FROM

32%

OF GDP IN BULGARIA TO

47%

OF GDP IN THE KYRGYZ REPUBLIC

[20] See UNICEF (1999).
[21] See ILO (2018a).
[22] See Mills et al. (2014).
[23] See UN Women (2015) and ILO (2016).
[24] See Grimshaw and Rubery (2015), Flynn and Harris (2015) and Costa Dias et al. (2016).
[25] See Kalb (2009) and Gong et al. (2010).
[26] See Baker et al. (2008) and Berlinski and Galiani (2007).
[27] See Barros et al. (2011).
[28] See ILO (2018b).

BOX 2.2. Projected labour market changes in the EBRD regions

There are many uncertainties in the world of work when it comes to the future of jobs and employment relationships. For example, there are concerns that employment conditions may deteriorate with the rise of the platform economy (economic activity that is made possible by new technological platforms). Similarly, the reallocation of labour across economic sectors – an intrinsic element of structural transformation – is also a cause of significant uncertainty.

This box analyses expected changes in employment relationships and working conditions across the EBRD regions over the period 2017-25, looking at aggregate sectors on the basis of the methodology developed in ILO (2018b).

Most economies in the EBRD regions are expected to experience substantial declines in the percentage of people working in the agricultural sector, with that sector's employment share falling by between 0.7 and 4 percentage points. That shift out of agriculture is expected to be somewhat less pronounced in central Europe and the Baltic states (CEB), as well as in Russia. In high-income comparator countries (the Czech Republic, France, Germany, Italy, Sweden and the United Kingdom), that shift is expected to be more limited (totalling 0.2 percentage points on average), reflecting the fact that advanced economies already have small agricultural sectors.

Unlike in the past, the structural shift away from agriculture is not expected to be accompanied by rising employment in manufacturing. Instead, employment in market services (such as wholesale and retail trade, transport and financial activities) is projected to increase further. Within market services, real estate and business and administration are projected to generate the most employment in the near future, followed by transport, storage and telecommunications, as well as restaurants and accommodation. The employment share of non-market services (such as public administration, education and healthcare) is also expected to rise, particularly in EU member states.

Changes in working conditions owing to employment shifts across industries

Employment conditions can vary significantly across sectors and industries within a given country. ILO (2018b) presents a comprehensive analysis of the impact that employment shifts across sectors have on working conditions at the global level using a partial shift-share analysis. This methodology takes account of the impact that inter-sector changes have on working conditions, but takes no account of the impact of intra-sector changes.

At the level of the EBRD regions, a significant decline is expected in the incidence of vulnerable employment (defined as self-employment and contributing to domestic work), which will, among other things, reduce the probability of requiring social protection (see Chart 2.2.1). As such working conditions are prevalent in agriculture, the decline in that sector's employment share across the EBRD regions will translate into an overall reduction in the incidence of vulnerable employment. The total percentage of employment across these economies that is regarded as vulnerable is expected to fall by around 1 percentage point to stand at 19 per cent.

CHART 2.2.1. Impact of sectoral shifts on vulnerable employment, 2017-25

Source: ILO.
Note: These estimates are based on shift-share analysis, as described in ILO (2018b).

Structural shifts are expected to have a similar – albeit smaller – impact on the prevalence of part-time employment, temporary employment and time-related underemployment (where workers put in fewer hours than a specified threshold and would be willing to work additional hours). At the same time, the incidence of part-time employment and time-related underemployment could rise slightly in the CEB region, owing to the projected decline in the employment share of manufacturing – a sector typically characterised by full-time jobs with relatively stable hours – in those countries.

BOX 2.3. Skills mismatches in the SEMED region

Skills mismatches – discrepancies between the supply of and demand for skills – remain an important bottleneck when it comes to economic development in the SEMED region, curtailing economic opportunities for employers and employees alike. Employers have to spend more on on-the-job training and endure lengthy recruitment campaigns, while workers have fewer employment opportunities. Many workers languish in jobs that they are overqualified for or take on duties that they are ill-prepared for, with negative implications for the aggregate productivity of the region's economies.

This problem is most acute among young people. Indeed, according to ILO data, more than a quarter of all people between the ages of 15 and 24 in the SEMED region are not in employment, education or training. Moreover, people educated to tertiary level account for 31 per cent of youth unemployment in Egypt and the West Bank and Gaza, and as much as 37 per cent in Tunisia, based on the latest available data from the ILO. Young women in SEMED economies tend to study for longer and gain higher qualifications than their male counterparts, but their employment outcomes tend to be much worse, especially when it comes to competing for private-sector jobs. Unsurprisingly, many young women end up leaving the labour market prematurely and forgoing further training.

The SEMED economies are among the most youthful in the EBRD regions, but they are also some of the economies that are struggling most to equip their populations with the right skills (as discussed in Chapter 1).

There are three different factors perpetuating skills mismatches in the SEMED region. First of all, shortcomings in primary and secondary education are ultimately resulting in demand for skills remaining unmet. Though levels of enrolment in compulsory education are high, approaching 100 per cent in some economies, teaching continues to rely excessively on passive engagement and rote learning. Outdated classroom resources are also obstacles to effective learning. Some pupils get by with the aid of costly after-school tuition, while others disengage altogether but remain technically enrolled on paper.

As a result, a considerable number of secondary school leavers fail to gain even a rudimentary understanding of key subject areas. Secondary school pupils in Jordan, Lebanon and Tunisia were among the worst performers in the OECD's 2015 PISA tests, which assessed the skills of 15-year-olds in 73 different economies. Across those three economies, between 60 and 75 per cent of pupils were classified as low achievers in mathematics; 46 to 72 per cent were regarded as low achievers in reading; and between 50 and 66 per cent of pupils were classed as low achievers in science. Furthermore, employers in Egypt, Morocco and Tunisia are among the least satisfied in the world with the quality of their countries' basic education, according to the World Economic Forum's Global Competitiveness Index 2017-2018.

Second, vocational education and training does not respond to employers' needs. In some cases, employers lack the initiative required to properly communicate their needs. And in other cases, providers of training may be too small to establish mutually beneficial partnerships with the business community. Whatever the cause, such dissonance is hindering improvements in the relevance and quality of training.

With EBRD support, sector skills councils (SSCs), such as the SSC for hospitality and tourism in Jordan, are now bringing together business leaders, education providers and policymakers. SSCs seek to improve vocational training at sector level by helping to establish feedback mechanisms between employers and training providers and ensuring that business needs are adequately reflected in sector-level qualifications frameworks.

More broadly, new opportunities for dual learning – whereby technical and vocational programmes combine traditional classroom-based learning with accredited experience in a business setting – represent promising developments. Dual learning enables businesses and education providers to work together to ensure that learning outcomes meet the industry's expectations. Such schemes enable learners to gain practical experience and develop business contacts.

Third, institutions such as national qualifications frameworks and labour market information systems are often underdeveloped or simply missing. Such institutions help to benchmark employers' needs against workers' skills and training outcomes. They also facilitate the forecasting of skill-related needs in the light of technological change. In the absence of such frameworks, potential labour market entrants lack clarity about demand for skills, which makes it harder to make informed decisions about education and training. The establishment of national qualifications frameworks and labour market information systems underpinned by coordinated private-sector involvement could go a long way towards addressing the issue of skills mismatches.

Annex 2.1.
Best practices for regulating crowdfunding

Introduction
This section of the *Transition Report 2018-19* examines best practices for regulating investment-based and lending-based crowdfunding.

Lending-based crowdfunding is a form of crowdfunding whereby money is lent to individuals or businesses with a view to achieving a financial return in the form of interest payments and the repayment of capital over time.

In the case of investment-based crowdfunding, money is invested in unlisted shares or debt securities issued by businesses.

In 2018, the EBRD's Legal Transition team conducted a study analysing the regulatory frameworks governing lending-based and investment-based crowdfunding platforms in Austria, the Dubai International Financial Centre (DIFC), France, Germany, the United Kingdom and the United States of America.

That group of jurisdictions offers a considerable degree of variety in terms of geographical location, market maturity and the approach to regulating crowdfunding. The UK and the USA are world leaders in this area, with effective regulatory regimes underpinning highly developed markets, while Austria, France and Germany (as civil law jurisdictions) and the DIFC are, in the EBRD's experience, regarded as key points of reference for the EBRD regions and provide a different perspective on the various issues.

That EBRD study looked at (i) the types of authorisation that are required in order to operate crowdfunding platforms, (ii) capital and liquidity requirements, (iii) know-your-customer (KYC) and anti-money-laundering checks, (iv) restrictions on the size of loans and investable amounts, (v) consumer protection measures (including disclosures to investors), (vi) warnings regarding risks, and (vii) due diligence and pre-funding checks. The study culminated in a report published on 24 October 2018,[29] which made recommendations regarding best practices for the regulation of lending-based and investment-based crowdfunding platforms.

Several economies in the EU and in the EBRD regions have adopted (or are in the process of adopting) bespoke crowdfunding legislation, tailoring their regulatory frameworks to the needs of local markets. There is no consensus, however, as to what constitutes best practice in terms of the regulation of crowdfunding.

The EBRD's study helps to fill this gap, providing guidance on best practice in this area, and is applicable not only in the EBRD regions, but also in other countries around the world.

Crowdfunding as a means of accessing finance
In the past few years, disruptive innovation has thrived and flourished in the financial services sector. Financial technology – "fintech" for short – is changing finance in many different ways. This disruption is posing a challenge to existing financial sector actors, but it is also creating opportunities – both for existing actors and for new entrants. By establishing an online market place where investors can be paired with investees, investment-based crowdfunding is increasing the level of competition in capital markets. Similarly, lending-based crowdfunding is boosting competition in respect of retail financial services by bringing lenders and borrowers together.

Besides providing an alternative source of financing, crowdfunding also offers a number of other benefits (see Table A.2.1.1 for an overview). It can, for example, help to attract other sources of funding, such as "business angels" or venture capital, with a recent study reporting that 45 per cent of angel investment in the UK takes place alongside crowdfunding investment.[30] Indeed, the presence of crowdfunding investment can help to validate the concept and finances of a novel project. It can also provide access to a large number of interested individuals, giving the entrepreneur valuable insights and information. And if a crowdfunding campaign is successful, it can act as a useful marketing tool. There is also evidence that crowdfunding may help women entrepreneurs to obtain investment funding from other women, in situations where women tend to find it difficult to secure financing for their entrepreneurial endeavours.[31]

Risks associated with crowdfunding
As with all investment, crowdfunding entails a number of risks, including project and liquidity risks, the risk of cyberattacks and the risk of platform failures. The lack of experience and expertise among potential investors is a major concern, particularly given the limited mandatory screening of borrowers in some jurisdictions (including the USA).

Other concerns relate to the reliability of investment, the lack of regulation and the existence of differing regulatory regimes for retail investors and SMEs. At the same time, if appropriate safeguards are put in place in order to protect investors, crowdfunding has the potential to act as an important source of non-bank financing, helping to support job creation, economic growth and competitiveness.

Findings of the EBRD's study
The question of what constitutes best practice as regards the regulatory framework governing crowdfunding platforms in a specific jurisdiction must necessarily take account of, and be informed by, the broader context in that particular jurisdiction. As a result, there is no one-size-fits-all approach when it comes to regulating platforms. That being said, the EBRD's study succeeded in identifying certain aspects of regulatory frameworks which appear to represent best practice and would probably prove beneficial in the vast majority of jurisdictions (as well as a number of optional additional measures, which could also be deployed depending on the context).

[29] See EBRD (2018).

[30] See Wright et al. (2015).
[31] See Greenberg and Mollick (2017).

TABLE A.2.1.1. Benefits of crowdfunding

Benefits for those seeking capital	Benefits for those providing capital	Broader benefits for entrepreneurs	Benefits for the economy or society
• Ability to obtain capital in an accessible and competitive market place • Ability, in most cases, to raise capital without giving up large amounts of equity in return • Alternative to venture and seed capital (particularly where access to the latter is limited) • Reduced cost of capital • Quicker access to capital, with less friction	• Higher returns relative to other lending and investment opportunities • Risk-spreading mechanisms (not only in terms of the impact of a single defaulting borrower or investee on multiple lenders or investors, but also in terms of lenders or investors having a range of potential borrowers or investees to fund) • Investable asset class for alternative credit providers (such as funds and other investors)	• Alternative way of obtaining proof of concept and validation of ideas • Diverse market for other sources of funding • Access to broad range of insights and information • Potential to use crowdfunding as a marketing tool	• Supports economic activity, particularly in relation to SMEs • Resilient source of funding in a downturn, when access to conventional sources of finance is more limited[32] • Greater competition in respect of retail financial services • Possible social impact of increased female representation

Source: EBRD.

The main conclusions of the EBRD's analysis were as follows:

- Where platforms' activities are aligned with other regulated activities, it may be possible to regulate crowdfunding by adapting an existing framework. However, a truly bespoke regime may be more appropriate.
- Imposing minimum capital requirements on platforms can help to ensure that operational and compliance costs continue to be covered in the event of financial distress. Capital requirements should be based on the nature and scale of the activities undertaken by the relevant platform and should be commensurate with the attendant risk.
- Platforms should be required to establish and maintain risk management systems and controls that can identify, track, report, manage and mitigate risks to their business (including operational risk, risks relating to cybersecurity and the protection of personal data, and the risk that the platform could be used to commit financial crimes).
- Platforms need to ensure that their senior management and employees are "fit and proper persons" to perform their roles. Platforms need to be able to assess this themselves.
- Platforms should have primary responsibility for identifying, reporting, managing and mitigating any conflicts of interest.
- The financial services regulator should, where appropriate, have the power to prevent platforms from investing in the projects they feature.
- Platforms should be subject to specific disclosure requirements, in order to ensure that investors and investees understand how platforms operate and earn revenue.
- Disclosures to investors and warnings regarding risks need to be tailored to the relevant product offered by the platform.
- There may be good reasons to differentiate between retail investors and institutional investors when it comes to providing information. Retail investors may benefit from receiving risk warnings and disclosures that are more explicit than those provided to institutional investors.
- A regime which differentiates between different types of investor is preferable to one that requires detailed suitability checks for all investors. Financial services regulators are best placed to decide on appropriate categories of investor.
- Platforms should be required to enter into agreements with their clients governing all key aspects of the client-platform relationship.
- Platforms should be permitted – but not necessarily obliged – to offer automated tools supporting the diversification of investors' portfolios.
- It is appropriate for lending-based platforms to provide information to investors on their post-investment arrangements and arrangement rights, whether that involves a trustee-type arrangement or a different type of enforcement mechanism.
- Platforms should be required to carry out KYC checks on their clients. The extent of those checks may vary on the basis of a risk assessment performed by the platform. Financial services regulators are best placed to provide platforms with guidance in this regard, which should be in keeping with the KYC requirements of the relevant jurisdiction. Such guidance should also be commensurate with the risk posed by clients.

The recommendations set out above cover just some of the best practices identified by the study, which the EBRD believes would be beneficial in the vast majority of jurisdictions. For a full list of those best practices, as well as details of the optional additional measures identified, see EBRD (2018).

Conclusion

The EBRD hopes that these recommendations will help regulators in the EBRD regions to establish effective regulations governing crowdfunding platforms – which will, in turn, give greater legitimacy to those platforms, while ensuring that investors are adequately protected.

Indeed, the EBRD's Legal Transition team is already assisting the Capital Markets Board of Turkey and the Astana International Financial Centre in Kazakhstan with the establishment of new crowdfunding regulations, in line with the best practices identified by the study. With various other countries expressing an interest in fostering the development of crowdfunding (and fintech more broadly), similar work is expected to be carried out in other jurisdictions across the EBRD regions in due course.

[32] See Kirby and Worner (2014).

Annex 2.2.
Job polarisation and macroeconomic indicators

TABLE A.2.2.1 Pair-wise correlations between job polarisation and macroeconomic indicators

	Job polarisation	Log of increase in robot density (2006-16)	Trade openness (2014)	Employment share of primary sector (2016)	Human Capital Index (2014)	Log of GDP per capita (2016)
Job polarisation	1					
Log of increase in robot density (2006-16)	-0.41*** -0.34	1				
Trade openness (2014)	-0.28** -0.15	-0.32** 0.51**	1			
Employment share of primary sector (2016)	0.58*** 0.76***	-0.46*** -0.66***	-0.27*** -0.51***	1		
Human Capital Index (2014)	-0.20* 0.02	0.56*** 0.41*	0.25*** 0.50***	-0.75*** -0.39**	1	
Log of GDP per capita (2016)	-0.34*** -0.61**	0.15 0.84***	0.45*** 0.38**	-0.65*** -0.73***	0.58*** 0.34*	1

Source: ILO, IFR, Penn World Tables, IMF and authors' calculations.
Note: Based on 155 economies. *, ** and *** denote values that are statistically significant at the 10, 5 and 1 per cent levels respectively. "Job polarisation" is the change in the employment share of medium-skilled occupations over the period 2006-16 in percentage points. "Trade openness" is the sum of exports and imports as a percentage of GDP. In each case, the top value relates to the global sample and the bottom value relates to the economies of the EBRD regions.

Annex 2.3.
Data on the use of robots, employment and ICT

Use of robots and employment
Data on the stock of industrial robots by industry, country and year come from the IFR and are based on annual surveys of robot suppliers. This dataset covers 22 economies in the EBRD regions and relates to the period 1993-2016. Dedicated industrial robots that are designed to perform a single task are not included in the dataset.

Data are also taken from the micro-level harmonised Labour Force Survey conducted by Eurostat, which covers 11 countries where the EBRD invests (Bulgaria, Croatia, Estonia, Greece, Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic and Slovenia). Using those surveys, the outcome variable (the employment rate) can be constructed for specific demographic groups by aggregating individual responses by age, level of education, gender or industry (whereby socio-economic groups with fewer than five observations are disregarded).[33]

ICT-intensity
In line with Marcolin et al. (2016), the ICT-intensity of an industry is defined as the percentage of employees in that industry who have ICT-related occupations, on the basis of the pan-EU Labour Force Survey. ICT-related occupations include computing professionals and associate professionals (for instance, computer system designers and industrial robot controllers), plus electrical and electronic equipment mechanics and fitters. Data on total populations and working-age populations are taken from the World Bank's World Development Indicators database. Exposure to Chinese imports is calculated as the change in Chinese imports between 2010 and 2016 using bilateral trade flow data from UN Comtrade.

Firms' performance
Firm-level panel data for the period 2000-14 come from Bureau Van Dijk's Amadeus dataset. This annual dataset covers all industries and provides information on firms' size, sales, profits, employment costs, materials, assets, ownership structures and patents. These data are used to estimate TFP.

[33] See Chiacchio et al. (2018) for a similar approach.

WITH MORE THAN
9.3
ROBOTS
FOR EVERY 1,000 WORKERS, THE SLOVAK REPUBLIC AND SLOVENIA HAVE THE HIGHEST LEVELS OF ROBOT DENSITY IN THE EBRD REGIONS

EACH ADDITIONAL ROBOT PER 1,000 WORKERS REDUCES THE EMPLOYMENT RATE BY
0.7
PERCENTAGE POINT

Innovation

Data on innovation come from the autumn 2014 edition of the European Patent Office's Worldwide Patent Statistical Database (PATSTAT) and cover 32 European countries. They include information on the location of the inventors and applicants for each patent. The number of patent applications in a given country serves as a measure of innovation, while the number of cross-border citations serves as a measure of knowledge flows.

The number of patent applications is aggregated by country, industry and year. The number of patent citations is aggregated by patenting country (the country of origin), cited country (the destination country), industry and year. If a patent has several international collaborators, it is assigned to the various countries in proportion to the number of inventors from each country. The sample covers the period 2000-14.

Other variables

Data on industry-level output, investment and employment, as well as bilateral industry-specific FDI flows, come from Eurostat. Measures of countries' proximity to each other and data on bilateral trade flows are taken from the CEPII database. Country-level variables such as GDP and FDI come from the World Bank.

Annex 2.4. Estimating the impact that robotisation has on employment

The following IV specification is estimated in order to establish the causal relationship between robotisation and the employment rate (defined as the percentage of the labour force that is in employment) across various industries and countries:

$$\Delta EmploymentRate_{cigae,2010-2016} = \beta_0 + \beta_1 \Delta IV(Exposure\ to\ Robots)_{ci,2010-2016} + \beta_2 \Delta ICT_{ci,2010-2016} + \gamma_c + \varepsilon_{ci}$$

The dependent variable is the change in the employment rate between 2010 and 2016, calculated separately for each gender *(g)*, age group *(a)* and level of educational attainment *(e)* in country *c* and industry *i*.

$$\Delta(Exposure\ to\ Robots)_{ci,2010-2016}$$

is the change in the number of robots deployed per 1,000 workers in country *c* and industry *i* between 2010 and 2016. Total employment in country *c* and industry *i* in 2009 is used as the denominator for robot density ratios to ensure that those ratios do not capture robot-induced changes in employment in the sample period.[34] Country dummies γ_c control for all time-invariant country characteristics. $\Delta ICT_{ci,2010-2016}$ (the change in the percentage of employees with ICT-related occupations within each industry in a given country between 2010 and 2016) measures exposure to ICT.

The time period chosen, 2010-16, focuses the analysis on medium-term trends. Various fixed effects absorb trends that are common across particular countries, industries and demographic groups. Robust standard errors are two-way clustered at the country-industry level. All regressions are weighted by the baseline industry employment structure in each country to account for differences in the relative importance of industries.[35] Some specifications also include the total population, the share of the working-age population and exposure to Chinese imports.

There remains a concern that certain unobserved trends may affect both robotisation and employment in the absence of a causal relationship between the two. Causality could also run in the opposite direction, with changes in the employment rate affecting robotisation. In order to address such concerns, this analysis follows the example of Acemoğlu and Restrepo (2017) in using two-stage least squares (2SLS) with IV. The instrument,

$$\Delta IV(Exposure\ to\ Robots)_{ci,2010-2016}$$

captures changes in the use of robots across various sectors in 11 comparator economies outside the EBRD regions. Such changes capture trends in robotisation, but are not influenced by changes in employment in the EBRD regions.

[34] See Acemoğlu and Restrepo (2017) and Chiacchio et al. (2018).
[35] See Graetz and Michaels (2018).

Annex 2.5.
Estimating the impact that the emigration of skilled workers has on firms

This annex looks at the empirical strategy that is used to establish the causal impact which emigration has on firms' performance. Baseline estimations represent regressions of firm-level outcomes (TFP, personnel costs and capital-to-labour ratios) on the labour mobility index.

Institutional background to labour mobility

A total of 10 countries (including eight in central Europe) joined the EU in 2004, and Bulgaria and Romania followed suit in 2007. The existing EU member states (the EU-15) and the four EFTA countries (Iceland, Liechtenstein, Norway and Switzerland) were able to restrict the free movement of labour from those new EU member states for up to seven years. Countries exercised this right to varying degrees. For example, the United Kingdom completely opened up its labour market to the 10 countries that acceded to the EU in 2004. In contrast, France kept transitional provisions in place until 2008, limiting free movement of labour to construction, tourism and catering. The United Kingdom then restricted migration from Bulgaria and Romania for the full seven years (that is to say, until 2014). At the other end of the spectrum, Germany restricted migration from all new EU member states for the full seven years.

Indicator of labour mobility

The differences between new EU member states' access to the labour markets of advanced European economies are captured by a set of dummy variables D_{odit}, which are defined for each new member state *(o)*, industry *(i)*, potential destination country *(d)* and year *(t)*. The indicator takes a value of 1 if legislation in the destination country opened that specific industry up to migration from the new member state in question; otherwise, it has a value of 0.

Those legislation-based dummy variables are, in turn, multiplied by a measure of labour shortages in a given industry in a destination country. This measure captures the percentage of firms that are constrained by the unavailability of labour according to a European Commission business survey.

The resulting variable captures not only legislative barriers to migration, but also implicit industry-specific demand for migrants in destination countries. The weighted average of these variables can be used to measure exposure to emigration for each industry in a given country of origin. The weights applied to potential destination countries are based on the distance between the largest cities in the two countries in question. For instance, firms in Estonia are more likely to be exposed to emigration when Finland's labour market opens up, rather than when restrictions are lifted in Malta.

$$FL\,M_{cit} = \sum_{d=1}^{19} = w_{do} D_{odit}$$

In this instance, variation in the rules governing labour market access was driven mainly by the political landscapes in the various destination countries and is unlikely to have been related to the performance of firms in the countries of origin of potential migrants.[36] It can therefore be used to establish the causal impact that emigration had on firms' performance.

The resulting labour mobility index (FLM) is standardised such that it ranges from 0 to 1 and can be used as follows in reduced-form regressions capturing the intention-to-treat effect:

$$Y_{fict} = \beta_1 FLM_{ict-1} + \gamma_1 a_{ft} + \gamma_2 I_{ict-1} + \gamma_3 J_{it} + \gamma_4 C_{ct} + \tau_t + \nu_f + \epsilon_{ft}$$

Dependent variables are measures of firms' performance. Control variables include the age of the firm (a_{ft}), as well as industry-specific variables (I_{ict-1}) such as total investment and average mark-up (the ratio of revenues to costs) which reflect common trends in terms of competition or demand for labour that may affect firms' performance. J_{it} are industry-specific controls measured at the aggregate EU level. These include total sales and labour shortages. Country-level controls C_{ct} include an EU membership dummy, GDP and FDI inflows. Specifications include firm and time fixed effects. Standard errors are clustered at the country-industry level (two-digit NACE[37] level).

Firm-level TFP is calculated using a TFP index, as in Gorodnichenko and Schnitzer (2013), or using a semi-parametric approach in line with Levinsohn and Petrin (2003). The latter method accounts for the fact that unobserved productivity shocks may affect firms' inputs and performance at the same time. The return on assets (the ratio of earnings before interest and tax to total sales) is used as an alternative measure of productivity.

Impact on knowledge flows

The following empirical model estimates the effect that emigration has on knowledge flows between destination country d and country of origin o in industry i in year t:

$$Y_{odit} = \beta_1 FLM_{odit-l} + \gamma_1 I_{odit-l} + \gamma_2 P_{oit} + \gamma_3 P_{dit-3} + \gamma_4 J_{it} + \gamma_5 C_{odt} + \tau_t + \nu_{odi} + \epsilon_{odit}$$

The outcome of interest is the log of the number of times that patents in destination countries are cited in patents filed by inventors from migrants' countries of origin (in this case, the 10 new EU member states in central and south-eastern Europe). For example, the number of Belgian patents that are cited in Polish patents filed in year *t* measures knowledge flows from Belgium to Poland.

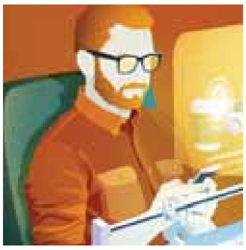
The specifications include multiple lags aimed at capturing events several years after the introduction of free movement of

[36] See Constant (2011), Kahanec (2012) and Kahanec et al. (2014) for cross-country analysis of emigration from new member states following their accession to the EU.
[37] NACE refers to the industry standard classification system used in the European Union.

labour. In this case, the labour mobility index is a dummy variable indicating whether a specific industry in a destination country was open to migrants from a given country of origin in a given year. Specifications also control for (i) the total number of patent applications in a given industry in the country of origin, (ii) the lagged number of patent applications in a given industry in the destination country, (iii) bilateral industry-specific and country-wide FDI and trade flows (using the same lags as for the FLM index), (iv) the total number of patents in a given industry at the EU level, (v) a dummy variable indicating pairs of countries that are both EU members and (vi) time and origin-destination-industry fixed effects. Standard errors are clustered at the origin-destination-industry level (two-digit NACE level).

Patenting asymmetries

A similar regression analysis is used to estimate the effect that emigration has on innovation. It uses the same set of explanatory variables, while the outcome variable is the difference between the log of the number of patent applications in migrants' countries of destination and the equivalent figure for their countries of origin, calculated for each industry and year. This measure captures convergence between new EU member states and advanced European economies in terms of industry-specific innovation. The coefficients for the various lags relative to the introduction of free movement of labour (β_1) indicate whether convergence in patenting within individual industries has become stronger following the introduction of free movement.



References

D. Acemoğlu and P. Restrepo (2017)
"Robots and Jobs: Evidence from US Labor Markets", NBER Working Paper No. 23285.

D.H. Autor and D. Dorn (2013)
"The Growth of Low-Skill Service Jobs and the Polarization of the US Labor Market", *American Economic Review*, Vol. 103(5), pp. 1553-1597.

D. Bahar and H. Rapoport (2018)
"Migration, Knowledge Diffusion and the Comparative Advantage of Nations", *The Economic Journal*, Vol. 128, pp. F273-F305.

M. Baker, J. Gruber and K. Milligan (2008)
"Universal Child Care, Maternal Labor Supply, and Family Well-Being", *Journal of Political Economy*, Vol. 116, pp. 709-745.

R. Barro and J.-W. Lee (2013)
"A New Data Set of Educational Attainment in the World, 1950-2010", *Journal of Development Economics*, Vol. 104, pp. 184-198.

R.P. de Barros, P. Olinto, T. Lunde and M. Carvalho (2011)
"The Impact of Access to Free Childcare on Women's Labor Market Outcomes: Evidence from a Randomized Trial in Low-Income Neighborhoods of Rio de Janeiro", paper prepared for the 2011 World Bank Economists' Forum.

U. Batsaikhan, Z. Darvas and I. Raposo (2018)
"People on the Move: Migration and Mobility in the European Union", *Bruegel Blueprint Series*, Vol. 28.

S. Berlinski and S. Galiani (2007)
"The effect of a large expansion of pre-primary school facilities on preschool attendance and maternal employment", *Labour Economics*, Vol. 14, pp. 665-680.

N. Bloom, C. Propper, S. Seiler and J. Van Reenen (2015)
"The impact of competition on management quality: evidence from public hospitals", *The Review of Economic Studies*, Vol. 82, pp. 457-489.

F. Chiacchio, G. Petropoulos and D. Pichler (2018)
"The Impact of Industrial Robots on EU Employment and Wages: A Local Labour Market Approach", *Bruegel Working Papers*, Issue 2.

P. Choudhury (2016)
"Return migration and geography of innovation in MNEs: a natural experiment of knowledge production by local workers reporting to return migrants", *Journal of Economic Geography*, Vol. 16, pp. 585-610.

A.F. Constant (2011)
"Sizing It Up: Labor Migration Lessons of the EU Enlargement to 27", IZA Discussion Paper No. 6119.

M. Costa Dias, W. Elming and R. Joyce (2016)
"The gender wage gap", IFS Briefing Note No. BN186.

W. Dauth, S. Findeisen, J. Südekum and N. Wößner (2017)
"German Robots – The Impact of Industrial Robots on Workers", Institute for Employment Research Discussion Paper No. 30/2017.

C. Dustmann, T. Frattini and A. Rosso (2015)
"The Effect of Emigration from Poland on Polish Wages", *The Scandinavian Journal of Economics*, Vol. 117, pp. 522-564.

EBRD (2018)
"Innovative and alternative finance: best practices for the regulation of crowdfunding platforms".

B. Elsner (2013)
"Does emigration benefit the stayers? Evidence from EU enlargement", *Journal of Population Economics*, Vol. 26, pp. 531-553.

G.J. Felbermayr and B. Jung (2009)
"The pro-trade effect of the brain drain: Sorting out confounding factors", *Economics Letters*, Vol. 104, pp. 72-75.

S. Flynn and M. Harris (2015)
"Mothers in the New Zealand workforce", *Labour, Employment and Work in New Zealand*, Statistics New Zealand.

C.B. Frey and M.A. Osborne (2017)
"The future of employment: How susceptible are jobs to computerisation?", *Technological Forecasting and Social Change*, Vol. 114, pp. 254-280.

C. Gathmann and U. Schönberg (2010)
"How general is human capital? A task-based approach", *Journal of Labor Economics*, Vol. 28, pp. 1-49.

X. Gong, R. Breunig and A. King (2010)
"How Responsive is Female Labour Supply to Child Care Costs? New Australian Estimates", IZA Discussion Paper No. 5119.

M. Goos and A. Manning (2007)
"Lousy and lovely jobs: The rising polarization of work in Britain", *The Review of Economics and Statistics*, Vol. 89, pp. 118-133.

Y. Gorodnichenko and M. Schnitzer (2013)
"Financial constraints and innovation: Why poor countries don't catch up", *Journal of the European Economic Association*, Vol. 11, pp. 1115-1152.

G. Graetz and G. Michaels (2018)
"Robots at Work", LSE working paper.

J. Greenberg and E. Mollick (2017)
"Activist Choice Homophily and the Crowdfunding of Female Founders", *Administrative Science Quarterly*, Vol. 62, pp. 341-374.

D. Grimshaw and J. Rubery (2015)
"The motherhood pay gap: A review of the issues, theory and international evidence", ILO Conditions of Work and Employment Series, No. 57.

M. Handel (2012)
"Trends in Job Skill Demands in OECD Countries", OECD Social, Employment and Migration Working Paper No. 143.

IFR (2017)
"IFR forecast: 1.7 million new robots to transform the world's factories by 2020", IFR press release, 27 September, Frankfurt am Main, https://ifr.org/ifr-press-releases/news/ifr-forecast-1.7-million-new-robots-to-transform-the-worlds-factories-by-20 (last accessed 26 September 2018).

ILO (2016)
Women at Work: Trends 2016, Geneva.

ILO (2018a)
Care work and care jobs for the future of decent work, Geneva.

ILO (2018b)
World Employment and Social Outlook: Trends 2018, Geneva.

B. Javorcik, C. Ozden, M. Spatareanu and C. Neagu (2011)
"Migrant networks and foreign direct investment", *Journal of Development Economics*, Vol. 94, pp. 231-241.

M. Kahanec (2012)
"Labor Mobility in an Enlarged European Union", IZA Discussion Paper No. 6485.

M. Kahanec, M. Pytlikova and K.F. Zimmermann (2014)
"The Free Movement of Workers in an Enlarged European Union: Institutional Underpinnings of Economic Adjustment", IZA Discussion Paper No. 8456.

G. Kalb (2009)
"Children, Labour Supply and Child Care: Challenges for Empirical Analysis", *The Australian Economic Review,* Vol. 42, pp. 276-299.

W.R. Kerr (2008)
"Ethnic Scientific Communities and International Technology Diffusion", *The Review of Economics and Statistics,* Vol. 90, pp. 518-537.

E. Kirby and S. Worner (2014)
"Crowdfunding: An Infant Industry Growing Fast", IOSCO Research Department Staff Working Paper.

J. Levinsohn and A. Petrin (2003)
"Estimating Production Functions Using Inputs to Control for Unobservables", *The Review of Economic Studies,* Vol. 70, pp. 317-341.

J. Manyika, M. Chui, M. Miremadi, J. Bughin, K. George, P. Willmott and M. Dewhurst (2017)
"A Future that Works: Automation, Employment, and Productivity", McKinsey Global Institute, McKinsey & Company.

L. Marcolin, S. Miroudot and M. Squicciarini (2016)
"GVCs, Jobs And Routine Content Of Occupations", OECD Trade Policy Paper No. 187.

K. Mayr and G. Peri (2009)
"Brain Drain and Brain Return: Theory and Application to Eastern-Western Europe", *The B.E. Journal of Economic Analysis & Policy,* Vol. 9, pp. 1-52.

M. Mills, F. Tsang, P. Präg, K. Ruggeri, C. Miani and S. Hoorens (2014)
"Gender equality in the workforce. Reconciling work, private and family life in Europe", RAND Europe.

L. Nedelkoska and G. Quintini (2018)
"Automation, skills use and training", OECD Social, Employment and Migration Working Paper No. 202.

OECD (2017)
OECD Employment Outlook 2017, Paris.

D. Parent (2000)
"Industry-specific capital and the wage profile: Evidence from the national longitudinal survey of youth and the panel study of income dynamics", *Journal of Labor Economics,* Vol. 18, pp. 306-323.

A. Saxenian (2006)
The New Argonauts, Harvard University Press.

UNICEF (1999)
Women in Transition, International Child Development Centre Regional Monitoring Report No. 6, Florence.

UN Women (2015)
Progress of the World's Women 2015-2016: Transforming Economies, Realizing Rights, New York.

World Bank (2016)
World Development Report 2016: Digital Dividends, Washington, DC.

M. Wright, M. Hart and K. Fu (2015)
"A nation of angels: Assessing the impact of angel investing across the UK", Enterprise Research Centre report.