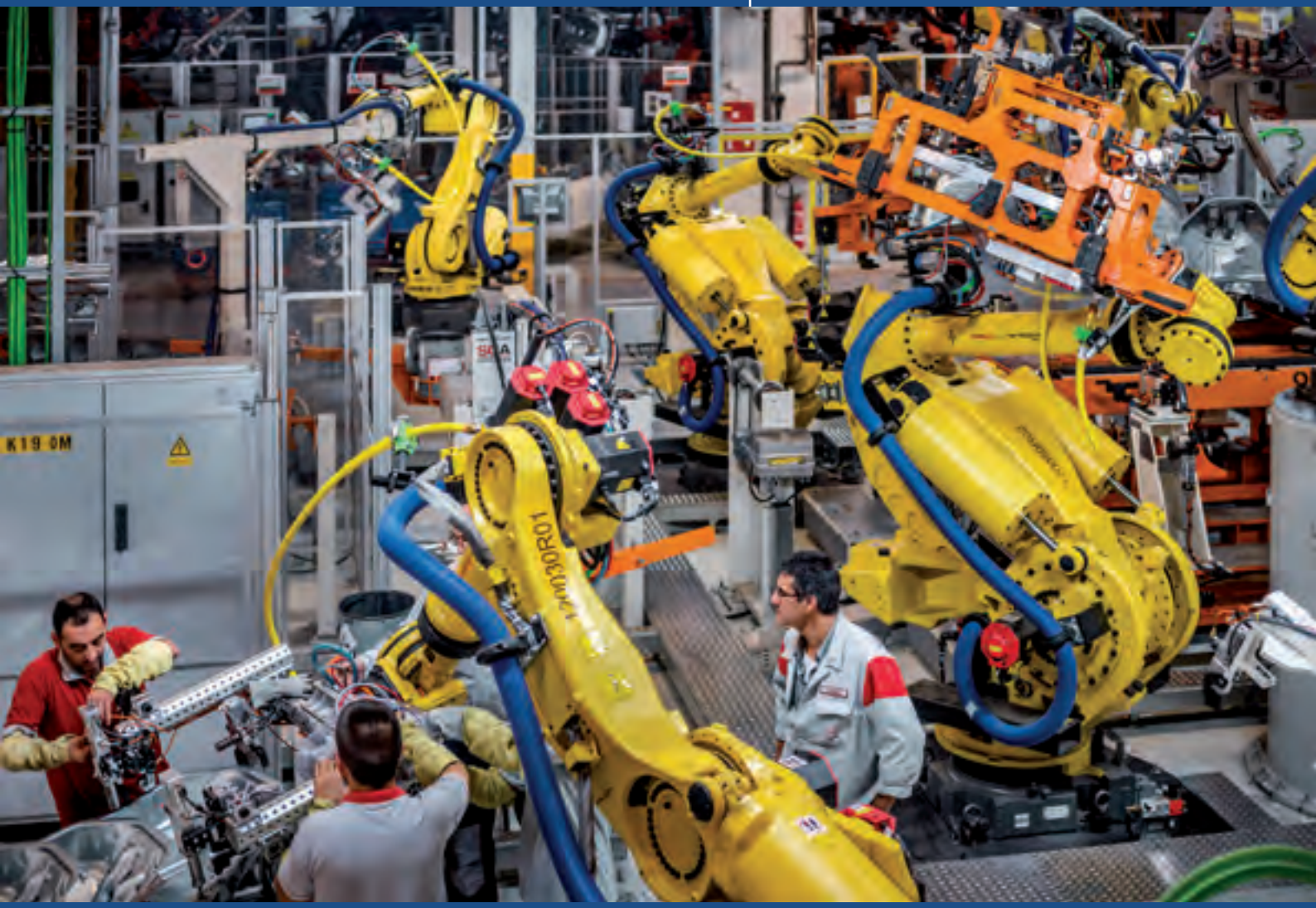
WORLD TRADE ORGANIZATION

WORLD TRADE REPORT 2017

Trade, technology and jobs



What is the World Trade Report?

The World Trade Report is an annual publication that aims to deepen understanding about trends in trade, trade policy issues and the multilateral trading system.

What is the 2017 Report about?

The 2017 World Trade Report examines how technology and trade affect employment and wages. It analyses the challenges for workers and firms in adjusting to changes in labour markets, and how governments can facilitate such adjustment to increase the positive impact of open trade and technological progress.

Find out more

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Disclaimer

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Foreword by the WTO Director-General

The story of economic progress is a story of economic change. It is a story in which whole industries can rise and fall, replaced by new ideas and innovations, which demand new skills. This relentless process of transformation has built the global economy of today, bringing growing prosperity for billions of people around the world – and it has made the ability to adjust and adapt an essential element of economic success. Now, as before, individuals, firms and societies are striving to respond to rapidly evolving economic conditions in order to share in the benefits. The difference today is the remarkable speed at which these changes are occurring.

The 2017 World Trade Report takes a closer look at this phenomenon. It focuses on trade and technology as two of the most powerful drivers of economic progress, and examines their effect on labour markets in both developed and developing countries.

The report finds that trade and technology are vital sources of economic growth. They drive up productivity, encourage the exchange of ideas, increase access to products and the range of products available, lower prices and improve living standards. Looking specifically at the labour market, they have a range of effects that are positive overall. For example, evidence highlighted in this report shows that trade's impact on a country's labour market is to increase overall employment and real wages. However, while the overall picture is very positive, with most regions, sectors, and individuals benefitting considerably from trade, it is important to acknowledge that others can lose out. The same is true, to a much greater extent, with technology. Clearly, benefits spread over the whole economy are of little comfort to someone who has lost his or her job, and therefore developing effective policies to support people to adjust is essential. We need to ensure that the benefits of economic progress reach everybody.

Skills are a central issue here. Trade and technology both increase the demand for skills in advanced economies and lead to upskilling in developing economies as trade supports the spread of new technologies and different production practices. The increased demand for skills often translates not only into an increased share of skilled workers in employment but also into a higher skill premium. This shift in the skill profile of the job market poses a challenge. A mismatch has emerged between the new skills demanded by an increasingly information-driven global economy and the older skill set of many workers, and this has led to a hollowing-out of the job market with a decline in the number of middle-skill jobs.

This situation is exacerbated by the sheer pace, scale and scope of economic change that we are seeing today. While a number of factors are behind this, there is no question that technology is the dominant force. Looking at the recent decline of manufacturing jobs in the United States, for example, evidence suggests that, while import competition from other economies may explain up to 20 per cent of the recent decline, technology is the main factor behind the other 80 per cent of jobs lost. This is an important point, because it is clear that the tensions in the labour market demand a policy response. If we do not accurately diagnose the causes of the problem, the policies that governments choose to respond to it may be ineffective, or even counterproductive.

Looking ahead, the prospects for increased automation – reflected by the increased use of industrial robots, supported by advances in artificial intelligence and robotics – suggest that technology may have an even greater impact on the future of jobs. The estimated share of jobs at risk of automation tends to be larger in developing countries than in developed countries. While drawing firm conclusions about what this could mean for the labour markets is problematic, we can be sure that technological progress is likely to have an increasingly disruptive impact, rendering some skills obsolete but enhancing others and leading to the development of new skills and new jobs.

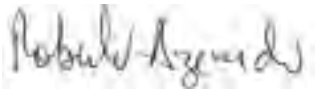
More than ever before, the ability of workers to move from lower- to higher-productivity jobs – and from declining sectors to rising ones – is the mechanism through which trade and technological progress contribute to growth, development and rising living standards. The need to constantly adjust and adapt is becoming one of the defining economic challenges of our era – and helping societies to do this is therefore becoming a key policy challenge for governments around the world. The report looks at

some of the approaches that governments are taking to help people to deal with and prepare for economic change. While there is a range of approaches, and different policies will be appropriate in different circumstances, the core elements tend to include steps to facilitate labour adjustment and ensure that the benefits of economic progress are spread more widely.

The evidence collected in the report suggests that success in facilitating adjustment involves finding an appropriate balance between labour market flexibility and employment security. Active labour market policies which help workers retrain and find new job openings, and assist them with relocation, can provide people with support and security, and encourage their transition into new opportunities. A focus on education, from the primary to the post-secondary levels, is also critical to equip individuals to take advantage of the new opportunities offered by technology and trade. Other policies that increase competitiveness can also make the economy more responsive to changes and facilitate adjustment, such as efficient and reliable infrastructure, well-functioning financial markets, and measures that improve the predictability of trade and level the playing field for traders. In addition, policies that support and compensate workers for permanent losses can help respond to the adverse effects of technological change and trade-opening for those most impacted.

Labour market problems must be responded to at the domestic level, but history has shown that if these issues are not responded to they can have global ramifications. Adjusting to economic change is a global challenge that requires a global response. By providing a forum where governments meet, talk and negotiate, the WTO – in cooperation with other relevant international organizations – offers an indispensable platform where governments can discuss constructively how best to maximize the benefits of economic change and how best to minimize or mitigate any adverse consequences. I believe that this work is more important than ever.

Finally, I would like to thank everyone who has worked on this report. It is a significant contribution to the debate on what must be considered one of the most pressing economic issues of our time.



Roberto Azevêdo
Director-General

Executive summary

A. Introduction

Unprecedented economic growth over the last quarter of a century has necessarily been accompanied by unprecedented economic change.

The dramatic opening of the world economy, combined with the rapid pace of technological change, have improved the welfare and living standards of billions of people around the world, including its poorest citizens. But this process has necessarily been accompanied by economic change and upheaval in the jobs market, as economies have shifted from lower to higher productivity and from declining industries to rising ones.

Technological progress and openness to trade – the two most important drivers of economic advances and change today – are also inextricably linked.

The rise of a more integrated global economy has accelerated the spread of innovation, information and know-how, and has spurred cross-border collaboration and competition, all of which have helped to fuel technological advances. At the same time, these technological advances – from containerization to improvements in air-travel, to the invention of the internet – have helped to bring about today's increasingly integrated global economy. The result tends to be a virtuous circle in which advances in technology lead to more openness to trade, and economic openness spurs technological advance, all helping to underpin deepening growth and greater integration of developing countries into the global economy.

The scale and pace of recent global economic change is unprecedented but the process is not new.

Since the Industrial Revolution some 200 years ago, economic development has progressively widened, deepened and accelerated, thanks in no small part to the interplay of technological innovation and global integration. Successive "waves" of development – for example, in Europe and North America in the 19th century, in the newly industrializing economies after the mid-20th century, and in the big emerging economies over the last 25 years – have depended both on harnessing new technologies and on integration into an increasingly global economy.

Continued economic progress hinges on the ability of societies to adjust, adapt and encourage inclusiveness.

The ability of workers to move from lower- to higher-productivity jobs, and from declining sectors to rising ones, is the essential mechanism by which trade and technological progress increase overall economic efficiency, promote development and improve living standards.

Although total labour market adjustment costs are typically much smaller than the total benefits of trade and technological change, these costs are often disproportionally borne by certain groups or communities, in the form of declining incomes or job losses.

The fact that some countries seem to be adapting to technological change and globalization better than others, by reducing obstacles to labour mobility in particular, and by more equitably and actively sharing the costs and benefits of change more broadly, suggests that government policy can play an important role in helping economies and societies to adjust to a changing world.

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B. Labour market outcomes: trends and analytical framework

A number of general labour market trends can be observed over the last 25 years, but the evolution of labour markets remains highly diverse across countries, suggesting that country-specific factors play a pivotal role in the functioning of the labour market.

Despite concerns about "jobless economic growth", the labour force participation rate and employment-to-population ratio have remained relatively constant across most high- and low-income countries, although they have decreased in middle-income countries. These different trends may be partially explained by factors such as macroeconomic conditions, demographic and institutional changes, including the expansion of secondary and tertiary education, the increasing participation of women in the labour force and the declining participation of

men, and increased incidences of non-standard jobs, such as temporary contracts, part-time work and self-employment.

Unemployment rates do not exhibit any long-term trends. The incidence of unemployment varies greatly across and within regions. It rose sharply in most developed countries during the post-2007 Great Recession and declined only gradually thereafter. The Great Recession also impacted a large number of developing countries, in particular through an increase in their large informal economy.

Average real wages have continued to rise, albeit at a slower pace since the Great Recession, across most countries over the past 10 years, with emerging economies experiencing the biggest relative increases.

Besides business fluctuations and price inflation, part of the evolution of real wages is linked to the growing share of part-time and temporary employment, which is often associated with lower wages. For many developing and least-developed countries, self-employment and unpaid family work continue to be common types of employment, which often imply lower earnings and higher uncertainty in income streams.

Important transformations in the sectoral and occupational structure of employment have occurred in a large number of countries over the past two decades.

The share of overall employment in services has continued to grow in both developed and developing economies, while the share of employment in the agricultural and manufacturing sectors continues to decline or to stagnate in developed countries and in an increasing number of developing countries.

This trend has been accompanied in developed economies and a number of developing countries by a relative increase in the share of high- and low-skilled occupations in total employment, together with a relative decline in the share of middle-skill occupations. The skill premium, defined as the ratio between the wages of skilled and unskilled workers, has also increased across several developed and developing countries, while it has remained constant or decreased in others. As discussed in Sections C and D, the literature has identified a number of factors, including technological progress and globalization, that could explain these structural changes.

As well as inherent mobility obstacles, institutional and political conditions shape the labour market performance, regardless of the origin of economic changes.

The complex interplay between factors shaping supply and demand for labour and their influence on wages and employment – including macroeconomic conditions, labour market institutions and mobility frictions or obstacles – and different external factors or structural changes – including trade and technological progress – is at the heart of labour market outcomes and it crucially affects the distribution of economic gains.

In a competitive labour market, unemployment can only arise if the wage rate does not adjust downwards to clear the market when there is an excess supply of labour.

Three main categories of unemployment have been identified. “Frictional” unemployment arises because a significant number of people are between jobs at any point in time. “Cyclical” unemployment arises when the decline in aggregate demand in the downswing phase of a business cycle leads to a decrease in labour demand but wages do not adjust downwards. “Structural” or “transitional” unemployment arises in the presence of wage rigidities for two reasons: either because there is a mismatch between the skills workers can supply and the skills employers demand; or because mobility obstacles prevent workers who lose their jobs from moving across either occupations or regions to fill new openings.

Search-and-matching models suggest that labour market institutions and regulations have an important influence on the cost of being unemployed and ultimately on the duration of unemployment.

More generally, the level of unemployment depends on the flow of individuals entering and exiting the labour market, the speed at which the unemployed find and accept a new job, and the conditions under which the bargaining over surplus takes place between employers and workers in the labour market exchange.

The speed, efficiency and effectiveness of the search process tends to increase, and therefore the level of unemployment tends to decrease, when access to information on jobs for applicants and on applicants for employers is improved by governments or otherwise. Similarly, the existence and the conditions of income support schemes for the unemployed affect the cost of being unemployed and thus also affect the speed at which they accept a new job.

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C. Impact of technology on labour market outcomes

Technological progress is the main source of economic growth…

Technological progress expands economic output and increases welfare by improving productivity – allowing more output to be produced with the same resources – and by enabling further innovation and development.

…but it is also the main source of labour market change.

However, by making some products or production processes obsolete, and by creating new products or expanding demand for products subject to innovation, technological change is necessarily associated with the reallocation of labour across and within sectors and firms.

Technology can increase the demand for labour, as well as decrease it.

Technology can, to varying degrees, assist the work of employees or render obsolete certain jobs. Autopilot technology on planes, for instance, assists the work of pilots, greatly increasing their overall performance. Automation technologies can, however, complete cognitive or manual tasks without human intervention. The corking of wine bottles in a winery, for instance, if undertaken by a machine, makes human labour input redundant.

Throughout history, technological change has been a source of anxiety for many workers. Labour-saving technologies, such as mechanization in agriculture, industrial robots in manufacturing, and automation in services, which has eliminated occupations such as elevator operators, have affected all sectors.

Labour-replacing technological change reduces the demand for labour. At the same time, however, it also reduces the cost of production and stimulates production, which in turn tends to increase labour demand. As a result of this and other factors such as local demand spill-overs (i.e., when new jobs generate additional demand in the local economy), the overall effect of labour-replacing technological change on labour demand is ambiguous.

The effects of labour-augmenting technologies on labour demand are also ambiguous, as they depend on how product demand responds to changes in relative prices induced by technological change. Whether technological change increases or decreases overall labour demand is, therefore, an empirical question.

The empirical literature has generally found small and possibly even positive effects of technological change on aggregate labour demand and employment. There are, however, a few relevant exceptions, with some studies showing the negative effects on labour demand generated by technological change. A common theme in the literature is that, in developed and developing countries alike, the most relevant effects are on the structure, rather than on the level, of employment.

Technological change also affects the relative earnings of workers with different skills…

The rapid diffusion of information and communication technologies (ICTs) in the work place is consistent with an increase in the (relative) demand for skilled workers because ICTs and skills are complementary.

There seems to be a consensus that technological change has been skill-biased over the past few decades in developed and in developing countries. For the United States, it has recently been estimated that computerization is the central force driving changes in the levels of wages between different education groups, accounting for 60 per cent of the rise in the skill premium.

… and the composition of employment.

Recent shifts in the nature of work include a strong decline in occupations that are intensively made up of routine work. In the United States, routine employment decreased from 40 per cent of the population aged 20-64 in 1979 to 31 per cent in 2014. During the same period, non-routine manual employment (such as house-cleaning or babysitting) expanded by 3.9 percentage points and non-routine cognitive employment (skilled professional and managerial jobs) expanded by 6.7 percentage points.

As a consequence, employment shares have grown in occupations at the two extremes of the skill distribution, and fallen at the middle of the skill distribution, during the last 25 years. This phenomenon of hollowing out of job polarization – observed in most developed countries and in several developing countries – is linked to technological change, which affects workers variously, depending on the job tasks they perform.

From a theoretical perspective, technology improves the relative employment prospects of skilled workers performing non-routine tasks (which are not easily

automated) and tasks involving cognitive skills, which are complemented by ICT technologies. Conversely, technology worsens the relative employment prospects of middle-skilled workers performing routine tasks (which are easily automated) and has little direct effects on employment prospects of low-skilled workers performing non-routine manual tasks, which are neither easily automated nor subject to ICT-skill complementarity.

With few exceptions, the empirical literature confirms the idea that technological change has been a major driver of the decline in routine occupations, and of the consequent employment polarization, in developed economies, while in the case of developing countries, the evidence that technological change is biased against routine employment is mixed.

The upcoming wave of technological advances, in particular artificial intelligence and robotics, raises a number of issues, including their impact on the future of jobs.

Some experts argue that history will repeat itself and the next wave of technological advances will replace many existing jobs but create new ones. Other experts disagree, arguing that the new wave of technologies is different (in terms of speed, scale and force) and will replace human jobs at a massive scale, leading to a "jobless future".

Several studies and reports have attempted to estimate the share of jobs that are at high risk of automation. Different methodologies and underlying assumptions lead to substantially different estimated shares of jobs vulnerable to automation. The estimated share of jobs at risk of automation tends to be larger in developing countries than in developed countries.

The estimated probability of automation does not, in any event, equal future unemployment, because the development, adoption and diffusion of future technologies will hinge on a number of factors, including feasibility, affordability, and the managerial culture within firms, as well as legal and regulatory frameworks and public acceptance.

While the debate remains unsettled and controversial, the upcoming technological progress is likely to continue being disruptive by having an impact on skills development, by making some skills obsolete but enhancing others and creating a need for new skills.

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D. Impact of trade on labour market outcomes

Like technological change, trade increases productivity and welfare.

Opening up to trade increases a country's welfare in a number of ways: through static gains – for example, by allocating productive resources more efficiently through greater specialization – and through dynamic gains – for example by encouraging the exchange of ideas that in turn accelerates innovation. The static gains from trade alone are significant. Some estimates indicated that gains from trade can be as high as one-third of a country's GDP compared to autarky.

Trade helps to allocate resources to the most productive activity in each country; however, like technological change, it simultaneously requires workers to adjust. The costs of these adjustments may be significant at the individual level and may require a policy response, but if considered for the whole economy, they are less than the overall gains from trade.

Many factors affect the costs of adjustment to trade or technological change, including aggregate savings and investment behaviour, business cycles, the initial industrial structure and the tariffs applied to particular sectors, and labour mobility. Labour mobility is not just a matter of regulation. The ease with which import-competing workers adjust to rising imports also depends on how diversified their own local labour markets are.

Trade increases overall wages and employment…

Many people work in trade-related activities. Jobs are created not only to fulfil a country's domestic demand, but also to produce goods and services that are directly exported to other countries, or that are used to produce goods and services that will be exported by other firms. Not only export-related activities, but also import-related activities produce jobs. In addition, both exporting and importing firms pay higher wages.

Evidence on the impact of trade on a country's aggregate labour market shows that trade tends to increase overall employment and real wages.

… but there are other effects, which may require a policy response.

While certain regions, sectors, and individuals benefit considerably from trade, others can be left worse off in the absence of adequate policy responses. These effects are similar to the varied impact of technological change.

A number of factors other than import competition have contributed to rising disparities across regions. Automation is a key factor, as illustrated by the increased use of industrial robots. The available empirical evidence suggests that trade can explain up to 20 per cent or 25 per cent of the recent decline in US manufacturing jobs. This implies that factors other than trade, such as technological change, may explain up to 80 per cent or more of the decline in manufacturing jobs in the United States.

There has been a lot of debate around the impact of China's economic rise. There is evidence for the United States, for example, that in regions less exposed to direct import competition, employment developed favourably compared to employment in more exposed regions. Yet the debate over the labour market effects of import competition needs to encompass other issues.

In the United States, for example, there is no conclusive evidence of nation-wide job losses from import competition. Indeed, when researchers take into account that, while some manufacturing jobs may be lost in a given region or a city, other jobs may be created in other regions or other cities or in the services sector, their findings suggest positive overall effects of trade on employment.

Trade increases the demand for skills...

Trade can lead to a reallocation of economic activity and therefore can lead to changes in a country's employment structure at the level of tasks, occupations, firms or sectors.

In advanced economies, trade increases the relative demand for high-skilled workers, especially in non-routine occupations. It thus behaves in a similar manner to skill-biased technological change. The main channels appear to be specialization in skill-intensive activities, the offshoring of routine tasks and increased innovative activity as a response to competition from low-cost exporters. Trade also leads to a higher demand for high-skilled workers in developing economies, mainly because of technology diffusion through imports of capital goods, intermediate inputs and know-how.

The increased demand for skills often translates not only into an increased share of skilled workers in employment, but also into a higher skill premium, that is, an increase in the nominal wages of high-skilled workers relative to low-skilled workers.

... but the gains also accrue to less skilled workers and poorer individuals.

There is evidence in developing countries that it is not only the wages of skilled workers, but also the wages of unskilled workers, that increase thanks to trade.

Furthermore, trade increases the purchasing power of poor, low-skilled workers more by enabling them to purchase cheaper imported products, and therefore its impact on the relative real wage can be favourable to the poorer.

Trade has fostered a transition from middle-class manufacturing jobs to services jobs.

Trade can lead to shifts of employment between broad sectors. In some advanced economies, it may accelerate the transition to a services-based economy because their comparative advantage is often strong in the tradable services sector.

In developing countries, trade is expected, in combination with other factors, to accelerate the shift of employment out of the primary, often informal, sector to both the industry and services sectors.

Trade has supported employment opportunities for women in some countries.

Trade expansion and increasing specialization in the textile sector have opened up job opportunities for women. In the Republic of Korea, the share of women employed in manufacturing grew from 6 per cent in 1970 to around 30 per cent in the 1980s and early 1990s. The importance of manufacturing as an employer of female labour in the Republic of Korea has since declined (to 14 per cent in 2007), but the sector still employs 10 times more women today than in the 1960s.

Given that time and mobility constraints are greater for women, particularly those with children, technological developments like e-commerce can have an important impact on work for women.

Because trade creates job opportunities for skilled workers, it increases the incentive to undertake schooling. This is particularly beneficial for women who have traditionally received less education than men, as is particularly the case currently in many developing countries.

Yet, there is evidence that women face higher constraints than men when it comes to accessing foreign markets.

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E. Policy reponses to labour market adjustment and distributional changes

Governments can help workers to manage the cost of adjusting to technological change and trade, while making sure that the economy captures as much as possible the benefits from these changes through a mix of adjustment, competitiveness and compensation policies.

Adjustment policy refers broadly to measures taken to lower the cost of reallocating resources, in particular labour, as a result of technological change or greater trade competition. Beyond improving economic efficiency, adjustment policy offers a way to compensate those who lose out from the dislocation caused by economic change. Adjustment programmes can also help to maintain political support for innovation and trade openness.

Adjustment policies may be general – for example, labour market, education and social policies are designed to help workers adjust to economic change, no matter what its initial cause may have been – or specific, as with trade adjustment programmes.

Adjustment policies may involve active or passive labour market policies. Active labour market policies aim to increase the likelihood of unemployed workers finding new jobs, through training or job-search assistance, for example. Passive labour market policies, on the other hand, help by providing financial support to workers who have lost their jobs.

Adjustment programmes may be activated in advance of economic dislocation, or assistance can be made available only after the economic effects have been felt.

Often, it is important to consider the wider social and political context in which adjustment policies operate. Research suggests that the degree of trust and confidence that the various sectors of society, such as business, labour and government, have in one another contributes to successful adjustment programmes.

Based on experiences in industrial countries, the economic literature offers some suggestions on how to make adjustment programmes work more effectively.

General adjustment programmes can deal with a wider range of economic changes but trade-targeted programmes can be cheaper than those that cover all types of these shocks.

There is room for governments to increase the funding of adjustment programmes so that a larger fraction of those who lose out from economic change get the required assistance and support. Programmes tailored to worker and country specifications appear to perform better.

Many countries use a mix of active labour market policies, employment protection, and provision of compensation to those who lose out. The specific balance to be struck will likely vary by country and circumstances.

This need for a mix of approaches also broadly applies to developing countries but one needs to take into account the larger share of workers in the informal, agricultural and state-owned enterprise sectors of those economies.

Self-employment and the informal labour market can provide a useful buffer for workers displaced from formal employment.

Economic shocks are likely to have a far larger effect on workers in the agricultural and state enterprise sectors in developing countries, given that a greater share of the labour force is employed in these sectors. Solutions might involve tailoring adjustment programmes in developing countries to reflect the particular challenges that arise from those sectors.

Policies that increase the competitiveness of the economy can make it more responsive to the opportunities created by innovation and trade.

Given that both technological change and trade tend to increase demand for skilled workers, greater investment in education and training will allow workers to respond better to economic change.

The quality, cost and reliability of infrastructure have a far-reaching impact on competitiveness. Among the key sectors in this regard are transport, power, telecommunications, and even housing. These are crucial not only to production, but also for moving goods, services and people within and across national borders and also for communicating and acquiring information.

Improving the functioning of the credit market can improve the competitiveness of domestic firms by lowering the cost of borrowing and making it easier for enterprises to finance their expansion or their requirements for working capital.

Trade measures can be used to increase the competitiveness of a country's producers. Negotiating greater market access in foreign markets reduces the trade barriers faced by a country's producers and allows them to sell more to foreign consumers.

If a country is integrated into global value chains (GVCs), reducing its own import barriers, and particularly those affecting intermediate inputs, may also increase its competitiveness in global markets, since imports of intermediate goods are essential to exports in GVCs.

Trade facilitation reform, through implementation of the WTO Trade Facilitation Agreement, lowers trade costs and offers another way to increase a country's competitiveness.

Governments can take measures to address possible adverse distributional consequences of technological change and increased trade competition.

While the process of labour market adjustment to technological change and increased trade competition may lead to permanent income losses for certain workers, recent research suggests that it is possible for governments to address this risk through measures that involve compensation and redistribution.

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F. Conclusions

Benefitting from economic progress involves adjusting to economic change.

Technological advances and trade opening have yielded enormous benefits for economies overall, but they can also adversely affect specific groups and regions – a problem which a number of countries are currently struggling to address. A key problem is the mismatch, or "friction", between the new skills demanded by an increasingly information-driven global economy and the older skill set of many workers. People need more creative and effective help in adjusting to economic change, irrespective of whether it is driven by technology or trade. The goal is to find an appropriate balance between labour market flexibility, on the one hand, and employment security, on the other.

The labour adjustment challenge may be local but the ramifications can be global.

Today's labour market problems are largely traceable to domestic policy shortcomings, but a failure to find answers could have global ramifications. By providing a forum where governments can meet, talk and negotiate, the WTO offers an indispensable platform – with other relevant international organizations – where governments can arrive at cooperative "win-win" approaches to the opportunities, as well as the challenges, of ongoing global economic change.

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A Introduction

That the global economy has gone through a period both of enormous dynamism and of enormous disruption over the past quarter-century is hardly surprising – the two are inextricably linked. The world economy only grows when productivity rises; and productivity only rises when the world economy generates more and better output more efficiently. Current concerns about globalization in many countries are traceable at least in part to the economic adjustment challenge posed by a global economy becoming ever more productive. The *World Trade Report 2017* looks at two of the most powerful drivers of global economic advance today, technology and trade, and examines how they are affecting labour markets. It analyses how the challenges of adjusting to this new labour market are changing and how economies are adapting. In particular, it examines the similarities and differences in the way that technology, on the one hand, and trade, on the other, influence labour market outcomes.

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1. Economic progress involves economic change

If economic progress and economic disruption go hand-in-hand, then no period has involved more global progress – together with more global disruption – than the last quarter-century.

The world economy has doubled in size since 1990 – its biggest expansion in history, despite the post-2007 Great Recession. China, India and other emerging giants – representing one-third of humanity – are rapidly catching up with the developed world, even as the global economy as a whole continues to reinvent itself and race ahead. The development, welfare and living standards of billions of people around the world, including the poorest, are progressing at an unprecedented rate.

But this extraordinary period of growth and development has been accompanied by an equally extraordinary period of disruption, as new products, new industries, and whole new economies force others to adapt or decline; as the demand for more skilled, specialized or knowledge-intensive work grows across many countries and sectors, even as the demand for less skilled, more routine work shrinks; and as most of us advance in today's more productive, dynamic and diverse global economy, but some of us fall behind.

The same forces that are delivering economic progress – innovation, specialization, producing more and better with less – are necessarily also delivering economic change, turnover and dislocation. Joseph Schumpeter's creative destruction – the process through which a new economic structure replaces the old one – is unfolding on a global scale.

No two forces are driving this global economic transformation more than technology and trade. Indeed, because economic openness encourages innovation, and *vice versa*, the two are not just related but mutually reinforcing. New technologies – from containerization to fibre optics, to the Internet – are linking together and "hardwiring" today's globalized economy, in turn fuelling even more openness and integration. China could not have emerged as the new "workshop of the world" without its integration into global production networks; India would not be on track to becoming a global services hub without access to the World Wide Web.

At the same time, today's more interconnected global economy has accelerated the spread of technology, information and ideas, and has increased the incentives to innovate and create, helping to fuel further technological progress, especially in those parts of the developing world cut off from advanced technologies in the past. What emerging economies have gained most from their growing integration into the global economy is not merely more exports or more capital but more technology, and the opportunity to leverage it for rapid and sustained development.

Much, if not most, of this economic transformation reflects technological change, as digitization, automation, and other productivity-enhancing innovations allow industries to create more output with less labour, freeing up resources to be employed more productively elsewhere. The fact that the share of employment in manufacturing is now starting to fall across some developing countries – in the same way that it has already fallen in developed countries – indicates that the disappearance of factory jobs today, like the disappearance of agricultural jobs in the past, has more to do with automation and digitization than with offshoring and outsourcing (Banister and Cook, 2011). Indeed, manufacturing in developing countries is probably most vulnerable to technology-driven creative destruction because repetitive, low-skilled labour is the easiest to automate. For example, the Changying Precision Technology Company in China, a manufacturer of mobile phones, recently announced its first "unmanned factory", where 90 per cent of the workforce has been replaced with robots – and its productivity has since risen by 250 per cent (The Asian Age, 2017).

Nevertheless, growing trade integration reinforces, as well as reflects, these underlying technological changes by enabling a "global" division of labour and specialization that would have been unimaginable just a few decades ago. In the 1980s, Toyota produced cars that were "Made in Japan"; today it produces cars that are "Made in the World". The Japanese workforce that was once mainly employed on assembly lines is now increasingly engaged in running a highly integrated and technologically complex system of global production taking in everything from research, design and marketing to finance, logistics and information and communications technology (ICT) coordination. The rise of such global production networks – in effect "world factories" – is only possible because of the marriage of open trade and integrating technologies.

2. New chapter in an old story

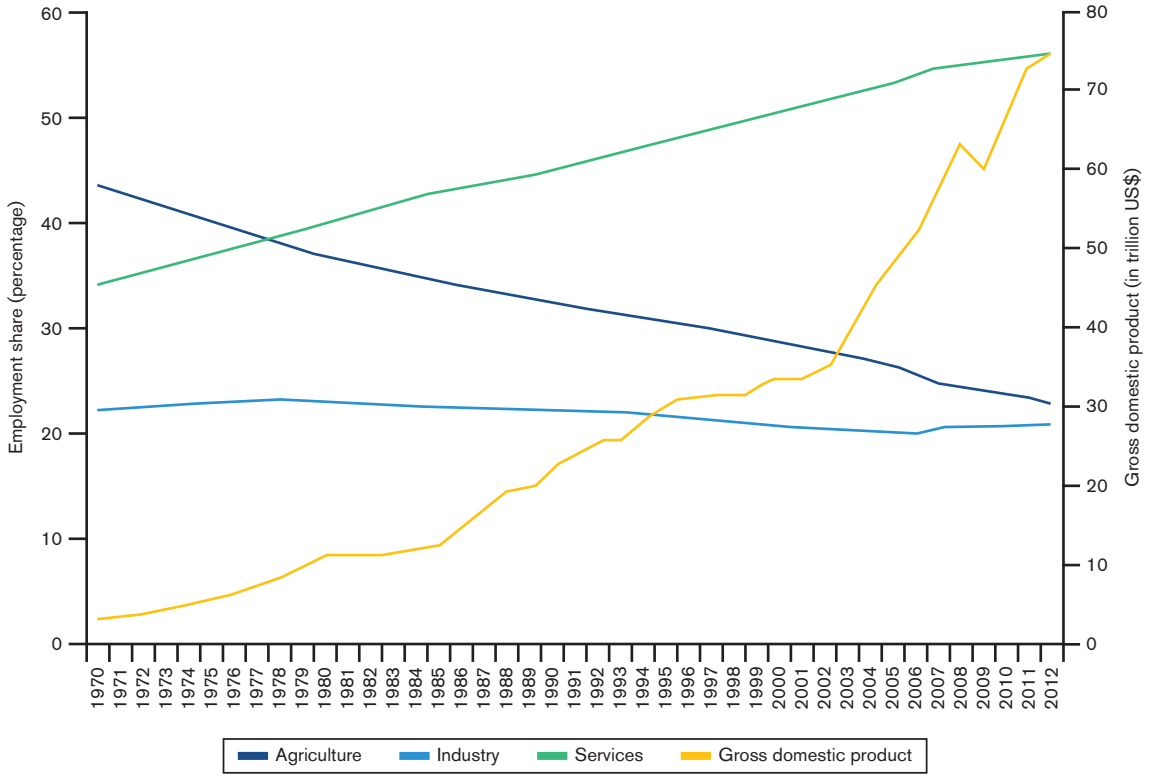
This process is not new, even if its scale and pace today are unprecedented. Since the Industrial Revolution began over 200 years ago, economic development has progressively widened, deepened,

and accelerated, thanks in no small part to the interplay of technological innovation and global integration. In the nineteenth century, new technologies – steamships, railways, the telegraph – allowed early industrializers in Europe and North America to race ahead of the rest of the world. In the twentieth century, newer technologies – automobiles, airplanes, telecommunications – enabled the next wave of industrializers – the Republic of Korea, Singapore, and other "Asian Tigers" – to catch up with the developed countries, even as they redoubled their *per capita* income lead on the less developed world. Now, even more advanced technologies – computers, smartphones, the internet – are fuelling the latest and biggest wave of economic catch-up, as dozens of developing countries achieve sustained annual growth rates of 8 per cent or more.

Even as developing economies continue advancing, advanced economies continue "developing", evolving from agricultural, to industrial, and now to services- and knowledge-based economies (see Figure A.1). In 1900, almost half of all workers in France were employed on farms; today, the figure is less than 3 per cent and, thanks to advances in agricultural productivity, consumers have more food and more choice than in the past. In 1970, over a quarter of American employees worked in the manufacturing industry; today, it employs less than 10 per cent, yet US manufacturing output has nearly tripled (Baily and Bosworth, 2014).

The biggest labour market shifts – and the most rapid productivity gains – are occurring in developing, not developed, economies. In less than two generations, more than 350 million Chinese workers have migrated from farms to factories and now increasingly to offices – a process that took a century or more in the West. As recently as the 1980s, China's economy was still overwhelmingly comprised of poor agrarian workers. Today, agriculture accounts for just 28 per cent of Chinese employment, while manufacturing accounts for 29 per cent and services – its fastest growing sector – account for 43 per cent.[1] Other developing countries are following the same trajectory: in Brazil, services now make up 67 per cent of GDP; in India, they make up 55 per cent.[2]

Figure A.1: Evolution of employment share by sector (1970 to 2012)



Source: Timmer, de Vries and de Vries (2015); World Development Indicators (July 2017).

Note: The five-year moving average of the employment share by sector in total employment covers 40 economies: 10 developed and 30 developing. The agriculture sector includes activities in agriculture, hunting, forestry and fishing. The industry sector includes mining and quarrying, manufacturing, construction and public utilities (electricity, gas and water). The services sector includes trade and transport services, business services, government services and personal services.

At each stage, continued economic advance has hinged on the ability of countries to adjust – to reconcile the tension between the opportunities presented by economic progress, on the one hand, and the challenge of helping people adapt to economic change and share in its benefits, on the other. While underlying technological and structural forces have been the main drivers of economic change, government institutions and policies have also played a central role, usually by facilitating or cushioning economic adjustment, but sometimes by impeding or resisting it.

The economic progress and globalization of the nineteenth century depended in part on nascent parallel social progress in the areas of labour laws, unemployment insurance, pensions and trade unions. In contrast, the economic reversals and de-globalization from 1914 to 1945 – marked by world war, trade protectionism, and economic depression – were at least partly traceable to the failure of countries, both individually and collectively, to adapt to a fast-changing economic landscape. It is no coincidence that the lesson drawn from the inter-war set-backs and crises by policymakers was that people support economic change only if they are sharing in its benefits.

Thus, the international economic system established after the Second World War was purposely designed around the interlinked objectives of open trade and integration, on the one hand, and full employment, social security, and mass public education, on the other – what John Ruggie has called "embedded liberalism" (Ruggie, 1982). Indeed, the evolution of the global economy over the past century, especially since 1945, has generally been accompanied not by a retreat of government but by its advance at the national and international level, providing the institutions, rules, regulations and social safety nets that are increasingly indispensable – along with less formal social and cultural institutions and networks – for the functioning of sophisticated and complex market economies.[3]

Now, as in the past, economic progress depends inescapably on adjusting to economic change. A key difference today is the pace, scale and scope of these changes. Labour market disruptions in many countries can now be perpetual and substantial, as employees are required to switch firms, localities and even careers with growing frequency. For example, every month an average of 1.7 million jobs disappear – and an equal number is created – in a US labour market of 160 million (Federal Reserve of St. Louis, 2015). In the late 1940s, 350,000 Americans worked as manual telephone operators in AT&T alone, while today, less than one-tenth of that number is employed across the entire telecommunications sector, despite the explosion of modern communications. Conversely, by 2012 almost half a million US jobs had been created to make mobile apps – none of those jobs existed five years before (Atkinson and Wu, 2017).

At the same time, the obstacles or labour mobility frictions experienced by workers who wish to move into rising sectors and out of declining ones can also be higher. Because of the increasingly global nature of labour markets, finding new work frequently means moving to different cities, regions, or even countries, which involves significant financial or political obstacles. And because economies today are increasingly knowledge-driven, being hired for a new job often depends on having ever higher and more specialized skills, which involves requalifying, retraining or even going back into education.

Workers with the skills, resources and flexibility to take advantage of new employment opportunities appear to be benefitting from these economic changes – career options are expanding, wages are rising, and living standards are increasing. More broadly, many have indirectly benefitted from economic progress because they spend less on food, clothing, and other necessities, thanks to productivity improvements in existing industries and lower-cost imports, and because they have access to smartphones, online movies, foreign vacations, and other luxuries that were once the preserve of the rich, thanks to technological advance and the formation of efficient global supply chains. The fact that billions in the developing world can now aspire to living standards that were once the preserve of a small minority in the developed world is the most notable benefit of economic progress.

Conversely, those who lack the skills, resources or flexibility to adjust to these new opportunities risk being adversely affected by economic change, experiencing shrinking career options and falling salaries in the face of automation, digitization and low-wage competition. The prolonged cyclical downturn and weak aggregate demand since the post-2007 financial crisis has exacerbated these challenges in many countries. For the first time since the Second World War, some groups in advanced countries face the prospect not just of progressing less rapidly than others, but of actually going backwards, often because they are no longer able to supply the new skills that advanced economies increasingly demand. For example, in 2016 roughly 5.9 million skilled US job vacancies went unfilled at the same time that millions of US workers saw their salaries stagnate or shrink – an illustration of the cost of skills mismatches in labour markets. By better matching jobs and skills, the allocation of labour across firms would likely improve (OECD, 2016b).

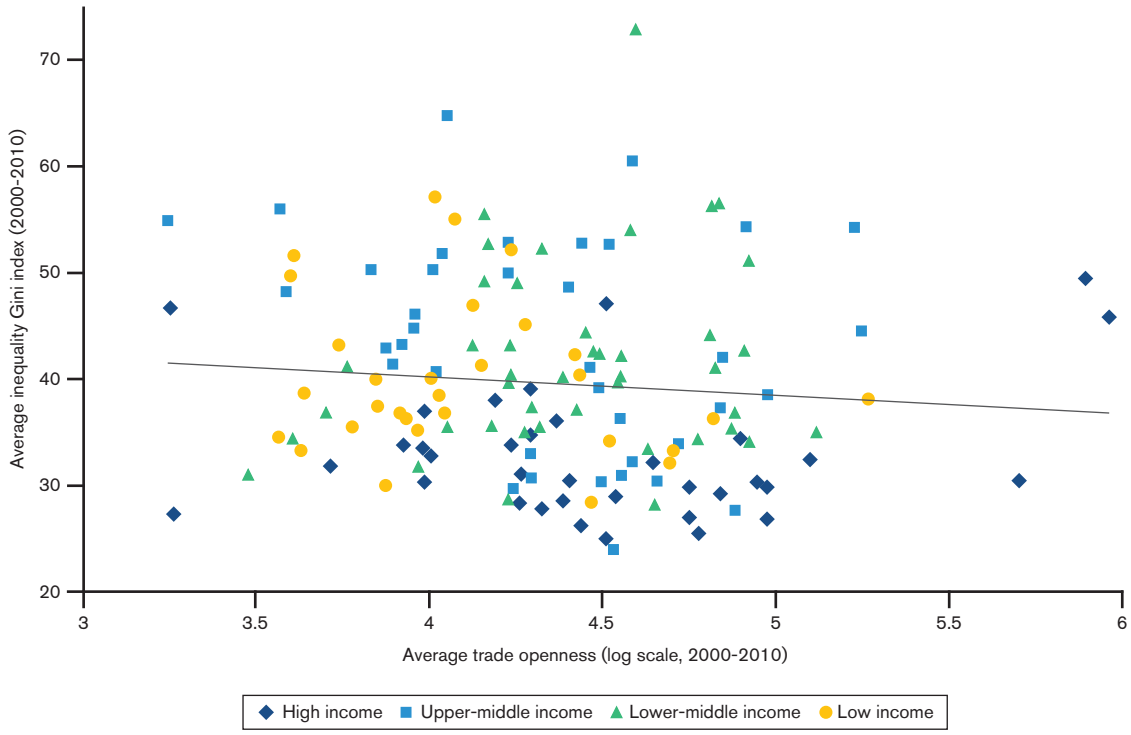
This gap between those who can successfully adapt to and benefit from economic change and those who cannot creates a risk of increasing inequality across classes, regions, genders and age groups. Some inequality is inevitable in economies – reflecting needed incentives to innovate or invest – but too much inequality can undermine economies by making it difficult for the poor or unemployed to receive the training or health care they need in order to contribute to economic growth, thereby adding to political resentments and tensions and potentially weakening popular support for continued economic progress.

The fact that certain economies seem to be adapting to today's global economy more successfully than others suggests that domestic policies and institutions play a key role in preparing societies for change, by facilitating adjustment and ensuring that the benefits – as well as the costs – of economic progress are widely shared. The evidence suggests that there is no correlation between openness to trade, on the one hand, and income inequality, on the other (see Figure A.2). Indeed, some of the most open and trade-dependent countries today, such as Germany, Latvia and the Netherlands, are also some of the most equal in terms of income levels, living standards, and wealth disparities, which suggests not only that economic openness can go hand in hand with economic inclusion, but that achieving the latter may be critically important to maintaining political support for the former.

Indeed, the pace and scope of global economic change today, as well as the evidence that popular support in some countries for the key drivers of this process is becoming eroded, have raised the policy bar, rendering the roles of governments and other institutions more, not less, important, and their policy successes (or mistakes) more, not less, consequential. They underline the importance of treating education, skills development and social safety nets as a work in progress, an exercise in continuously equipping people for a global economy that is itself continuously changing.

They also underscore the need for governments and other institutions to increase their efforts to pursue structural reform policies that further

Figure A.2: Trade openness versus inequality (2000 to 2010)



Source: World Development Indicators (consulted in July 2017).

Note: Trade openness corresponds to the ratio between the sum of exports and imports and gross domestic product (GDP). The Gini coefficient measures the extent to which the distribution of income among individuals or households within an economy deviates from a perfectly equal distribution. A Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality. The average trade openness and Gini coefficients are calculated for the period 2000 to 2010, or a shorter period, based on data availability. The linear trend is represented by the black line, which is statistically not different from zero.

promote technological innovation, trade openness, and business dynamism as essential steps towards reviving global economic growth and encouraging economies to be more responsive to emerging opportunities. There are worrying signs that the period of rapid global economic advance since the end of the Cold War began to slow even before the 2007/08 financial crisis, and that it decelerated precipitously after that, first in the developed world and now in a number of developing countries too (see OECD, 2016b). While current concerns about globalization seem to have contributed to the slowing pace of trade opening and structural change, the opposite may also be true – that the slowing pace of globalization has contributed to growing popular discontent, widening divisions, and growing geo-economic tensions. Rapidly expanding economies where living standards are rising tend to encourage optimistic "positive sum" attitudes – the belief that everybody is moving ahead together. But slow-growth economies can foment more pessimistic "zero-sum" attitudes – the belief that if one group or economy is progressing, it must be at the expense of some other group or economy. Slowing global growth since 2009 – itself partly a function of the slowing pace of global trade liberalization and other reforms – risks breeding the latter. Ironically, the backlash to technology- and trade-driven economic change in certain developed countries seems to be growing at a time when they are experiencing relatively less labour market churn (i.e. workers moving from job to job) than in the recent past – and certainly less than is currently unfolding in many fast-changing developing countries (Atkinson and Wu, 2017). Indeed, one answer to the current discontent with globalization may be – paradoxically – to redouble efforts to revive it.

3. Structure of this report

The *World Trade Report 2017* examines the similarities – but also the differences – in the way technology and trade are impacting labour markets today. Although technology and trade are related and affect labour markets through similar mechanisms, they also have distinct effects that warrant separate analysis. More broadly, the current debate about the impact of globalization, and whether it is technology or trade that is "responsible" for today's labour disruptions, raises important questions about how both are affecting the level and composition of employment. These questions deserve further examination if policymakers are to provide informed responses to the labour market challenges we face. Indeed, in light of the confluence and intertwining of these twin challenges, this report highlights the debate around the need for 21st-century adjustment policies, education systems and social support networks to match the 21st-century global economy that is emerging.

Section B places the discussion of the labour market effects of trade and technology in context. It presents a number of major trends in labour market outcomes and introduces basic insights from labour economics. Trends in real wages, unemployment and labour force participation do not show dramatic changes over the past two decades, other than those related to the post-2007 Great Recession. These broad trends, however, mask large differences across countries, including between economies in the same region or with a similar level of economic development. At a more disaggregated level, labour markets across many developed and developing countries have experienced profound changes over the past 25 years, with a sustained shift of employment from agriculture and manufacturing toward services. At the same time, the labour markets of many developed countries and several developing countries have become polarized due to the relative decline in the number of middle-skill/middle-paid jobs compared to the relative increase in the number of low-skill/low-pay and high-skill/high-pay jobs. Both phenomena may be relatively disruptive for workers, who face the risk of job losses and of having to switch jobs.

The diversity of outcomes across countries is in line with one of the main insights from labour economics introduced in Section B, which suggests that country-specific factors play an important role in explaining labour market outcomes. The section explains why the impact of technology and trade needs to be assessed in the context of the other major factors shaping supply and demand for labour and their influence on wages and employment, including macroeconomic conditions, labour market institutions and mobility obstacles. The 2007/08 financial crisis, for example, delivered a profound shock to labour markets across many countries, irrespective of longer-term technology or trade-driven change, from which many are still recovering. This section examines in particular how search and matching frictions (i.e. difficulties experienced by firms in searching for workers and matching them with jobs), mobility frictions (i.e. obstacles faced by workers in moving to regions or sectors where there are more job opportunities), or skills mismatches can prevent a smooth adjustment of the labour market, limiting the productivity gains from technology and trade, contributing to short-term unemployment, and widening the gap between the winners and losers of economic change.

Section C looks at how technological change impacts labour market outcomes. It explains that while

technology increases productivity by allowing firms to produce more output with less labour, it can have an ambiguous impact on labour market outcomes. Depending on whether cost savings associated with "labour-substituting" technology – such as automation – or with "labour-augmenting" technology – such as autopilot technology on planes – lead to increases in product demand, employment may rise or fall. This section discusses in particular the various effects of technological change on workers, depending on their skills and on the work tasks they perform. Current technological change tends to be both skill-biased – increasing the relative demand for skills – and routine-biased – decreasing demand for workers performing routine tasks. Therefore, relatively skilled workers performing non-routine tasks tend to benefit from technological change, while relatively unskilled workers employed in routine tasks tend to be vulnerable to job losses. This has important implications for skills development.

Section D examines how international trade influences labour market outcomes. It shows that the effect of trade on aggregate employment and real wages tends to be positive, but varies within economies and across regions and individuals because of different skills requirements and/or limited labour mobility. This section shows that, while trade benefits, such as lower consumer prices and greater variety, are often shared by many, the costs of adjustment, such as job losses, are typically borne by relatively few, though of course adjustments are very important at the individual level, as addressed in this report. Beyond the number of jobs, the section discusses how trade affects the composition of employment. It shows that trade often favours high-skilled workers more than others, and that trade plays a significant role in creating jobs for women in many countries.

Section E discusses how the costs of technological progress and trade can be reduced, how to better distribute the benefits from economic change and compensate those who are adversely affected, and how domestic policies and institutions fundamentally affect this distribution. This section suggests that globalization can be made more beneficial and inclusive for all, by making labour markets work more efficiently and by better compensating those adversely affected – either indirectly, in the form of retraining and education, or directly, in the form of income redistribution. Part of the problem is that many economies have attempted to correct twenty-first century labour market problems with twentieth-century education and social systems. However, the possibility of better designed policies and the spread of new technologies suggest that considerably more promising solutions are within reach.

Endnotes

1 World Bank national accounts data (July 2017), and OECD National Accounts data files (July 2017).

2 World Bank national accounts data (July 2017), and OECD National Accounts data files (July 2017).

3 According to estimates by the International Monetary Fund (IMF), the share of government spending in GDP has increased in most countries around the world since the 1950s, ranging from 25 per cent and 30 per cent in low- and middle-income countries to 43 per cent in high-income countries (IMF, 2014).

B Labour market outcomes: trends and analytical framework

This section aims to put the discussion of the labour market effects of trade and technology into perspective. A narrow focus on these effects may give the misleading impression that trade and/or technology are the main determinants of employment or wages. As explained in this section, however, levels of employment or unemployment and of wages are largely determined by how the labour market works. In other words, the effects of technology or trade on labour market outcomes depend, to a large extent, on institutional conditions in the labour market, concomitant economic changes and the diversification of employment opportunities when shocks occur.

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Some key facts and findings

- Labour markets have evolved in many different ways across countries, suggesting that a pivotal role is played by country-specific factors.
- The labour force participation rate and the ratio of the population in employment have remained relatively stable across most high- and low-income countries but have decreased in middle-income countries. Unemployment rates tend to be lower in developing countries, but the share of the population in informal employment tends to be high.
- Average real wages have continued to rise, albeit more slowly since the post-2007 Great Recession, in most countries over the last 10 years.
- The evolution of labour markets has been marked by the expanding proportion of workers with secondary or tertiary education, increasing participation of women in the job market, declining participation of men in employment, and the increasing number of non-standard jobs, such as work based on temporary contracts, part-time work and self-employment.
- The proportion of employees in the services sector continues to increase in both developed and developing economies. At the same time, the proportion of workers in agriculture and manufacturing sectors is declining or stagnating. In developed economies and some developing economies, there has been a relative increase in the share of high- and low-skilled occupations and a relative decline in the share of middle-skill occupations.
- Smooth adjustments in the labour market can be hampered by the potential mismatch between those searching for jobs and the types of workers needed by employers. Adjustment can also be hampered by the obstacles faced by employees in moving to where new jobs are located, therefore limiting the gains from technological change or trade.

The section opens with a brief presentation of major labour market trends at the aggregate level. Section B.2 documents two important structural changes occurring in the labour market of a large number of countries, namely the increasing share of services employment in total employment and the relative decline in the share of middle-skill occupations in total employment. Finally, Section B.3 reviews a number of important theoretical insights on the functioning of the labour market.

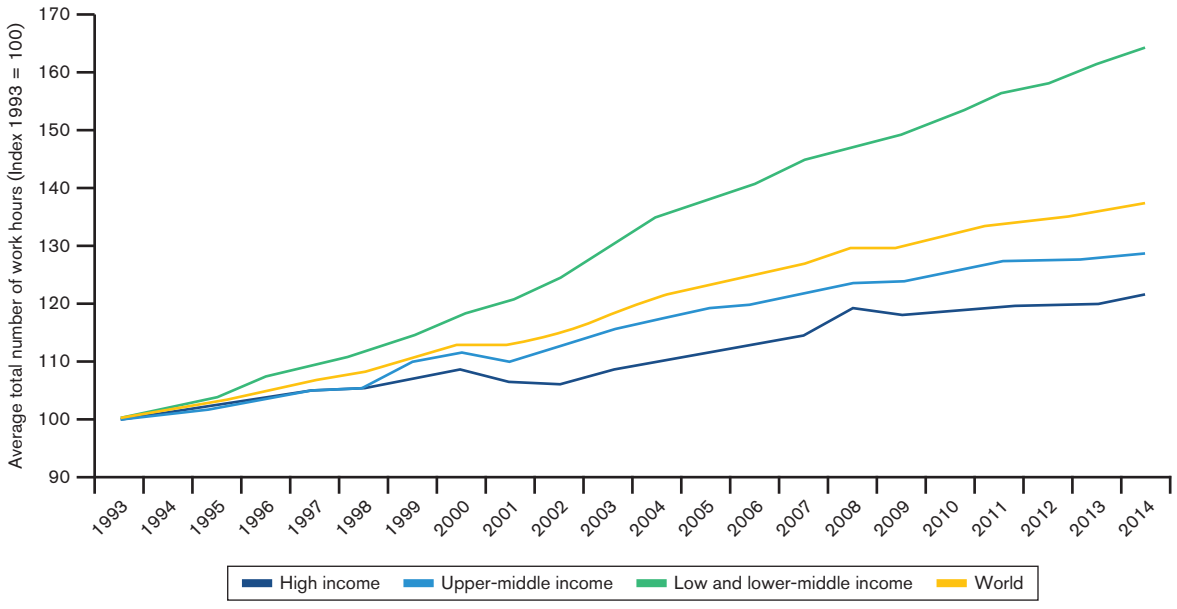
1. Major trends in employment and wages

This subsection presents some general labour market trends in order to provide a general overview of the labour market. Some of these trends are longer-term, while others refer to more recent developments, in particular developments observed since the global financial crisis of 2007/08. Overall, although a number of general labour market trends can be observed, the evolution of labour markets remains highly diverse across countries, suggesting that country-specific factors play a pivotal role in the functioning of the labour market. As discussed in greater detail in the next subsections, labour markets are indeed affected by a broad range of demographic, social, economic and institutional changes.

Employment and labour issues continue to be high on the agenda of policymakers across countries, although reasons for concern might differ. A broad range of indicators have been developed in the literature to measure the multi-faceted nature of labour markets. Important dimensions of the labour market include unemployment, wage inequality, the quality of jobs, the informal sector, gender inequality and labour unions. Given that most of the literature discussing the impact of technology or trade on labour markets focuses mainly on employment level and wages, much of this report also focuses on those two important dimensions. It is important to bear in mind, however, that more labour market data tend to be available for developed countries than for developing economies, and that where data are available for developing countries, the time-periods covered may be shorter and detailed breakdowns by age, gender and economic sector may not be available.[1]

One common measure developed to track the evolution of the total amount of labour employed across the economy is the total number of hours worked. As highlighted in Figure B.1, over the past 20 years the overall number of hours worked has, on average, increased in both developed and developing countries. The growth rate of total hours worked has been, however, much higher in low-income and lower-middle-income countries, such as Bangladesh, Cambodia, Costa Rica and Malaysia. Conversely, since the trough of the Great Recession, which was triggered by the 2007/08 financial crisis, total hours worked seem to have grown at a slower pace in high-income countries.

Figure B.1: Evolution of the total number of work hours (1993 to 2014)



Source: Penn World Table 9.0., Feenstra et al. (2015).

From a pure accounting perspective, the total number of hours in a given country is determined by four main factors besides the size and growth rate of the population:

(1) the proportion of the working-age population willing to work, defined as the labour force market participation;

(2) the share of the working-age population actually employed, defined as the employment-to-population ratio;

(3) the share of the working-age population willing and able to work but unemployed, defined as the unemployment rate; and

(4) the average number of hours worked.

These four indicators, as well as real wages are discussed in greater detail below. See Box B.1 for a list of definitions of terms related to labour market.

Box B.1: Labour market definitions

A **job** or **occupation** is a group of specific **tasks** to be undertaken by an individual on a paid basis.

Different typologies of tasks have been developed in the literature. Based on their performance goals, tasks can be grouped in four main categories: generating, choosing, negotiating and executing (McGrath, 1984).

In establishing such bundles of tasks, the employer also generally specifies the **skills, qualifications and expertise** an individual is required to possess in order to perform the tasks satisfactorily and do the job. In practice, different types of occupations are often technically interdependent. Some tasks generate tangible or intangible outputs that are inputs for other tasks. As a result, the relationship between occupations and tasks can evolve over time. While an occupation can disappear in a given organization, the tasks of this former occupation can still be performed by the incumbent of another occupation.

The **labour force** consists of all the persons in a country who are in work or are unemployed seeking work. People who are not employed and who are not looking for work are not counted in the labour force, often referred to as working age population.

The **labour force participation rate** is the percentage of the labour force that is either employed or unemployed but is actively seeking work.

The **employment-to-population ratio** is the percentage of the working-age population with work (as dependent, self-employed or entrepreneurs).

The **unemployment rate** is the percentage of workers in the labour force that are unemployed. A worker is considered to be **unemployed** when she/he is not employed but would be willing and able to work at jobs she/he believes to be currently attainable (Jacobsen and Skillman, 2004). A worker is considered to be **involuntarily unemployed** if she/is looking for work but does not find any.

A worker's **reservation wage** is the wage below which she/he will not work.

The **full employment** (or natural) rate of unemployment can be and has been defined in different ways (see Ehrenberg and Smith, 2012). It can be defined as the rate at which:

- job vacancies equal the number of unemployed workers;
- any increases in overall demand will cause no further reductions in unemployment;
- all unemployment is voluntary (frictional and perhaps seasonal, as explained in Section B.3); or
- the level of unemployment is unchanging and both the flows into unemployment and the duration of unemployment are normal.

Informal employment encompasses all remunerative work – both self-employment and wage employment – that is not recognized, regulated or protected by existing legal or regulatory frameworks and non-remunerative work undertaken in an income-producing enterprise (ILO, 2002).

(a) The labour force participation rate has remained constant in many high- and low-income countries in recent years

As explained above, only a part of the population, which is typically defined as the proportion of individuals aged 15 and older that is economically active, is willing and able to work.[2] Out of the working-age population, the labour force encompasses individuals who work, as well as those who are unemployed but seeking work, and first-time job-seekers. According to estimates by the International Labour Organization (ILO), the overall labour force participation rate has, on average, decreased in middle-income economies but has remained relatively constant in high- and low-income economies over the past two decades, as highlighted in the upper panel of Figure B.2.

These broad trends mask, however, large differences across economies, including between economies in the same region or with a similar level of economic development. As shown in the lower panel of Figure B.2, countries in South Asia, East Asia and the Pacific experienced the largest reduction in the labour force participation rate between 1990 and 2016. For instance, China's participation fell from 77 per cent to 71 per cent while India's rate dropped from 59 per cent to 53 per cent. Conversely, the labour force participation rate has, on average, remained relatively constant or increased slightly in many countries in the Middle East, North Africa, and Sub-Saharan Africa. Countries in Latin America, such as Colombia and Peru, have experienced, on average, the highest relative increase in the labour force participation rate.

The labour force participation rate has also evolved differently across developed countries. While labour force participation has generally remained stable or has slightly increased in many European countries, such as France, Italy and the United Kingdom, other major developed economies saw their participation rates decline even before the Great Recession. Both Japan and the United States have recorded falling participation and employment rates, since 1997 in the case of Japan and since 2000 in the case of the United States, with the pace of decline accelerating after the global financial crisis.

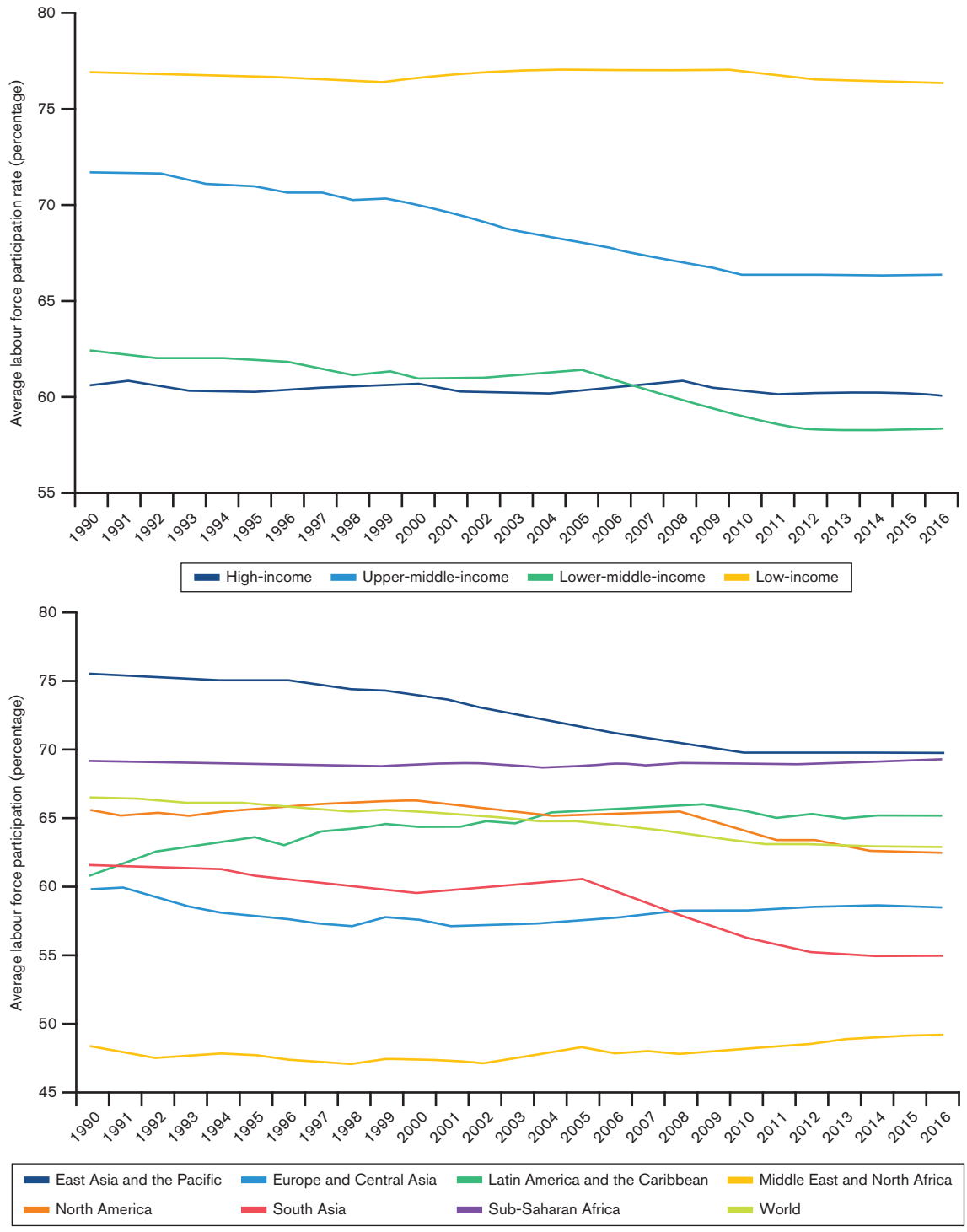
Part of these different trends in labour force participation is associated with changes in the output growth in response to business cycle fluctuations. While prior to the Great Recession of 2009 the correlation between gross domestic product (GDP) growth and the labour force participation rate was weak, that relationship has strengthened significantly ever since (see Appendix Figure B.1). In particular, GDP growth has tended to be associated with an increase in the labour force participation rate since the end of the financial crisis in 2010.

Besides business-cycle fluctuations, changes in population growth can also explain part of the different evolution of the labour force participation rate in and across countries. Population growth, in particular of people aged 15 and over, represents an important component of the evolution of the workforce, defined in economics as the labour supply. Economies are facing important changes in the size and composition of their populations as a result of the so-called "demographic transition" – a process characterized by a reduction in mortality rates, followed by a decline in fertility rates. Among the four stages of the demographic transition, the second stage, characterized by a reduction in fertility and an increase in the working-age population, as younger people reach adulthood, can, through a growing labour force and increased savings, potentially boost economic growth and expand labour markets, generating a so-called "demographic dividend".[3] Many developing and least-developed economies are still in the early stages of their demographic transition with an increasing younger population, while other developing economies and most developed economies have already reached more advanced demographic stages (WTO, 2013).[4] One of the most important consequences of the demographic transition is the shift in the age distribution of the population at the later stages of the transition, which can ultimately lead to a reduction in the labour force as a share of the population.

An increase in the prime working-age population, typically defined as the population aged 25-54, tends to be positively associated with an increase in the labour market participation rate for countries experiencing early and late demographic dividends, such as Argentina, El Salvador, Ghana, Malaysia and Pakistan (see Appendix Figure B.2).[5] Conversely, the relationship between population growth and labour market participation tends to be much weaker for countries with a low population growth rate, such as Angola, Belarus, Canada, Cuba, France, Japan, Senegal and the United States. There are, however, noticeable differences among economies, highlighting the different demographic dynamics each country is experiencing.

Labour force participation rates are also driven by two opposite trends: the relative decline in the labour force participation among the young (most often defined as 15-24 years old) and the relative increase in the labour force participation among older individuals (54-64 years old) (see Appendix Figure B.3). Labour force participation among the young has

Figure B.2: Evolution of labour force participation rate by income group and region (1990 to 2016)



Source: ILO, ILOSTAT database (July 2017).

fallen significantly in both developed and developing economies, such as China, Ecuador, Germany, Jamaica, Rwanda, Tanzania and Thailand. In fact, the share of young people in the total working-age population reached its peak between the 1970s and 1980s in most regions, with the exception of many Sub-Saharan countries, which peaked in the early 2000s. In comparison with countries for which the labour force participation among the young has decreased, the rise in the participation among the young in a limited number of countries, such as Mali, the Netherlands, Nigeria, Oman, Uganda and

Uzbekistan, is relatively more limited. The rise in labour force participation among older individuals is also much more modest in low- and middle-income economies than in developed economies.

The uneven evolution of the labour force participation rate across regions and countries also reflects the expansion of secondary and tertiary education, which tends to delay the entry into the job market of younger individuals and keep part of the adult individuals pursuing higher education out of the labour market for a longer period.[6] The relationship varies, however, even among countries within the same level of economic development (see Appendix Figure B.4). While most high-income economies, such as Canada, the Republic of Korea and the United States, tend to have relatively high tertiary school enrolment rates and a low labour force participation rate, several developing countries, such Belarus, Cuba, Kazakhstan, the Russian Federation, Ukraine and the Bolivarian Republic of Venezuela, are in relatively similar positions. Although access to secondary and tertiary education levels has also improved in a number of developing and least-developed countries, the tertiary enrolment rate remains relatively low compared to high-income countries. Access barriers to higher education due to income and location often persist in many countries. Individuals with limited financial means must often work in parallel, which can hinder their participation, retention and academic success in secondary and tertiary education (UNESCO, 2015).

Part of the uneven evolution of the labour force participation rate across regions and countries can also be explained by two other opposite labour market trends, namely the relative increase in female participation in the labour force and the relative decrease in male participation in the labour force. Overall, the ratio of female to male labour force participation has slightly decreased in middle-income economies, but has increased in high- and low-income economies in the past two decades (see Appendix Figure B.5).

Female participation rates have risen across many economies, but more so in some than in others. Economies such as Chile, Colombia, Peru and Spain have experienced some of the sharpest increases in women's participation rates. Many other economies, such as Canada, France, Indonesia and the Republic of Korea, have registered a more modest rise in the female participation in the labour force. Several other economies, such as China, India, Japan and Poland, have experienced a relative decline in the labour force participation of women.[7] Despite the fact that female labour force participation has increased in a number of countries, the global labour force participation rate for women (46 per cent) remains lower than the rate for men (72 per cent).

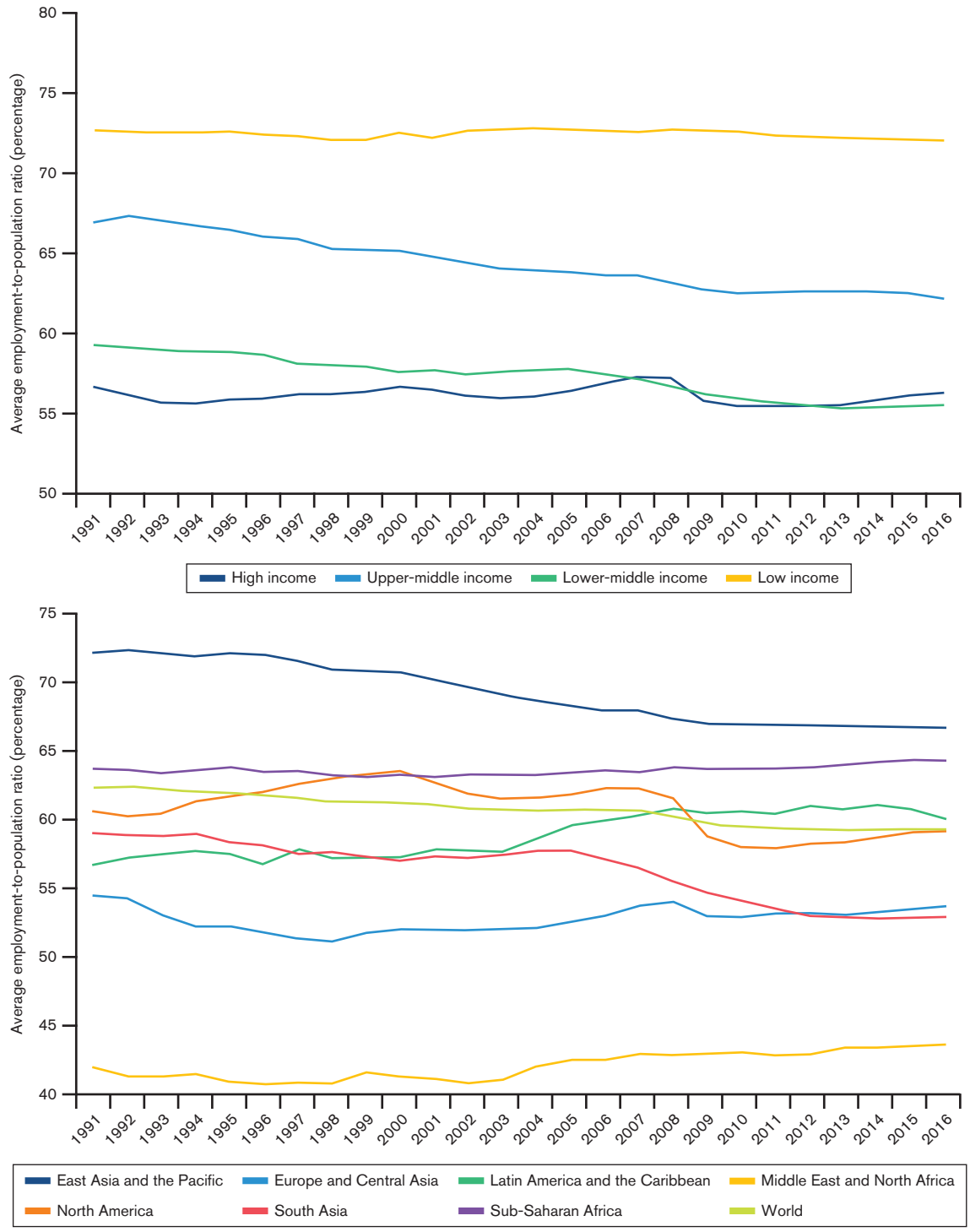
The participation rate for men has decreased across a large number of countries, although the level of decline differs significantly across countries. Most high-income economies, such as Australia, Japan and the United States, have experienced a significant decrease in male labour force participation, and many developing and emerging economies, such as Argentina, Bangladesh, China and India, have also faced a decrease in the male participation rate. However, male participation rates have increased in several other economies, such as Cambodia, Colombia, Ghana, Myanmar and Peru. In a few economies, such as Angola, Qatar and Sweden, the male participation rate has remained relatively constant.

(b) The employment-to-population ratio has remained constant in many low- and middle-income economies but has increased in high-income economies in recent years

The employment-to-population ratio, defined as the share of a country's working-age population that is actually employed, measures the ability of an economy to provide jobs for individuals who want to work. According to ILO estimates, the overall employment-to-population ratio exhibited a downward trend in middle-income countries up until the Great Recession, after which it became relatively constant (62 per cent and 55 per cent in upper- and lower-middle-income countries, respectively, in 2016). Low-income countries experienced a relatively constant employment-to-population ratio for a longer period time (72 per cent in 2016). Conversely, high-income countries have faced a much more volatile employment-to-population ratio. It dropped sharply during the Great Recession and remained stable for a few years, but has increased in the last three years (56 per cent in 2016). Like the labour force participation rate, the levelling and decline in the employment-to-population ratio tends to be more marked in middle-income economies than in developed economies, as shown in the lower panel of Figure B.3.

There are, however, sizeable disparities among developing and least-developed countries, as documented in the lower panel of Figure B.3. Economies in Asia and the Pacific have experienced the largest reduction in the employment-to-population ratio, from 72 per cent in South Asia and 59 per cent in East Asia and the Pacific in 1991 to 66 per cent and 52 per cent in 2016, respectively. Conversely,

Figure B.3: Evolution of employment-to-population ratio by income group and region (1991 to 2016)



Source: ILO, ILOSTAT database (July 2017).

most countries in the Middle East, North Africa, Sub-Saharan Africa, and Latin America and the Caribbean went through a relatively small increase in the ratio. Similarly, many developed countries, such as Canada, Germany and the United Kingdom, have registered a relative increase in the ratio. Other high-income countries, such as Japan and the United States, have faced a declining employment-to-population ratio for more than 15 years, which tended to accelerate after the Great Recession.

Besides cyclical economic fluctuations, part of these different trends in the employment-population ratio reflects labour market differences between age groups

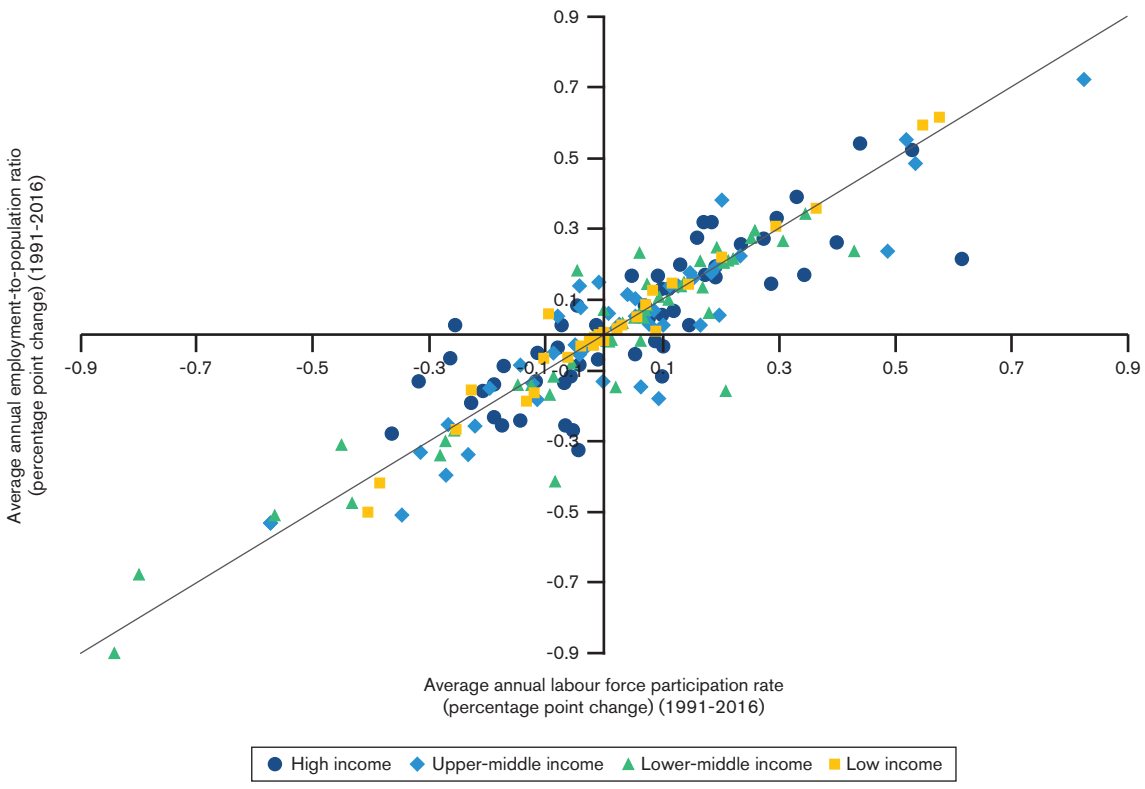
and gender. In particular, the youth employment-to-population ratio has exhibited a downward trend across many countries over the last two decades (ILO, 2015a). The level of the youth employment-to-population ratio is lower in North Africa and the Middle East (20 per cent in 2016) in particular, as well as in Southern Asia (33 per cent) and in Central and Southeastern Europe (34 per cent). As discussed in Section B.2, the declining trend of youth employment-to-population is closely associated with increasing trends in educational enrolment. The employment-to-population ratio also remains significantly lower for women (47 per cent in 2016) than for men (72 per cent). The gender employment gap is more marked in North Africa and the Middle East, in particular, as well as in Southern Asia, where the female employment-to-population ratio is more than three times lower than that for men (ILO, 2016d).

Overall, and as highlighted in Figure B.4, the employment-to-population ratio tends to be, on average, closely correlated with the labour force participation rate. This strong positive relationship between the labour force participation rate and the employment-to-population ratio is to be expected and reflects, at least partially, the negative impact job losses and unemployment may have on labour force participation rate.

(c) The unemployment rate does not exhibit any long-term trends

The unemployment rate, defined as the fraction of the labour force that is unemployed, is the most widely used measure of labour market slack, i.e. unused labour resources.[8] According to ILO estimates, there were 38.6 and 159.1 million unemployed workers in developed and developing countries, respectively, in 2016. The geographical distribution of the number of unemployed workers differs significantly across regions. East Asia accounts for the largest number of unemployed workers, with 41.6 million jobless individuals, followed by Southern Asia (29.5 million), Sub-Saharan Africa (28 million), Latin America and the Caribbean (25.1 million) and Western Europe (20.2 million). The number of unemployed workers is significantly lower in other regions, such as North Africa and the Middle East (11.8 million), North America (9.4 million) and Central and Western Asia (6.6 million).

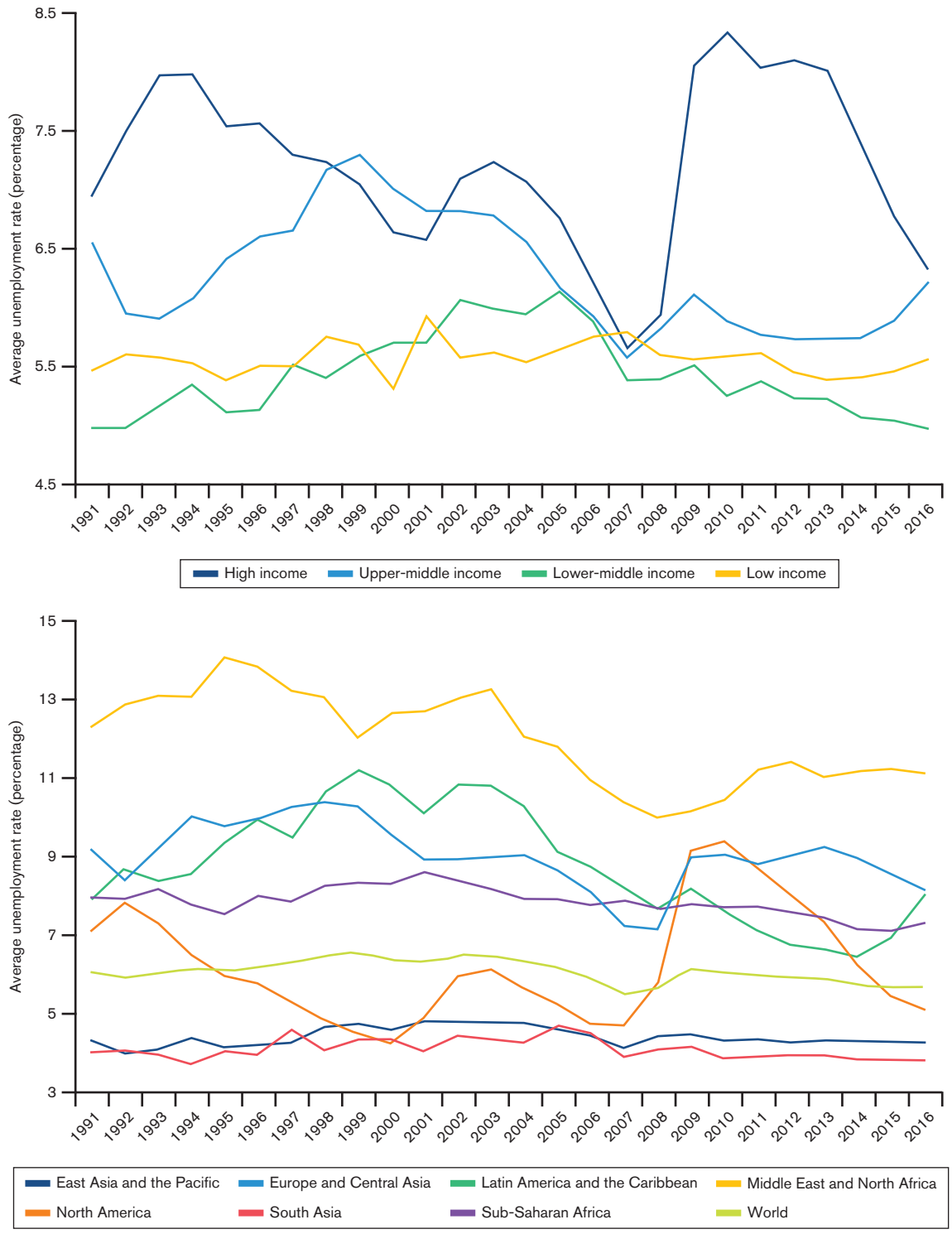
Figure B.4: Changes in labour force participation and employment-to-population ratio (1991 to 2016)



Source: ILO, ILOSTAT database (July 2017).

As highlighted in the upper panel of Figure B.5, the overall unemployment rate does not seem to present any specific long-term trends. It often tends to follow a cyclical pattern characterized by alternating periods of low and high unemployment. Part of this pattern reflects business cycle fluctuations. Periods of unusually high unemployment rates are often associated with severe economic slowdown and recession. Although there are some similar trends (co-movements) in unemployment rates between certain countries, typically in the same region and with a similar level of economic development,

Figure B.5: Evolution of unemployment rates by income group and region (1991 to 2016)



Source: ILO, ILOSTAT database (July 2017).

unemployment rate patterns remain highly country-specific, underscoring the diverse and idiosyncratic conditions prevailing in different countries.

Unemployment rose sharply in most developed countries during the Great Recession and declined only gradually thereafter.[9] By 2015, unemployment rates in some developed countries had returned to their pre-crisis levels, such as in Germany (4.6 per cent in 2016), Japan (3.4 per cent) and the United States (4.8 per cent). Conversely, countries of the European Union hit hardest by the Euro-zone crisis continue to experience extremely high jobless rates, including Greece (23 per cent in 2016) and Spain (19.6 per cent), highlighting the persistent nature of unemployment in certain economies. Overall, the global unemployment rate, which currently stands at 5.7 per cent in 2016, has not yet returned to its pre-crisis level of 5.5 per cent in 2007.

While the unemployment rate tends to be lower in developing countries, the relative incidence of joblessness varies greatly across and within regions, as highlighted in the lower panel of Figure B.5. North Africa and the Middle East have consistently had the highest regional unemployment rates. There are however important contrasts between these economies, as some have relatively low unemployment rates, such as the Kingdom of Saudi Arabia (5.5 per cent), and others have much higher rates, such as Egypt (12 per cent in 2016) and Tunisia (14.8 per cent). Other developing countries with a relatively high unemployment rate include Armenia (16.7 per cent), Brazil (11.4 per cent), Saint Lucia (24 per cent), South Africa (25.9 per cent) and the former Yugoslav Republic of Macedonia (26.7 per cent). While, as explained above, countries in Eastern and Southern Asia account for the largest number of unemployed workers, their ranking in terms of the unemployment rate is reversed, and they have some of the lowest unemployment rates in the world, e.g. 3.3 per cent in Malaysia, 3.6 per cent in the Republic of Korea, and 2.2 per cent in Viet Nam.

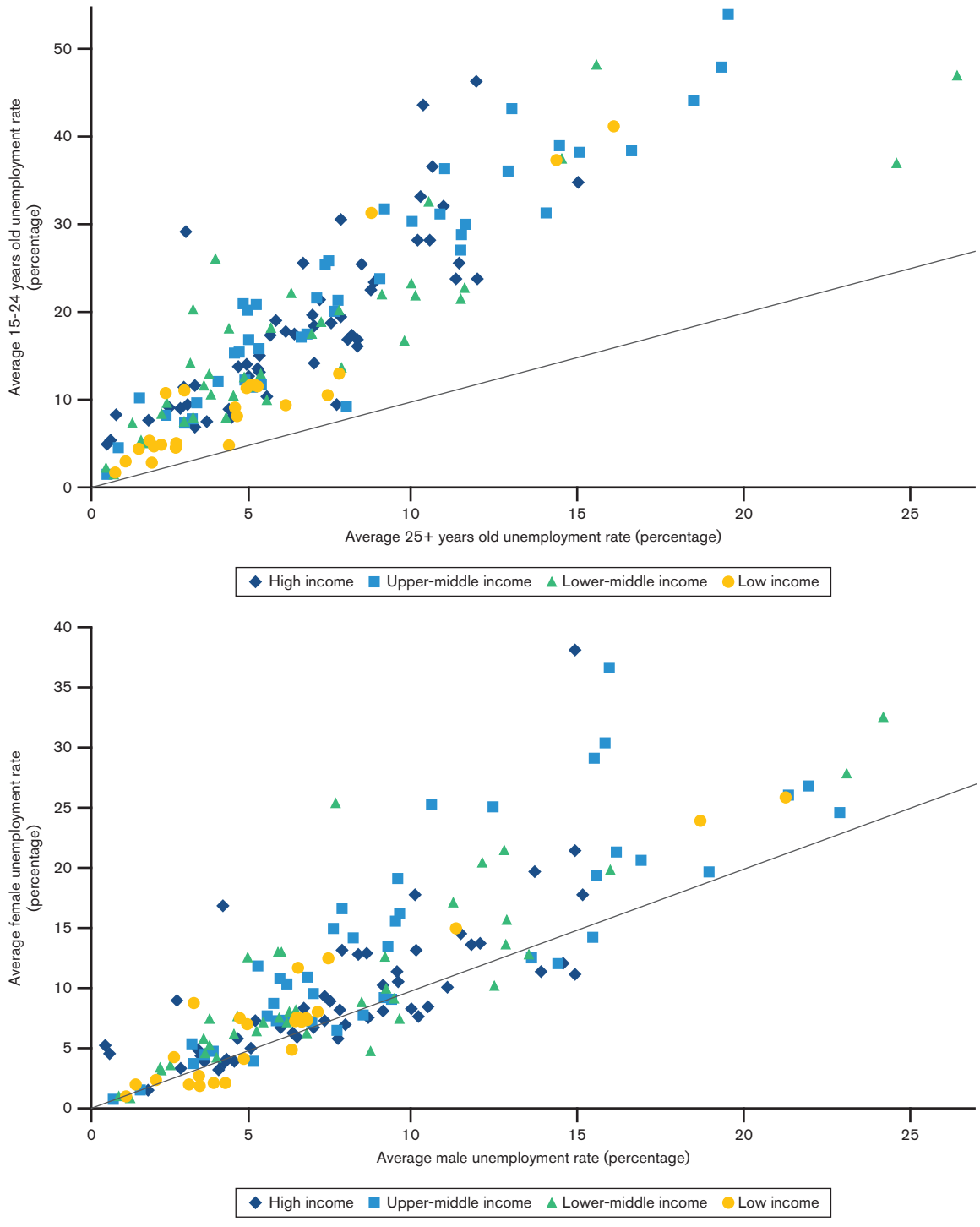
Even though the Great Recession hit high-income economies harder, it also had an impact on a large number of developing countries, in particular through an increase in their large informal economy, where employment relationship is, in law or in practice, not subject to labour legislation, income taxation, social protection or certain employment benefits (IMF and ILO, 2010). While measuring the size of the informal sector and tracking the trends in informal employment are particularly challenging, available data suggest that informal employment rates tend to decline with economic development but remain highly persistent in most developing countries (Bacchetta et al., 2009). According to ILO estimates, informal employment rates differ substantially between and within regions (ILO, 2014a).[10] In Eastern Europe and Central Asia, the informal employment rate ranges from 8 per cent in Serbia and 19 per cent in the Russian Federation to 39 per cent in Armenia and 63 per cent in Albania. Similarly, the informal employment rate varies across Latin American economies, from 25 per cent in Uruguay and 27 per cent in Mexico to 64 per cent in Guatemala and 74 per cent in Peru. Economies in Sub-Saharan Africa and South and Southeast Asia experience particularly high informal employment, such as Cambodia (77 per cent), India (80 per cent), Madagascar (97 per cent), Mali (76 per cent), Nepal (91 per cent) and Zimbabwe (94 per cent).

Like labour force participation rates, unemployment rates tend to differ across population groups, as illustrated in Figure B.6.[11] Historically, young people aged 15 to 24 years old have always been disproportionately more affected by unemployment than their adult counterparts. Unemployment among young people has exhibited an upward trend over the last 25 years; it declined in many countries in the early 2000s but then proceeded to rise again during the Great Recession (ILO, 2016g). According to ILO estimates, unemployment among young people is on average two to three times higher than that of adults, and is up to four or more times higher in some countries in Southeast Asia, Southern Asia and the Middle East. The youth jobs crisis is particularly acute in countries in North Africa and the Middle East (29.7 per cent in 2016), Pacific island small states (26.3 per cent), Caribbean small states (25.7 per cent) and Europe (20.9 per cent).

Traditionally, women's unemployment rates have also been higher than those of men in most countries. Although the unemployment rate gender gap decreased in many countries in the early 2000s, it has remained relatively constant since then. Women's unemployment rates tend to be larger in North Africa and the Middle East (on average 19.6 per cent in 2016) as well as in the Pacific island small states (17.6 per cent) and Caribbean small states (16.3 per cent). They are also relatively high in a number of Sub-Saharan African economies, such as the Gambia, Lesotho, Namibia and Swaziland. During the Great Recession, however, the sharp increase in the men's unemployment rate was such that it became larger than that for women in many economies (ILO, 2016d).

As mentioned above, many countries face persistent unemployment, which is characterized by a growing share of individuals with continuous periods of unemployment lasting a year or more. The situation worsened for many high-income countries during the Great Recession. In cases where the share of long-

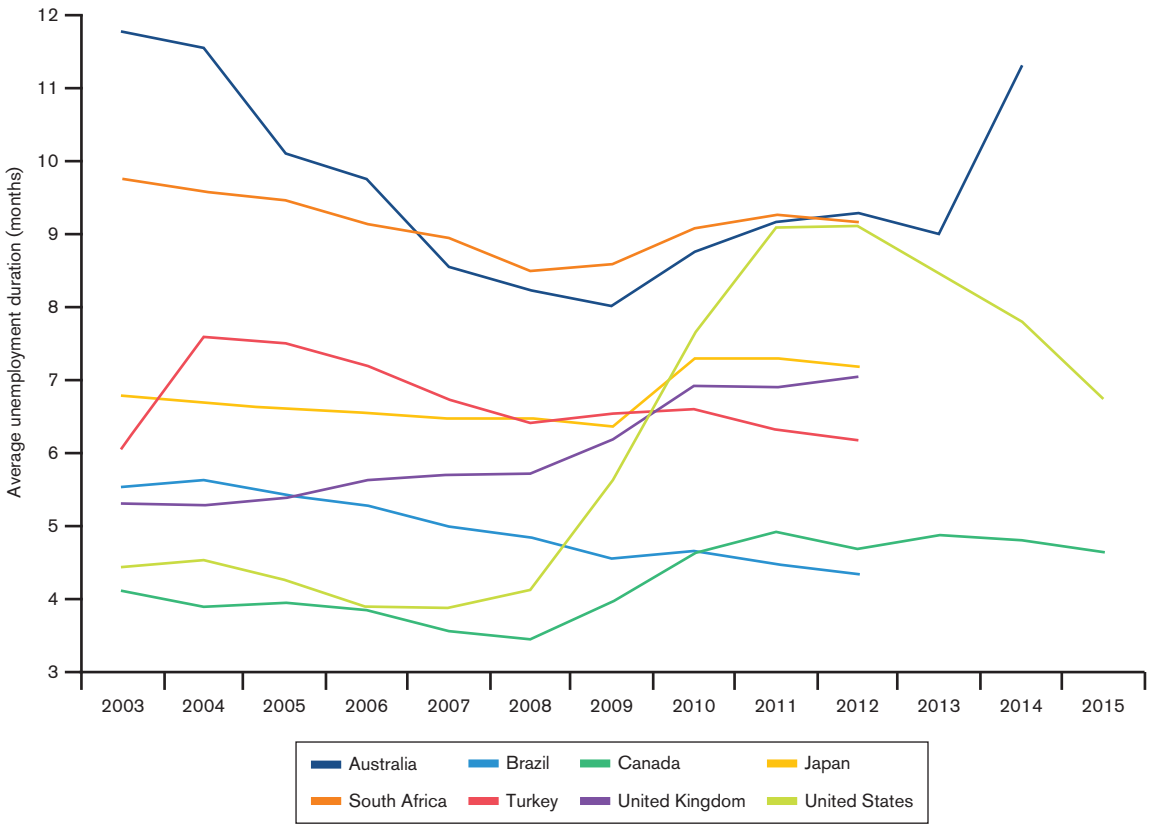
Figure B.6: Unemployment rate by age group and gender (1991 to 2016)



Source: ILO, ILOSTAT database (July 2017).

term unemployed did not increase, such as Germany, France, Italy and Japan, the share had persistently been very high even before the global economic recession (OECD, 2017). This increasing share of long-term unemployment is also associated with an increase in the average unemployment duration and a reduction in the average probability of being rehired. As highlighted in Figure B.7, the evolution of the unemployment duration among the employed differs greatly from one country to another. In many developed countries, the average unemployment duration increased significantly during the Great

Figure B.7: Average unemployment duration in selected countries (2003 to 2015)



Source: ILO (2014a), OECD database (July 2017).

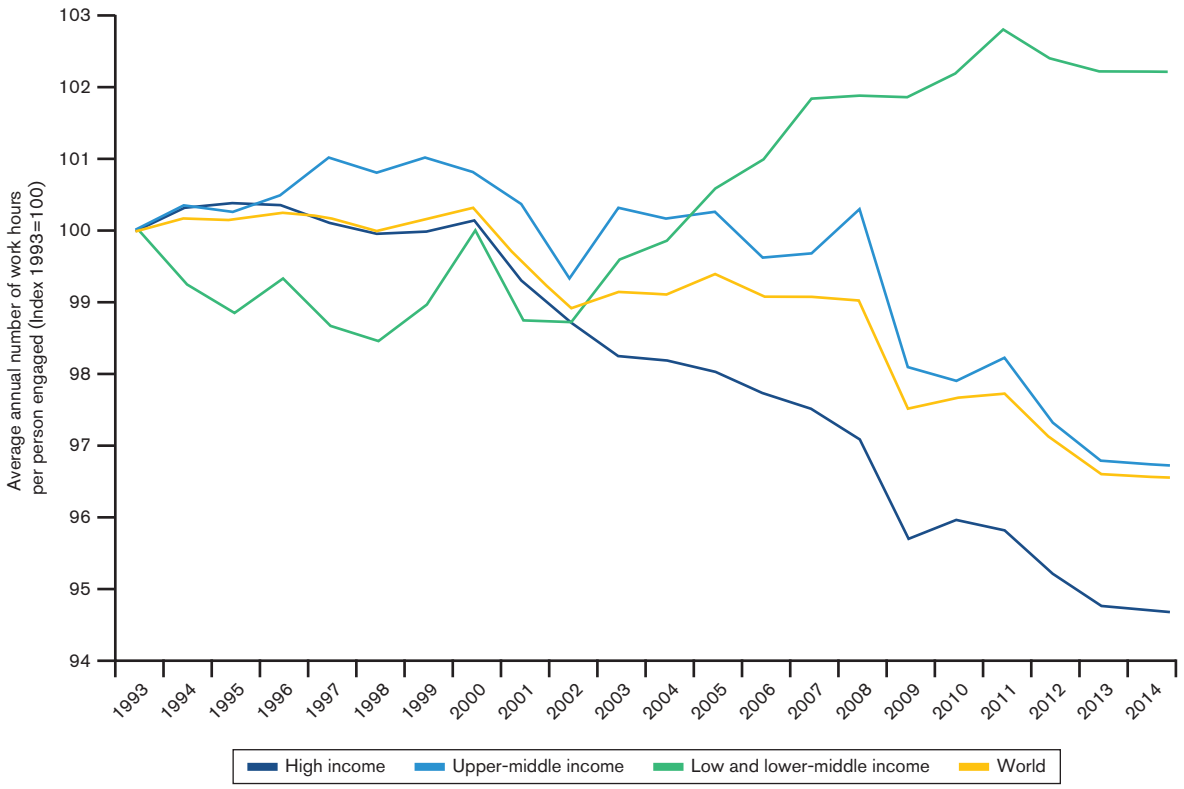
Recession but has not reverted to its pre-crisis level since then. This could increase the potential risk of hysteresis in unemployment, where unemployment remains high even after the causes that lead to its increase have disappeared (IMF and ILO, 2010). Conversely, the unemployment duration tends to be shorter in developing countries given the absence or limited access of unemployment compensation and benefits. Most developing countries have further experienced a steady decline in the average unemployment rate, which was not particularly affected by the Great Recession (ILO, 2014a).

(d) Average hours worked decreased in higher-income countries but increased in lower-income countries

The average number of hours worked varies significantly over time and across economies.[12] According to ILO estimates, the average weekly hours actually worked per employed person ranges from less than 35 hours in Australia, Ethiopia, the Netherlands and Uganda to more than 50 hours in Egypt, Myanmar, Qatar and Nepal. As shown in Figure B.8, the average annual number of hours worked per person engaged has, on average, decreased in high- and upper-middle-income countries but has increased in low- and lower-middle-income countries in the past two decades.

However, these broad trends mask important regional differences and country-specific evolution. In some countries, such as Colombia, Japan and the Republic of Korea, the decline in the average annual worked hours per person employed is relatively steady, while in other countries, such as Pakistan and Peru, the downward trend fluctuates more. Similarly, the upward trend is much more volatile in some countries, such as Sri Lanka and Viet Nam, than in others, such as the Russian Federation. Some other countries, such as Barbados, Malaysia and Singapore, have followed an inverted "U"-shaped pattern, where the average annual worked hours per person employed increased during the 1990s and decreased during the 2000s. The observed large volatility in hours of work reflects in part business cycle fluctuations (Ohanian and Raffo, 2012).

Figure B.8: Evolution of average hours worked (1993 to 2014)



Source: Penn World Table 9.0., Feenstra et al. (2015).

The average annual number of hours worked per person employed dropped significantly during the Great Recession in many economies. In some of these countries, such as Malaysia and Turkey, it has continued to decrease, while it has increased in several other countries, such as Argentina, the Philippines, the United Kingdom and the United States.

Part of the downward trend in average hours worked can be accounted for by changes in employment arrangements, in particular the increased incidence of non-standard jobs, namely temporary contracts, part-time hours and self-employment, in both developed and developing countries (ILO, 2015d). More than half of the jobs created in high-income countries between 1995 and 2013 have been non-standard jobs (OECD, 2015c). Non-standard work represented around one-third of total employment in high-income countries in 2013, shared almost equally between permanent part-time jobs, temporary jobs and self-employment. The use of temporary employment differs, however, greatly across economies, oscillating between less than 5 per cent in Jordan, Norway and Sierra Leone to more than 25 per cent in Mongolia, Peru and Poland in 2010. Casual work, for which there are no guaranteed work hours, is one form of temporary employment that has gained in importance in developing and emerging countries. For instance, casual employment accounts for almost 33 per cent of all wage employment in Mali and Zimbabwe and 66 per cent in Bangladesh and India (ILO, 2016c).[13] Casual and "on call" work arrangements, such as "zero-hours" contracts with no guaranteed minimum hours, are also increasingly being used in many high-income countries, such as the United Kingdom and the United States.

While part-time employment has been rising across many countries over the past two decades, it is important to distinguish between voluntary and involuntary part-time employment. Voluntary part-time employment refers to individuals who have deliberately decided not to work full-time or who have accepted a part-time job in the absence of full-time job opportunities. Conversely, involuntary part-time work concerns individuals who would rather be working full-time. From a macroeconomic perspective, involuntary part-time employment represents underemployment, which can, beyond a certain level, reduce demand and ultimately impact economic growth and employment negatively.[14] According to ILO estimates, the time-related under-employment rate, defined as the share of employed persons willing and available to increase their

working time but having worked fewer hours than a specified threshold, tends to be higher in low- and middle-income countries, such as Benin (37 per cent in 2010), El Salvador (21 per cent in 2013), Ethiopia (42 per cent in 2012) and Madagascar (49 per cent in 2010), than in high-income countries. There are, however, important variations across countries within the same region and income group.

Like the other labour market outcome variables discussed above, the distribution of hours worked is highly diverse across demographic groups (ILO, 2016c). In particular, the probability of being in temporary or part-time employment is higher for young and/or female workers. While in many economies part-time and temporary employment can serve as a foothold into more stable and better-paid jobs, this seems to be less the case for many high-income countries, where young individuals mainly participate in temporary and part-time job arrangements because of the lack of permanent or full-time job opportunities (OECD, 2015c). Women are also more likely to be underemployed (ILO, 2016d). A substantial part of temporary employment also tends to be informal in many developing countries, although informal employment is often also characterized by longer work shifts (ILO, 2015d). There are also important differences in working hours between sectors and between firms. In many countries, the range of working hours tends to be relatively higher in the services sector compared to manufacturing. Working hours tend to be very high in certain services activities, such as transport, catering and retailing (Lee et al., 2007). According to ILO estimates, 60 per cent of firms in developing and emerging countries did not rely on temporary labour in 2010, while more than 7 per cent used it intensively, with more than half of their workforce on temporary contracts (ILO, 2016c).

(e) Real wages have been growing in recent years but at a slower pace

Wages play an important role in determining living standards and the development of individuals. In some situations, wages may be part of the decision to choose a job. In others, jobs may not necessarily be remunerated. Work arrangements can be broadly grouped into (1) wage employment and (2) self-employment and unpaid family work.[15]

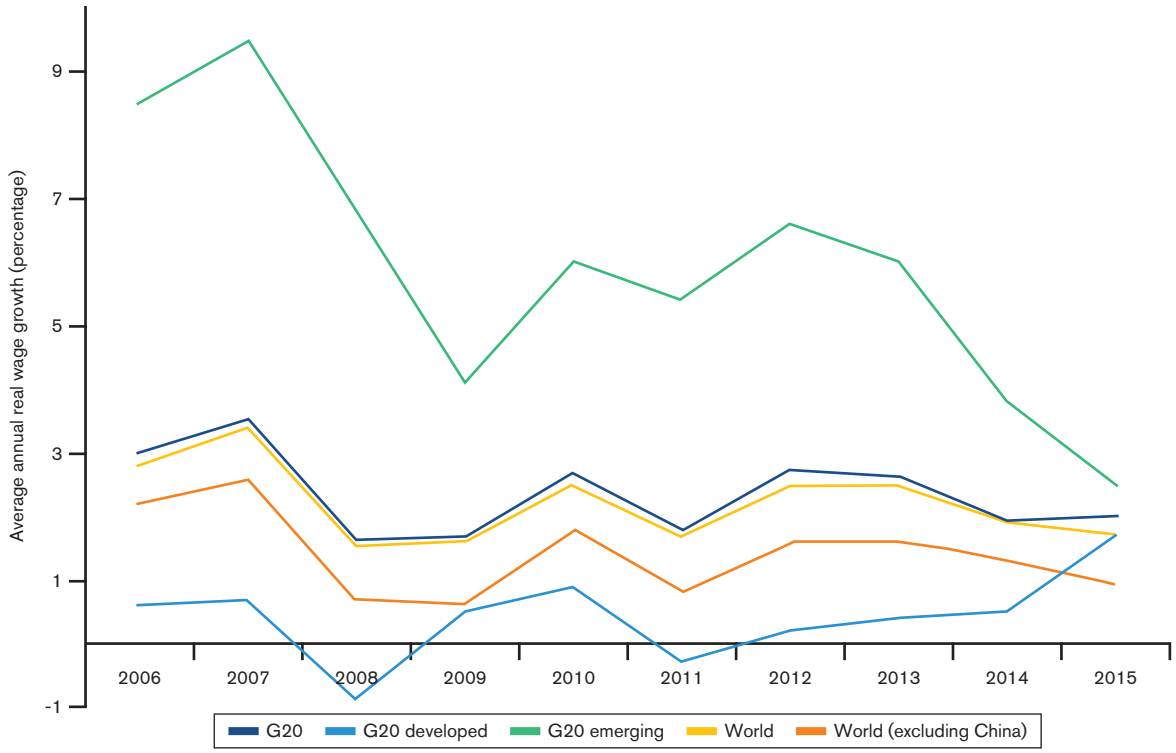
Data availability on wages, in particular for low-income economies, is limited. Available empirical evidence suggests that labour earnings, which encompass the wages and earnings of self-employed and other types of non-wage workers, tend to increase with economic development. Similarly, job benefits, such as holiday leave, sick leave, health insurance and retirement plans, tend to be offered and developed as an economy's economic development increases and reaches a high level. Wages for the same occupation also tend to converge across countries (World Bank, 2013). As highlighted in Figure B.9, once inflation is taken into account, average annual real wage growth has been relatively stagnant in high-income countries, and has been higher but declining in emerging countries during the years from 2006 to 2015 (ILO, 2016b). As with the labour outcome variables discussed above, these general trends hide differences across regions and countries.

While real wage growth has been restrained in some high-income countries, it turned negative in many countries on several occasions during the Great Recession. Indeed, wage growth tends to be weak whenever unemployment is high, which is typically the case during recessions, as discussed above. Since the end of the Great Recession, the average real wage growth has exhibited an upward trend, reaching the highest rate of the past 10 years in 2015 with 1.7 per cent. Faster real wage growth in Australia, France, Germany and the United States accounts for a large part of the upward trend given the decline in real wages experienced by other high-income countries, such as Italy, Japan and the United Kingdom (ILO, 2014b; 2016b).

Similarly, the evolution of average real wage growth in emerging countries, and more generally in the world, has been driven to a large extent by emerging economies in Asia and the Pacific, in particular China and the Republic of Korea. The average real wage growth in emerging economies initially bounced back following its steep decline during the Great Recession but eventually reverted to a downward trend. However, it tends to grow faster in emerging and developing countries in Asia and the Pacific (4 per cent in 2015) and in Central and Western Asia (3.4 per cent) than in most high-income countries in North America (2 per cent) and Northern, Southern and Western Europe (1.5 per cent). Tentative estimates suggest a similar situation in Africa and the Middle East. The annual average real wage growth tends to be more volatile in Eastern Europe and in Latin America and the Caribbean, where it turned negative in 2015 mainly because of decreasing wages in Brazil, the Russian Federation and Ukraine (ILO, 2016b).[16]

In a broader context, real wages are associated with the evolution of the labour-income share, defined as the share of national income paid in wages, including benefits to workers. For a long time the labour-income share was considered stable over time. However, recent empirical evidence pointed to a long-term

Figure B.9: Annual average real wage growth (2006 to 2015)



Source: ILO (2016b).

Note: The G20 developed group includes Australia, Canada, the European Union, France, Germany, Italy, Japan, United Kingdom and the United States. The G20 emerging group includes Argentina, Brazil, China, India, Indonesia, the Republic of Korea, Mexico, the Russian Federation, the Kingdom of Saudi Arabia, South Africa and Turkey. The second global estimate, "World (excluding China)", omits China because its large population of wage employees weighs significantly on the global estimates ("World").

downward trend in the labour-income share (with the consequent increase in the capital income share) in a large number of developed, but also developing, countries, such as Argentina, Canada, China, Indonesia, South Africa, Turkey and the United States (ILO, 2011b; ILO-OECD, 2015; World Bank, 2016; IMF, 2017).[17]

The evolution of the labour-income share remains highly country-specific, even among countries with a declining labour-income share. Several developed and developing countries, such as Brazil, Malaysia, New Zealand, the Philippines and the United Kingdom have experienced an increase in the labour-income share in the last 25 years, while it has remained relatively constant in a few other countries, such as Hungary, Mexico and Morocco (IMF, 2017).

Besides business fluctuations and price inflation, part of the evolution of real wages is linked to the growing share of non-standard employment, such as part-time and temporary employment, which is often associated with lower wages (ILO, 2016c). Real wages tend also to differ across different population groups. Women tend to earn less than men even after controlling for differences in individual and job characteristics (ILO, 2017; Verick, 2014). Empirical evidence from a large number of different countries suggests that this gender wage gap between men and women with similar characteristics ranges from 4 per cent in Tunisia and 6 per cent in Bosnia and Herzegovina to 38 per cent in United Kingdom and 52 per cent in Congo (Ñopo et al., 2011).

Informal employment tends also to be less remunerative than formal employment (Normand et al., 2016; Dasgupta et al., 2015). The level of wages depends also on the type of firms active in the country with larger firms tending to pay higher wages (WTO, 2016; World Bank, 2013). As discussed in detail in the next subsection, part of the evolution of wages also reflects changes in the skill composition within employment, with a higher premium generally paid for more skilled occupations.

As explained above, besides wage employment, individuals can be engaged in self-employment and unpaid family work. Yet, these workers are more

likely than wage earners not to have formal work arrangements, not to be covered by social protection, to receive lower earnings and to face less predictable income streams (ILO, 2015d; Bianco, 2017). In many developing and least-developed countries, self-employment and unpaid family work continue to be important forms of employment.[18] According to ILO estimates, wage and salaried employment accounted for 57 per cent of global employment in 2016, while self-employed and contributing unpaid family workers represented almost 47 per cent and 79 per cent of total employment in emerging and developing countries, respectively (ILO, 2016f).

Although the share of self-employment and unpaid contributing family employment has declined in many countries over the years, its downward trend seems to have slowed down in several regions since the late 2000s.[19] The share remains particularly high in Southern Asia (75 per cent in 2016) and Sub-Saharan Africa (68 per cent). The incidence of self-employment and unpaid family work tends also to be higher among women and young people (ILO, 2016g; 2017).

2. Structural changes in the labour market

As documented above, labour markets are complex and multifaceted systems shaped by demographic, economic, social and institutional factors. Two important transformations in the sectoral and occupational structure of employment have occurred in a large number of economies over the past two decades.

First, developed countries and an increasing number of developing countries have experienced a sustained shift of employment from agriculture and manufacturing toward services.

Second, the labour markets of many developed countries and several developing countries have been polarized with the relative decline in the number of middle-skill/middle-pay jobs compared to the relative increase in the number of low-skill/low-pay and high-skill/high-pay jobs.

These important structural changes, which have changed and continue to change the labour market, may be relatively disruptive for workers, who face a higher risk of job loss and of having to switch to a job in a different type of occupation or sector (see Box B.2). This subsection discusses both phenomena, which have received increasing attention in the literature and in the political arena.

(a) Employment has shifted from agriculture and industry toward services in many countries

The role of the agricultural, industry and services sectors in terms of job number has changed significantly in most countries over the past few decades. While the employment shares of agriculture and manufacturing in total employment have declined or stagnated in an increasing number of developed and developing countries, the services employment share has steadily increased in most countries.

(i) Agricultural employment growth and share have declined and slowed down in many countries

The agricultural sector, which encompasses activities in agriculture, hunting, forestry and fishing, was the world's largest provider of jobs up until the early 2000s (FAO, 2015). Since then, the number of jobs in agriculture has been decreasing in most countries. In parallel, the share of agricultural employment in total employment has fallen steadily in both developed and developing countries over the last 50 years, as highlighted in Figure B.10. According to ILO estimates, the world share of agricultural employment in total employment decreased from 39.6 per cent in 2000 to 29.1 per cent in 2016.

While the share of agricultural employment in total employment is very low in developed countries (on average 3.1 per cent in 2016) and relatively low in an increasing number of developing countries in Latin America and the Caribbean (15.6 per cent) and Pacific island small states (16.2 per cent), it remains relatively high in many economies in Africa, in particular Sub-Saharan Africa (55.7 per cent), and in Southern Asia (44.2 per cent). The employment share is particularly high in certain low-income economies, such as Burkina Faso (80.1 per cent in 2016), Burundi (91.3 per cent), Lao People's Democratic Republic (79 per cent) and Papua New Guinea (68.4 per cent). The agricultural sector often represents an important source of informal employment in many developing countries (Walther, 2011).[20] In addition, as explained in the previous subsection, self-employment and unpaid family work are the most important forms of employment in many developing and least developed countries, where many agricultural workers are engaged in small subsistence farming. Women tend also to be over-represented in the agricultural sector in many economies in Southern Asia, and to a lesser extent in North Africa and the Middle East, Sub-Saharan Africa, and Central, Western and Eastern Asia (ILO, 2017).

Box B.2: Workers transition between economic activities

In the presence of important structural changes in the labour market, along with technological change and globalization progress, a common perception is that workers may have to transition between economic activities more frequently. However, recent empirical research based on longitudinal household data, tracking individuals over a long period of time, suggests that this does not seem to have been the case for several high- and middle-income countries for at least the past decade (Muendler, 2017).

In fact, the share of cross-sector transitions has gradually declined in economies that offer historic longitudinal household data, as shown in Table B.1. In particular, the frequency of cross-sector moves has gradually declined, from 15 per cent to 9 per cent in the United States between 1977 and 2013, from 12 per cent to 5 per cent in the United Kingdom between 1995 and 2013, and from 8 per cent to 6 per cent in the Republic of Korea between 2007 and 2013. The analysis of cross-industry transitions reaches the same conclusion. The Russian Federation is the only economy for which data are available that has faced a different experience, both in terms of the level of transition frequency and of changes over time, with an increase in the frequency of cross-sector moves from 64 per cent to 75 per cent between 2008 and 2013 (not reported in Table B.1).

Table B.1: Shares of four-year transitions of workers across sectors (1977 to 2013)

	Australia	Germany	Republic of Korea	Russian Federation	Switzerland	United Kingdom	United States
1977	-	-	-	-	-	-	15.3%
1983	-	-	-	-	-	-	11.7%
1989	-	13.4%	-	-	-	-	11.6%
1995	-	14.5%	-	-	-	11.8%	11.5%
2001	-	10.8%	-	-	-	10.7%	12.1%
2007	11.6%	10.1%	7.6%	-	9.1%	8.9%	10.1%
2013	8.8%	10.2%	6.4%	74.6%	6.8%	4.5%	9.3%

Source: Muendler (2017)

Note: Share of four-year transitions of workers among three consistently defined sectors: (1) agriculture, energy and mining, (2) manufacturing and (3) services. Entries show the share of household members, with wage employment in the reported year and the four years prior, who are currently employed in one sector but were employed in another sector four years prior.

The recent decline in the frequency of workers' cross-industry and cross-sector moves could raise concerns that, in the wake of the Great Recession, workers may have transitioned into unemployment or out of the labour force altogether, rather than transitioning between economic activities. Yet the broad-based decline in transition frequencies occurs both in economies that were less affected by the Great Recession, such as Germany and Switzerland, and those that were strongly affected, such as the United Kingdom and the United States. One potential explanation for the common perception that workers transition between economic activities more frequently today than in the past may have to do with the specific transition experiences of the manufacturing sector, where technical change can be disruptive and globalization can occur quickly. The speed of gross worker outflows from manufacturing, among workers who continue in the workforce, seems to be steady in most economies, as shown in Table B.2. Some economies, such as Australia or the Russian Federation, have experienced fast gross worker moves out of manufacturing, while others, such as Germany or Switzerland, have undergone more gradual transitions out of manufacturing. Yet other economies, such as the United Kingdom and the United States, saw a slowdown in gross worker moves out of manufacturing. However, given the decline of manufacturing employment in total employment across these economies, net worker flows must be directed away from the manufacturing sector.

As workers continue in or move between sectors, their earnings change. If transitions out of a sector are driven by a pull from stronger labour demand in other sectors, moves are likely to be associated with wage gains. In contrast, if workers move out of a sector because of a push from weakening labour demand in their initial employment sector, the sector changes are expected to be accompanied by wage losses. Workers who stay in the manufacturing sector over a four-year period, either retaining their jobs or moving to different manufacturing jobs, command real wage increases in all reported periods, except for continuous manufacturing workers in the United Kingdom in 2013, as reported in Table B.3. Conversely, experiences with real wage changes for workers who moved to the primary or services sectors are much more diverse over time and across countries. Workers who transitioned to non-manufacturing sectors in the United States

suffered slower real-wage changes or outright real wage declines, while workers who switched out of manufacturing employment in Australia or, more recently, in the Republic of Korea, Switzerland and the United Kingdom experienced faster real wage gains than those who remained in the manufacturing sector.

Table B.2: Shares of four-year continuations and transitions of workers across sectors from manufacturing (1989 to 2013)

		Australia	Germany	Republic of Korea	Russian Federation	Switzerland	United Kingdom	United States
1989	Primary	-	0.6%	-	-	-	-	1.7%
	Manufacturing	-	78.7%	-	-	-	-	77.5%
	Services	-	20.7%	-	-	-	-	20.8%
1995	Primary	-	1.3%	-	-	-	1.2%	1.7%
	Manufacturing	-	72.1%	-	-	-	69.3%	72.5%
	Services	-	26.6%	-	-	-	29.6%	25.7%
2001	Primary	-	1.0%	-	-	-	0.7%	1.1%
	Manufacturing	-	77.4%	-	-	-	67.9%	69.4%
	Services	-	21.7%	-	-	-	31.4%	29.5%
2007	Primary	5.2%	0.6%	1.0%	-	0.6%	2.4%	1.2%
	Manufacturing	61.2%	78.2%	81.7%	-	76.5%	70.5%	68.8%
	Services	33.6%	21.1%	17.3%	-	22.9%	27.1%	30.1%
2013	Primary	4.0%	2.6%	0.7%	3.3%	1.1%	0.9%	1.8%
	Manufacturing	63.0%	75.7%	86.2%	55.0%	80.1%	81.8%	75.7%
	Services	33.1%	21.7%	13.0%	41.7%	18.8%	17.3%	22.5%

Source: Muendler (2017)

Note: Share of continuations or transitions to the primary, manufacturing or services sectors for workers who were in manufacturing employment four years prior. Entries show the share of household members, with wage employment in the reported year and four years prior, who were employed in the manufacturing sector four years prior.

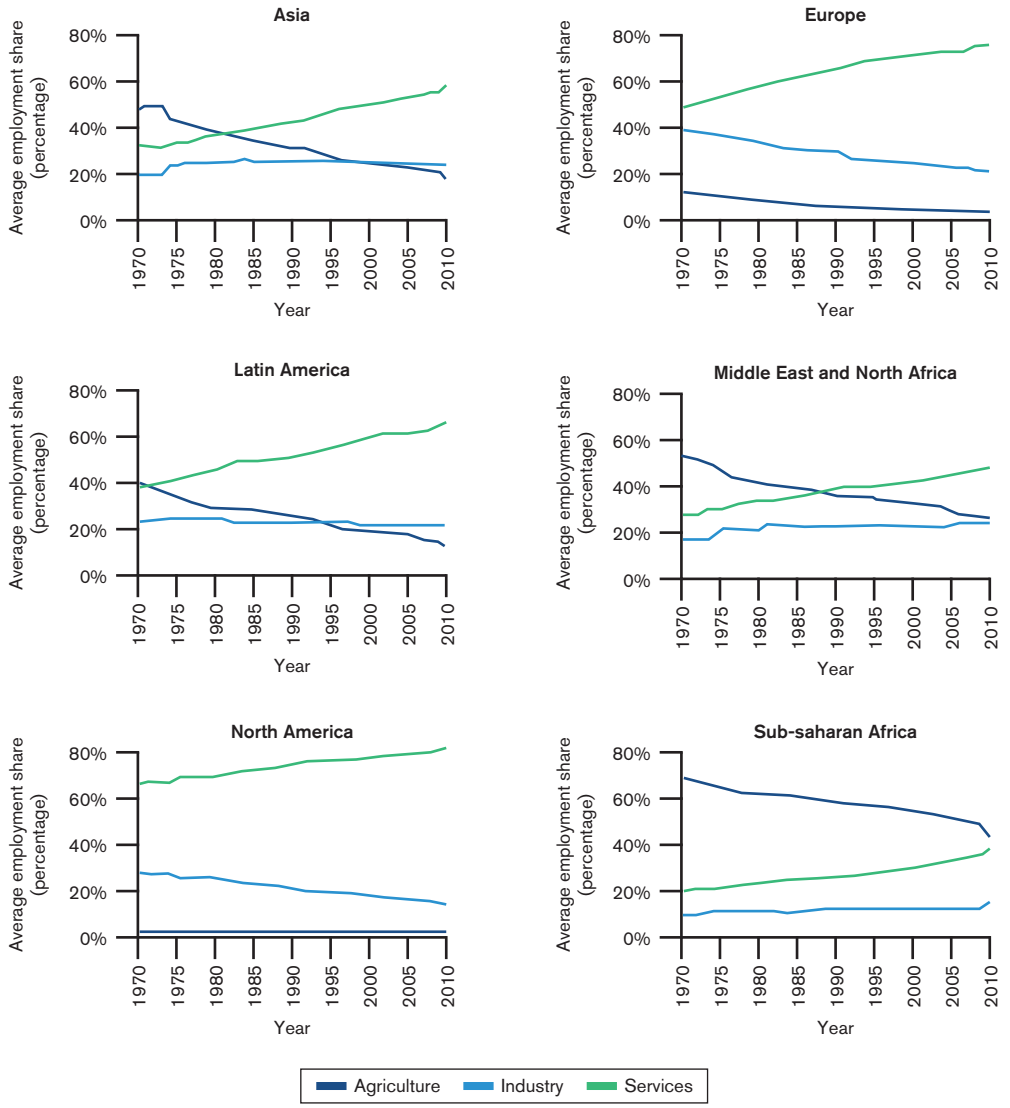
Table B.3: Annual real wage differences of four-year continuations and transitions of workers across sectors from manufacturing (1989 to 2013)

		Australia	Germany	Republic of Korea	Switzerland	United Kingdom	United States
1989	Primary	-	0.31	-	-	-	0.47
	Manufacturing	-	0.20	-	-	-	0.11
	Services	-	0.18	-	-	-	-0.04
1995	Primary	-	0.38	-	-	-0.59	-0.03
	Manufacturing	-	0.10	-	-	0.16	0.07
	Services	-	0.09	-	-	0.07	-0.09
2001	Primary	-	0.15	-	-	0.35	0.10
	Manufacturing	-	0.15	-	-	0.18	0.19
	Services	-	0.21	-	-	0.07	0.08
2007	Primary	0.41	0.20	-1.11	-0.29	-0.11	0.36
	Manufacturing	0.16	0.03	0.17	0.06	0.07	0.07
	Services	0.25	-0.03	0.15	-0.18	-0.13	-0.10
2013	Primary	0.25	0.06	0.14	0.62	0.02	-0.37
	Manufacturing	0.13	0.11	0.10	0.10	-0.01	0.00
	Services	0.16	0.00	0.15	0.15	0.01	-0.14

Source: Muendler (2017).

Note: Four-year difference of annual gross wages, expressed in local currency real terms, with continuations or transitions to the primary, manufacturing or services sectors conditional on their manufacturing employment four years prior. Entries show the mean differences of the logarithm of gross annual wages, after deflating wages with the country-specific consumer price index (base year 2014) for longitudinally trackable household members, with wage employment in the reported year and four years prior, who were employed in the manufacturing sector four years prior.

Figure B.10: Employment share by sector (1970 to 2011)



Source: Timmer, de Vries and de Vries (2015).

Note: This figure covers 40 economies: 10 developed and 30 developing. The agriculture sector consists of activities in agriculture, hunting, forestry and fishing. The industry sector consists of mining and quarrying, manufacturing, construction and public utilities (electricity, gas, and water). The data range from 1970 to 2011, except for North America (1970 to 2010) because of data availability.

(ii) The manufacturing employment share has declined or stagnated in many economies

The industrial sector, which encompasses mining and quarrying, manufacturing, construction, and public utilities, has played an important role in the economic development of many developed and developing countries by attracting agricultural workers towards industrial activities with higher wages. In particular, the emergence and development of the manufacturing sector has enabled many low-income countries to develop and become middle- and high-income countries. Even though the global number of manufacturing jobs has increased relatively steadily in the past 25 years, manufacturing employment growth has been slowing down since the end of the Great Recession.

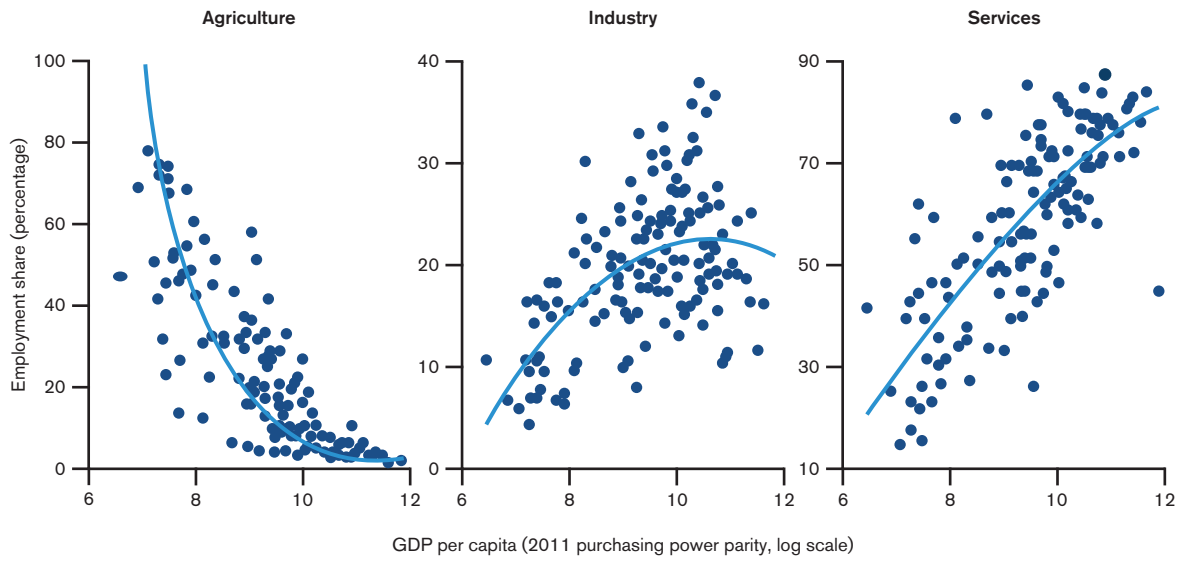
While manufacturing remains an important sector in many countries in terms of output and innovation, the world share of manufacturing employment in total employment decreased from 14.4 per cent in 1991 to 11.5 per cent in 2014.[21] The decline in the manufacturing employment share has been occurring in high-income countries for several decades but accelerated in the past two decades. For instance, the manufacturing employment share

fell from 30.6 per cent and 17.7 per cent in Germany and the United States in 1991 to 19.4 per cent and 9.8 per cent in 2014, respectively. In some countries, such as the United Kingdom and the United States, the manufacturing employment share actually slowed down significantly after the Great Recession. The downward trend of the manufacturing employment share has been less pronounced in other high-income countries, such as Japan (from 24.3 per cent in 1991 to 17 per cent in 2014) and Switzerland (from 17.1 per cent to 13.5 per cent) (UNIDO, 2015). However, the decline in employment differs significantly within the manufacturing sector. Some industries have experienced a larger decline in the employment share, such as textiles and footwear, wood, pulp and paper, while the employment share has increased in a couple of other industries, such as transport equipment and food products (OECD, 2017). While these structural changes may be relatively disruptive for workers, who face the risk of job losses and having to switch jobs, the decline in manufacturing employment has generally not translated into a falling manufacturing output (see Box B.2). It has, for instance, remained stable in Japan and increased in Germany and the United States.

The decline in the manufacturing employment share in total employment is not limited to high-income countries. Several emerging economies have also experienced a decrease in manufacturing jobs. For instance, the manufacturing employment share fell from 26.7 per cent in 1991 to 16.4 per cent in 2014 in the Republic of Korea. Other emerging economies exhibit a more stable trend, such as Brazil (12.9 per cent in 1991 and 2014) and Mexico (16.1 per cent in 1991 and 15.7 per cent in 2014). Conversely, a few emerging economies, such as China and India, have experienced a relative increase in the manufacturing employment share (Lardy, 2015; UNIDO, 2015). Similarly, the manufacturing employment share has expanded in several low-income economies, such as Botswana and South Africa.

As illustrated in Figure B.11, the share of industry employment in total employment tends to increase with economic development but ultimately decreases beyond a certain intermediate *per capita* income. A similar pattern applies to the manufacturing sector. Several recent studies have documented that late-industrializing developing countries tend to experience a decline in the manufacturing employment share at lower levels of economic development than early-industrializing countries (Rodrik, 2016; ILO, 2015c). In addition, the peaks in manufacturing employment share in late-industrializing countries tend to be lower than those in early-industrializing countries (with a 30 per cent manufacturing employment share on average).

Figure B.11: Employment share by level of economic development (2015)



Source: World Development Indicators (July 2017).

Note: The agriculture sector consists of activities in agriculture, hunting, forestry and fishing. The industry sector consists of mining and quarrying, manufacturing, construction and public utilities (electricity, gas, and water). Data on employment shares cover 2015 or the latest available year.

Another phenomenon that has received increasing attention in the literature is the decline in the share of female employment in the manufacturing sector as industrial production upgrades and becomes more capital-intensive from 50 per cent in 1991 to 38 per cent in 2014 (Greenstein and Anderson, 2017; UNIDO, 2015).

(iii) Services employment growth and share have increased in many countries

The deindustrialization process highlighted above is associated in many countries with the growing share of services employment in total employment. The services sector encompasses a broad range of activities ranging from professional services, healthcare and banking to retail and wholesale trade, tourism and transport. According to ILO estimates, the services sector has been the world's largest provider of jobs since the early 2000s. The global number of services jobs increased steadily by an average of 3 per cent annually between 2000 and 2016. Services accounted for more than half of total global employment growth in 2016. In parallel, the world share of services employment in total employment increased from 40.9 per cent in 2000 to 49.4 per cent in 2016.[22]

Although the share of services in total employment has increased in all regions of the world, this broad upward trend masks important differences between income groups and regions. As shown in Figure B.11, the services employment share tends to be significantly larger in high-income and upper-middle-income economies, ranging respectively from 42.4 per cent and 43.9 per cent in China and Thailand to 78.5 per cent and 82.7 per cent in the United States and Macao, China in 2015. The employment share of services tends also to be relatively larger in economies in Latin America and the Caribbean and relatively smaller in North Africa and the Middle East. Conversely, the services employment share remains particularly low in several low-income economies, in particular in Sub-Saharan Africa and Southern Asia, such as Burkina Faso and Nepal, with a 14.9 per cent and 16.2 per cent share, respectively.

As discussed in Section D, part of the growth in the number of services jobs, in particular in business and transport services, is related to the emergence and development of global value chains (ILO, 2015d; Kizu et al., 2016). An increasing number of services jobs is also created to support manufacturing production or sales, a phenomenon referred to as the "servicification of manufacturing". The incidence of temporary employment tends to be higher in services than in manufacturing in most developing regions, except North Africa, the Middle East and Southern Asia (ILO, 2015b).

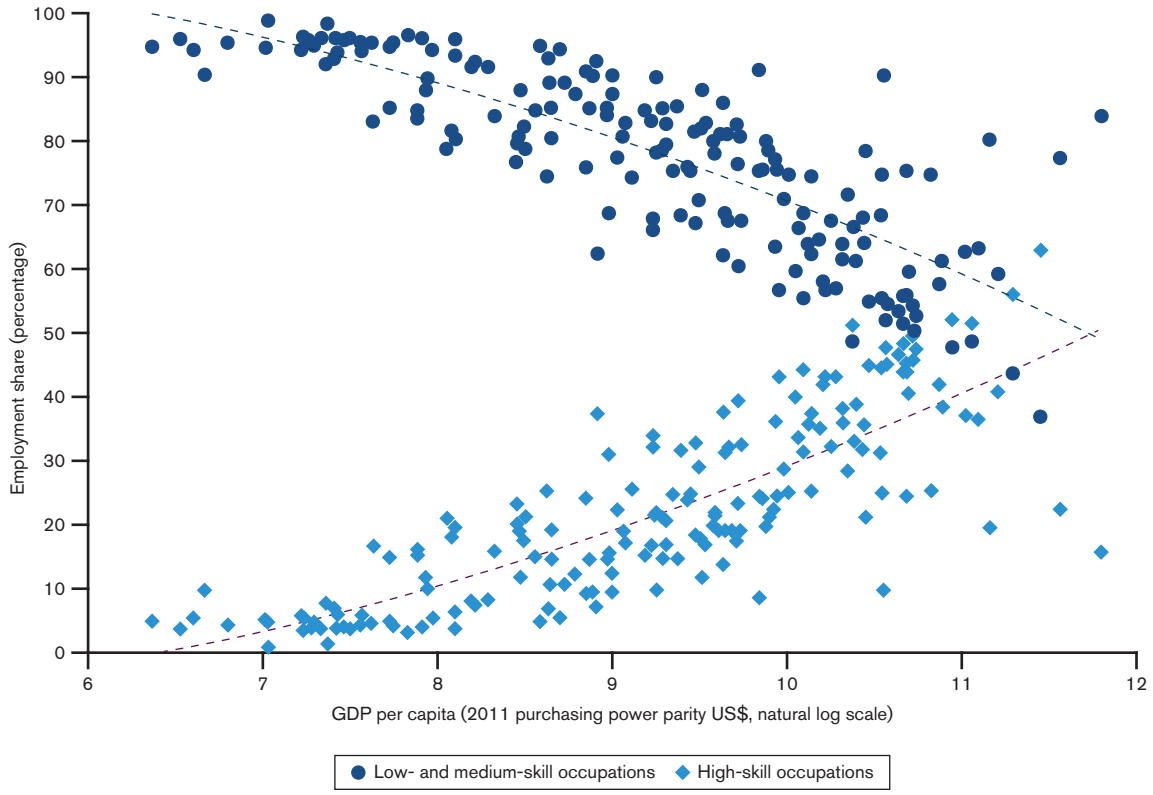
Unlike the manufacturing sector, where women tend to be underrepresented in some countries, the share of women in services tends to be higher, and in many cases is growing faster, than that of men in both developed and emerging economies (ILO, 2017). The services sector is the largest provider of jobs for women in many regions, including, in 2016, in North America (92 per cent), Europe (85 per cent), Southern Africa (81 per cent) and Latin America and the Caribbean (79 per cent). Similarly, unlike the agricultural sector, in which most of the working poor in developing countries are employed, 7 per cent of the individuals employed in services were in extreme poverty in developing countries in 2012 (ILO, 2016e).

(b) The demand for high skills has increased in many countries

While most countries have been experiencing substantial changes in their sectoral structure of employment, important changes in terms of skill requirements at the occupation level have also been occurring in many countries. Skills refer to job-relevant knowledge, expertise and personal attributes, as well as specific competencies required to perform a job's specific tasks. Each job and related tasks require a specific combination of skills. A distinction is often made between manual, cognitive and social skills to perform, respectively, physical, mental and personal interactive tasks (World Bank, 2013).[23] These skills requirements differ across occupations, sectors and geographical locations, as well as between and within firms (ILO-WTO, 2017).

Different approaches are used in the literature to measure skills. A large strand of the economic literature generally classifies skills into two (or three) categories based on occupation or level of qualification: low-, (middle-) and high-skilled workers.[24] A related classification is often made between production, or "blue-collar", workers and non-production, or "white-collar", workers. As highlighted in Figure B.12, the share of low- and high-skilled workers in employment evolves with economic development. A high level of economic development tends to be associated with a higher share of high-skilled workers in total employment. Conversely, the share of low-and medium-skilled workers is relatively larger in low- and middle-income countries. However, even for a given level of economic development, the skill structure of employment can vary significantly between countries, highlighting the important role of country-specific factors.

Figure B.12: Employment share by skill levels (2015)



Source: ILO, ILOSTAT database (July 2017), World Development Indicators (July 2017).

Note: Employment share across skill levels based on aggregating categories from the International Standard Classification of Occupation (ISCO): low- and medium-skill levels include elementary occupations (e.g. cleaners and helpers, agricultural labourers, food preparation assistants and street sales workers), clerical, services and sales workers, skilled agricultural and trade workers, plant and machine operators and assemblers. The high-skill level includes managers, professionals and technicians. Data cover 2015 or latest available year.

The share of workers in high-skill occupations in total employment is particularly large in high-income countries, such as Israel (52 per cent in 2016), Luxembourg (63 per cent), Singapore (56 per cent) and Switzerland (52 per cent). It is also relatively large in several upper-middle-income countries, such as Cuba (43 per cent in 2016) and the Russian Federation (44 per cent). In contrast, the share of high-skill occupations is significantly lower in low- and lower-middle-income countries, ranging from 1 per cent and 4 per cent in Guinea and Papua New Guinea to 22 per cent and 34 per cent in Bangladesh and Egypt in 2016.

As discussed in the previous section, the changes in the labour market over the past two decades partly reflect the expansion of secondary and tertiary education. While there are different ways to acquire and develop skills, including through vocational training and on-the-job learning, primary and secondary education are often the foundations necessary to further skills development throughout life (ILO-WTO, 2017).[25] Higher levels of educational attainment can therefore ultimately lead to a more skilled workforce. Education coverage, measured by the literacy rate, varies widely across countries. Developed countries tend to have much better educated workforces than developing countries. Although education coverage has improved significantly over the last two decades, it remains relatively low in many developing and least-developed countries (UNESCO, 2015). Overall, the increasing education coverage, albeit uneven, points towards a relative increase in the demand for skilled labour over time.

The relatively low education coverage in developing economies, in particular in low-income countries, is often associated with important skills mismatches, defined as imbalances between skills offered and skills needed in the world of work (ILO-WTO, 2017). As discussed hereafter in Section C.3(b), there are different types of mismatches. An increasing number of countries experience underskill mismatches, in which workers fill positions for which they do not have the required education and training (Hays, 2016; Sakamoto, 2017). According to ILO estimates,

the share of underskilled workers in total employment in the Southeast Asian region ranges from 22 per cent in Viet Nam in 2015 and 24 per cent in the Philippines in 2013 to 51 per cent in India in 2012 and 67 per cent in Timor-Leste in 2015. Although much lower, the incidence of overskill mismatches, in which workers are overqualified for the jobs they undertake, has been increasing in recent years in many developing economies. The share of overskilled workers in Southeast Asia ranges from 3 per cent in Timor-Leste in 2015 and 8 per cent in Cambodia in 2013 to 21 per cent in Viet Nam in 2015 and 32 per cent in the Philippines in 2013 (Sakamoto, 2017).

Part of the diverse skill structures across economies also reflects differences between sectors and demographic groups. The share of low-skill workers tends to be larger in agriculture, fisheries, mining, construction and transportation, as well as in food services and preparation, retail sales and customer services, and personal and home care helpers (OECD, 2008).[26] Similarly, women tend to be highly represented in certain low- and medium-skill occupations, such as certain elementary occupations (in restaurants, hotels, agriculture and fisheries) and as clerical supports.[27] However, women in high-income countries are also represented in certain highly paid managerial, professional and technical positions. High-skill occupations have also grown faster for women than for men in emerging economies in recent years (ILO, 2016d).

(i) Middle-skill and paid jobs have declined in many countries

According to ILO estimates, the share of middle-skill (routine) jobs in total employment of the global economy has remained relatively stable since at least the 2000s (37 per cent in 2013), while the share of high-skill (non-routine cognitive) jobs has increased, from 15 per cent in 2000 to 18 per cent in 2013, and the share of low-skill (non-routine manual) jobs has decreased from 50 per cent in 2000 to 45 per cent in 2013 (ILO, 2015c). These broad trends mask, however, stark differences between countries.

One phenomenon that has received increasing attention in the literature and political arena is so-called "job polarization", by which the number of high- and low-skill and paid jobs increases, while the number of middle-skill and paid jobs decreases. As discussed in Sections C and D, the literature has identified a number of factors that could explain the hollowing out of the middle-skilled occupations, including technological progress and international trade and, more generally, globalization.

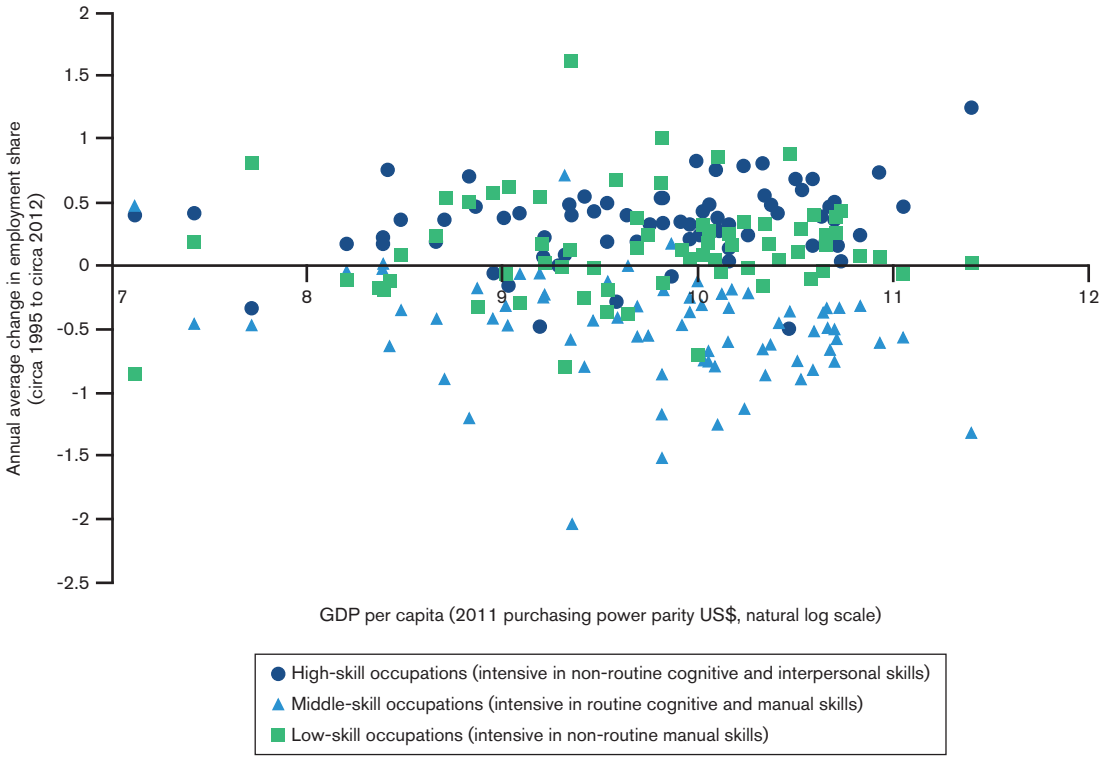
The polarization of employment in many developed countries during the last two or three decades has been widely documented. In particular, Goos and Manning (2007) show that employment shares over the preceding 25 years in the United Kingdom grew at the two extremes of the skills distribution, and fell at the middle of the skills distribution. Several studies have since then confirmed job polarization as a fact common to most developed economies – see Autor et al. (2006) for the United States, Spitz-Oener (2006) and Dustmann et al. (2009) for Germany, and Goos et al. (2009) for most European economies.

The phenomenon of polarization accelerated further in Europe and the United States during the Great Recession (Jaimovich and Siu, 2014; Verdugo and Allègre, 2017). Recent empirical evidence further shows that job polarization is widespread across most industries in high-income countries (OECD, 2017). In addition, the decline in the share of middle-skill occupations in total employment has been, on average, totally compensated for by the increase in the share of high-skill occupations in most industries. Industries for which the share of middle-skill occupations has declined, on average, the most include the pulp and paper industry, the chemical industry, transport equipment manufacturing, and finance, insurance, real estate and business services. In contrast, the hotel and restaurant industries and wholesale and retail trade have, on average, experienced a shift from middle- and high-skill occupations to low-skill occupations in most developed countries. In the case of the United States, only the labour market of the services sector seems to have become polarized (Cerina et al., 2017). Overall, job polarization experienced by most high-income countries tends to reflect the reallocation of employment from middle-skill to low- and high-skill occupations inside individual industries and, to a lesser extent, the reallocation of skill employment between industries (OECD, 2017).

As highlighted in Figure B.13, several developing countries have also experienced job polarization over the past two decades (World Bank, 2016). The decline in the share of middle-skill occupations in total employment has been relatively larger in Panama and the former Yugoslav Republic of Macedonia than in other developing countries, such as Chile, India, Mauritius, Sri Lanka and Uganda. Job polarization has also been documented for other developing countries, such as Brazil, Liberia, Mexico and Turkey (Maloney and Molina, 2016; de Vries, 2017).[28]

However, job polarization is not widespread across all developing countries, in particular countries with large natural resources endowments and commodity

Figure B.13: Evolution of the skill composition in employment (circa 1995 to circa 2012)



Source: World Bank (2016).

Note: The figure displays change in percentage points of employment shares between circa 1995 and circa 2012. The occupation classification is based on Autor (2015). High-skill occupations include legislators, senior officials and managers, professionals, technicians and associate professionals. Middle-skill occupations comprise clerks, workers in crafts and related trades, and plant and machine operators and assemblers. Low-skill occupations refer to service and sales workers and elementary occupations, e.g. cleaners and helpers, agricultural labourer, food preparation assistants and street sales workers.

exporters. In several countries, such as El Salvador, Mongolia, Thailand and Ukraine, the declining share of middle-skill occupations has been associated with an increasing share of low-skill occupation and a decreasing share of high-skill occupations. In contrast, several economies, such as Costa Rica, Jamaica, Kazakhstan and the Russian Federation, have seen a drop in the share of low- and middle-skill occupations but an increase in the share of high-skill occupations. Botswana, China and Ethiopia are among the few developing countries that have experienced an increase in the share of middle-skill occupations and a decrease in the share of low-skill occupations. Conversely, the share of low-, middle- and high-skill occupations has remained relatively constant in certain countries, such as Peru (World Bank, 2016).

While, as explained above, job polarization seems to be pervasive across many industries (at least in many high-income countries), recent empirical research suggests that women and men may not necessarily be equally affected by job polarization. This seems to be the case for the labour market in the United States between 1980 and 2008, where female workers experienced job polarization, while male workers did not (Cerina et al., 2017). More generally, the exposure to job polarization often changes over time, highlighting its dynamic nature.

(ii) The evolution of the skill premium varies greatly across countries

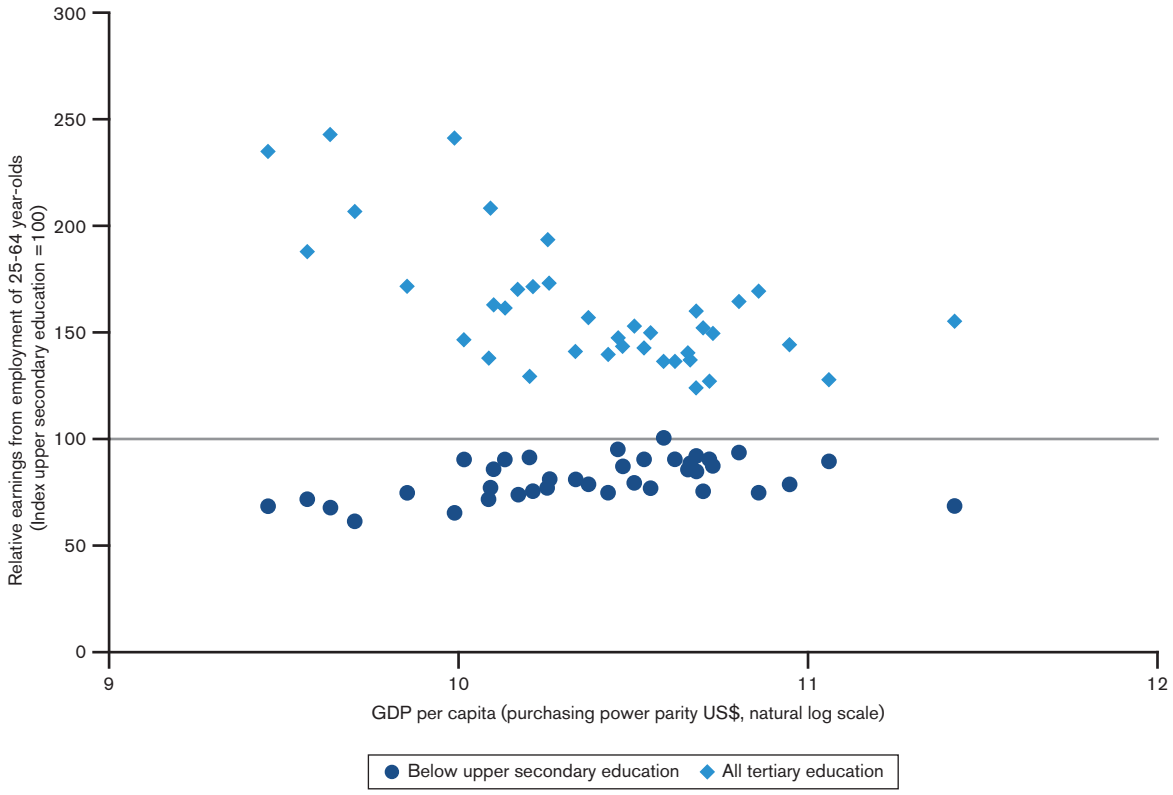
As explained above, skills play a critical role in the labour market, including in relation to wages. Different levels and combinations of skills can imply different wage levels. Although different measures of the return to skills are used in the literature, one common indicator is the skill premium, defined as the ratio or per cent difference between the wages of skilled and unskilled workers.[29] Economists frequently use the rate of return to investment in tertiary education, often measured by the earnings gap between university and high school education, as a measure of the skill premium. Comparable cross-country data on the skill premium are, however, limited, in particular for developing and least-developed countries.

Empirical evidence confirms that high-skilled workers receive relatively larger wages than middle- and low skilled workers. Rates of return to investments in education are the highest for tertiary education across both developed and developing countries (World Bank, 2013). However, these general trends mask noticeable differences across countries. As shown in Figure B.14, the skill premium for tertiary education with respect to upper secondary education tends to be relatively larger in developing countries than in developed countries. For instance, the average skill premium is more than twice as high in Brazil than in high-income countries. Part of these differences between developed and developing countries reflect a lower share of the workforce with tertiary education in developing countries, as discussed previously. In fact, the skill premium tends to be relatively lower in many high-income countries with a relatively large supply of high-skilled workers.

The skill premium varies also across sectors and demographic groups. For instance, women often tend to have a better rate of return to tertiary education than males. Similarly, the rate of return to tertiary education often tends to be higher in occupations that make more intensive use of information and telecommunication technologies compared to the rest of the economy (World Bank, 2013). Rates of return to investment in education tend also to be higher in (high-income) countries with a relatively high share of well-matched workers, i.e. whose educational attainments correspond to what is required for their jobs (OECD, 2015b).

A large body of empirical work has shown that the skill premium rose, albeit at a different pace, in many industrialized and developing countries in the 1980s and 1990s, such as Argentina, Australia, Brazil, Canada, Chile, Colombia, Germany, Japan, Hong Kong (China), India, Mexico and the United States (Parro, 2013; Pavcnik, 2011).[30] As shown in Figure B.15, some economies, such as China, India and the United States, have continued to experience an increase in the skill premium over the last 15 years. An increasing skill premium has also been documented for other Asian economies, such as Bhutan, Pakistan, the Philippines and Thailand between the mid-1990s and the mid-2000s (ADB, 2012). In some economies, such

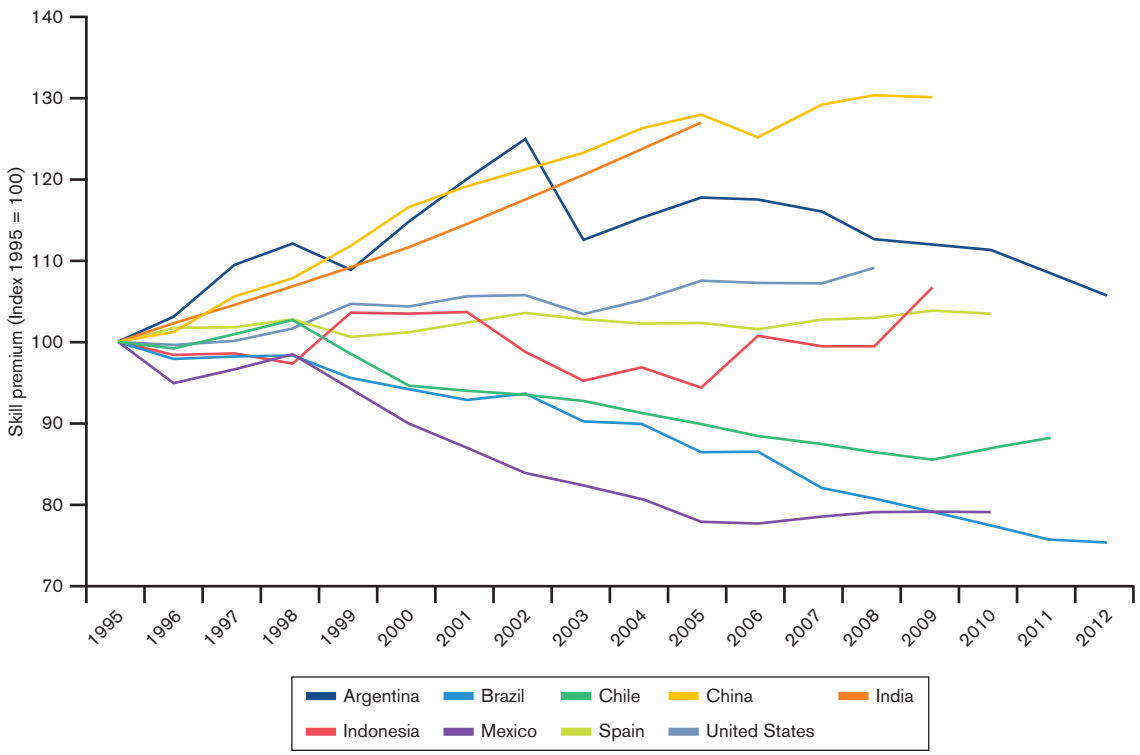
Figure B.14: Relative earnings of adults working full-time by level of educational attainment (2014)



Source: OECD (2016a).

Note: Tertiary education includes short-cycle tertiary, bachelor's, master's, doctoral or equivalent degrees. Both indexes of below upper secondary education and tertiary education are expressed in relative terms with respect to upper secondary and post-secondary non-tertiary education. Data cover 2014 or latest available year.

Figure B.15: Evolution of the skill premium in selected countries (1995 to 2012)



Sources: WTO Secretariat based on Acemoglu and Autor (2011), Bonhomme and Hospido (2012), Campos et al. (2014), Cruz and Milet (2017), Goel, (2017) and Li et al. (2017).

as China, the increase in the skill premium seems to have slowed down during the mid-2000s.[31]

In contrast, several other developed and developing economies have experienced a reduction in the skill premium over the last 15 years.[32] In some countries, such as Brazil, Chile and Mexico, the decline in the wage premium has been relatively steady. A similar downward trend was documented for Bolivia, Colombia, Ethiopia, and Paraguay in the mid-2000s and early 2010s (Cruz and Milet, 2017). In other countries, such as Argentina, the skill premium exhibited an upward trend during the mid-1990s followed by a downward trend through the 2000s. In the case of Ecuador, the decline in skill premium seems to have slowed at the end of the 2000s and early 2010s. Overall, the varying evolution of the skill premium highlights the important role of country-specific factors.

3. Forces driving labour market outcomes

This subsection reviews a number of important insights from labour economics to help explain the main forces that drive labour market outcomes.[33] It first considers the competitive labour market model. This is the classic benchmark framework. It explains the central relationship between employment and wages in equilibrium, when all agents are satisfied with the employment decisions, given the market-clearing equilibrium wage rate, which equalizes labour supply and demand.

The subsection then discusses the more realistic search and matching labour market models which can explain wage differentials between employers and unemployment in equilibrium, two features of labour markets also discussed in Sections B.1 and B.2. Search and matching models are the modern-day reference frameworks for those more intricate labour market features. Search involves workers searching for jobs and employers posting vacancies and searching for workers. Matching involves employers and workers meeting for interviews. Bargaining involves individual workers or collectives (unionized workers) negotiating over the rent that additional employment creates at the employer (firm or industry). While important "stepping-stone" models, such as union-bargaining models, fair wage models or efficiency wage models, elucidate select features in isolation, the most comprehensive frameworks allow for search, matching and bargaining.

(a) The competitive model

This subsection discusses the relationship between employment and wages in equilibrium and the effects of various external factors on this equilibrium in the classical competitive labour market model. It discusses the limitations of the model and shows how relaxing some of its basic assumptions can help explain unemployment.

(i) Employment and wages

Labour demand and labour supply play an important role in determining labour market outcomes, quite independently of whether the market reaches the competitive equilibrium or is impeded by forces that hamper adjustment. In labour markets, the agents that demand labour services are the employers, modelled as industries or firms in economic theory, while the suppliers of labour services are the workers. Employers combine labour and capital, as well as intermediate goods and services, to produce goods or services which they sell in product markets. The number of workers that firms demand thus depends on a number of factors: the demand for the good or services they produce; the costs of labour and capital, i.e. the wage rate and the user cost of capital; the relative price of intermediate goods; the substitutability between labour and capital; and the choice of technologies to which they have access. The wage rate that employers care about is the real wage rate, calculated as the nominal wage divided by the price of the firm's product bundle. The user cost of capital depends on the price of the capital goods, the depreciation rate, and the interest rate which captures the cost of financing the capital investment.

Workers, on the other hand, generally decide whether, where and how much they want to work. They depend on the wages for various occupations and take into consideration other options for spending their time. More specifically, workers can be thought of as making two sorts of decisions. They first decide whether and how much they want to work or, in other words, how they want to spend their time. Because the opportunity cost of leisure (i.e. the cost of preferring leisure to work) is the wage rate, the individual labour supply can be expressed as a function of the wage rate.[34] The second decision workers make relates to the choice of occupations and the specific region(s) in which to seek offers. Like employers, workers care about the real wage, which, for them, is the nominal wage divided by the consumer price index. Note that the consumer price index includes all consumption goods, i.e. more prices than those of the products the firm produces and perhaps none of the prices of the firm's products if it only supplies intermediate goods.

In this subsection, we assume that workers have already decided how much they want to work and we focus on their choice of an occupation and of a particular employer.

If we consider the market for assembly workers (assemblers), the labour demand schedule represents the number of assemblers that firms wish to hire at any level of the wage rate, assuming that all other factors that affect the demand (e.g. user cost of capital, product demand, product price and technology, prices of intermediate inputs) are kept constant. The demand schedule is negatively sloped, meaning that a given increase in the wage rate leads firms to reduce their demand for labour. The reason for this is that firms hire workers as long as the revenue generated by the last worker hired (the marginal revenue) exceeds the market wage. A firm knows how much revenue it can generate if it hires one more assembler all else given. The firm then asks itself whether this incremental revenue exceeds the cost of the incremental worker, which is the wage rate. Only if it does will the firm hire the incremental worker. Labour demand is negatively sloped because adding more workers while keeping all other production factors fixed reduces the incremental revenue (which stays positive but declines with each additional worker). All workers of the same type command the same wage, so at higher wages employers contract fewer workers because the workers need to generate a sufficiently high revenue per worker to break even at the higher wage. The revenue less the cost of intermediate inputs (the value added) is the surplus that the employer can generate from labour and capital.

The labour supply schedule indicates the number of job-seekers who would be willing to work as assemblers at each level of the nominal wage rate, holding wages in other occupations constant. The labour supply curve has a positive slope if an increase in the wage rate of assemblers, keeping wage rates in other occupations constant, leads more people to be interested in becoming assemblers.[35]

In a competitive labour market, with homogeneous workers and firms, with no exchange costs, no wage-setting power on either side and with perfect information, the intersection of the labour supply and demand curves determines the market-clearing wage rate, which is the wage rate at which all the workers who wish to work at the prevailing wage rate are employed. Appendix B.2 shows graphically how the supply and demand of assemblers jointly determine

the market-clearing wage rate. Note that labour economists have proposed many alternative wage-setting models to capture certain observed features of labour markets. These models are discussed in Box B.3 and subsection B.3(b).

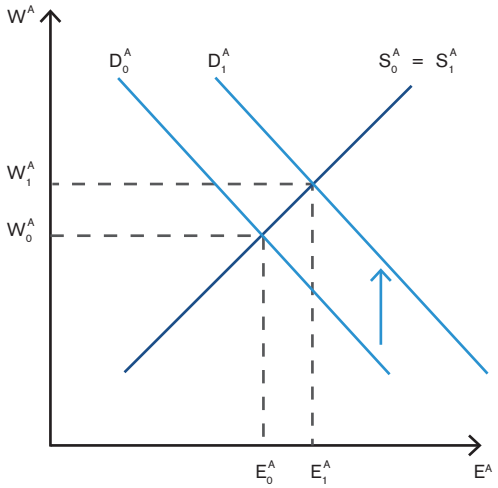
Changes in product demand, the user cost of capital, the prices of the firms' output, and technology translate into shifts of the labour demand schedule. An increase in the product demand for the goods and services produced by the firms which employ assemblers, for example, raises the marginal revenue and thus the demand for assemblers for any given employment level, because the product price increases as the same workers now encounter more demand for their products (see Figure B.16).

The effects of a fall in the user cost of capital are not as easy to predict. A fall in this cost leads the firm to install more capital (pair workers with more machinery), which makes all existing workers more productive and hence also raises their marginal revenue product. However, capital (machinery) also substitutes existing workers, so the net effect on the marginal revenue product curve and thus the direction of the shift of the labour demand curve is ambiguous. If the productivity effect dominates, the labour demand curve shifts up, while it shifts down if the substitution effect dominates.

Finally, technological change can take the form of either new products or of new production techniques. If it takes the form of a new product which substitutes for an older one, such as when computers replace typewriters, technological innovation lowers the demand for the old product while it raises the demand for the new product. This translates into a downward shift in the demand for labour used to produce typewriters and an upward shift in the demand for the workers who produce computers.[36] Some workers will thus need to change jobs and, in the presence of mobility obstacles, this may lead to unemployment, an issue which will be discussed below.

If, by contrast, technological innovation takes the form of automation, it can be seen as a reduction in the cost of capital relative to the cost of labour. As such, it affects the demand for labour through both a productivity and a substitution effect. It makes existing workers more productive and thus leads to an increase in the marginal product revenue of workers, but at the same time also leads to the substitution of capital for labour and thus a decrease in the marginal revenue product. Depending on which of the two effects dominates, automation can shift the demand for labour either up or down.

Figure B.16: Effect of an increase in the demand for assembled products on the market for assemblers



Note: Figure B.16 represents the market for assemblers with the upward sloping supply of assemblers S_0^A and the downward sloping demand for assemblers D_0^A. The increase in the demand for assemblers resulting from the increase in the demand for assembled products translates into an upward shift of the demand for assemblers from D_0^A to D_1^A. As a result of this upward shift of the demand curve, labour market equilibrium will change. At the initial equilibrium wage rate W_0^A, the shift in demand creates an excess demand, which, in the competitive model, pushes the wage rate up to W_1^A and raises the level of employment to E_1^A. The market will stabilize at the new equilibrium at a higher wage level and a higher level of employment.

Another factor that can shift labour demand is government policies. Trade opening, for example, like technology, may contract the demand for workers in import-competing firms and expand labour demand in export-oriented firms. This may have repercussions on employment in the market for certain occupations at the local or sectoral level in the presence of obstacles preventing seamless adjustment. Also, a payroll tax imposed on firms and workers makes it more expensive for firms to hire workers and would thus prompt firms to lower their demand for labour. Alternatively, a government subsidy that supports firms' hiring, such as a tax credit to firms for every worker they hire, would increase labour demand. In a competitive market, an increase (shift upwards) of the demand for labour will tend to raise employment while raising the wage rate, because workers can only be enticed to supply additional work if wages increase.

Finally, a number of factors can lead to shifts in the labour supply schedule. Changes in other wages than those of assemblers were held constant when drawing the supply schedule for assemblers. An increase in the wage rate of machinists, for example, would attract more persons to choose to work as machinists than as assemblers at any given level of the wage rate for assemblers. The supply schedule

Box B.3: Wage-setting when labour markets are not competitive

The usual supply-demand framework in perfectly competitive labour markets assumes atomistic agents, in the sense that neither workers nor firms have the ability to influence the equilibrium wage rate. This framework can also be used to explain market outcomes when either firms or workers have wage-setting power, but not when both have it at the same time. When both firms and workers have wage-setting power, the wage rate will be set through bargaining, in which case game-theory models with the strategic behaviours of market actors can be used to adequately explain wage-setting. This box briefly discusses wage-setting when either workers or firms have wage-setting power (for more detailed explanations, see Borjas (2013) and Ehrenberg and Smith (2012)).

Wage-setting when firms have wage-setting power

An economy has multiple labour markets. If workers were completely mobile across these labour markets, there would be no wage differential for the same occupations between these labour markets. If there are impediments to the mobility of workers (often called "mobility frictions" in the economic literature), there can be wage differentials for the same occupations across these labour markets because firms in each market can set wages depending on their own characteristics.

For example, consider a coal mine in an isolated small town. The coal mine (firm) is the only buyer of labour in this labour market, which is therefore referred to as a "monopsonistic market". As mobility frictions make it costly for workers to move into or out of this specific labour market, the firm can act strategically so as to influence (manipulate) the market-clearing wage. Concretely, the coal mine can set its labour demand lower than it would if it had to take wages as given.[37] The mine's strategically reduced labour demand depresses the local wage in the mining town, so that the monopsonistic employer can enjoy a lower wage bill than it usually would in a competitive labour market. In other words, both the wage rate and employment in a monopsonistic market are lower than in a competitive market, if all other factors are equal. Note that while the monopsonistic firm has the power to set wages, this choice is not entirely free, as it is still bound by its productivity, the labour supply it faces given the employment in the other monopsonistic labour markets, and competition in its product market.

Wage-setting when unions have wage-setting power

Workers exercise their power to set wages through labour unions, which are organizations of workers that bargain with firms with the purpose of improving the wage-related and non-wage-related conditions of employment of their members, including employment protection. Workers can become union members by paying a union membership fee.

Two important questions arise when analysing wage-setting in the presence of unions with supply-side market power. The first question regards how much wage-setting power unions have; this depends on labour market institutions (the power of unions to act on behalf of workers in setting or influencing wages is often legally guaranteed) and on the proportion of workers who are unionized, among other things. The second question regards the objective that the union is pursuing. Unions aim to raise wages, but they are also generally concerned with matters such as employment, the riskiness of labour income and working conditions. Because there are many answers to these questions, alternative models of wage-setting in the presence of unions have been elaborated.

One of the simplest models is the monopoly-union model, in which the union is assumed to care about both the wage and the employment level of its members. In this model, the union sets the wage and the firms respond by choosing the level of employment that maximizes their profits. Knowing how firms will behave, the union will set the wage rate at a level which maximizes its influence subject to the constraints of the resulting wage/employment combination on the demand curve. Given that this wage level is likely to be higher than the competitive wage rate, employment is likely to be lower than what it would be in a competitive market.

of assemblers would thus shrink (shift upwards). In a competitive market, this would put upward pressure on the wage rate and would lead to a contraction of assembler employment.[38] Demographic factors, often driven by changes in policy, also play a role, although maybe more at the aggregate level. Immigration, for example, can increase labour supply (shift the labour supply curve downwards) as workers coming from abroad provide more labour to the domestic labour market. An increase in the labour force participation

of women at any wage level would also increase labour supply and, in the longer term, an increase in the birth rate could have a similar effect.

Whether and by how much a shift in the demand for labour affects employment and wages depends on the elasticity of labour supply to a change in the wage level. A distinction is often made between the short and the long run. The assumption is, typically, that labour supply is less elastic in the short run than in the long run. As a consequence, an increase in labour demand would raise the wage rate with little effect on employment in the short run, while the opposite would be true in the long run.

(ii) Unemployment

The previous subsection introduced the competitive labour market model and used it to discuss the effects of a number of factors on the equilibrium wage and employment. This subsection presents the classical approach to unemployment, which builds on the competitive model.

In the perfectly competitive market model, competition drives the wage rate to the equilibrium level that clears the market. All the workers who wish to work at the prevailing wage rate are employed. The others choose not to be in the labour force at this level of the wage rate. In the pure competitive model, there can thus be no involuntary unemployment. A shift in labour supply or demand such as the ones discussed in the previous subsection would induce a change in the market clearing level of the wage rate and in the level of employment. Under the simplistic assumptions of the basic competitive model, however, adjustment would be swift and there would be no unemployment in the new equilibrium.

For unemployment to arise in the competitive model, it is necessary to relax the simplifying assumption that the wage rate is flexible and that it immediately adjusts to clear the market. The empirical literature seems to suggest that nominal wages are (partially) rigid downwards (i.e. the wage rate will not adjust downwards to clear the market when there is an excess supply of labour) but not upwards (Jacobsen and Skillman, 2004). Note that this does not necessarily mean that real wages are inflexible. Given the downward rigidity of nominal wages, however, real wages can only fall as a result of an increase in prices. Multiple reasons, which are discussed in this and the next subsection, can explain downwards wage rigidity.[39] If the market is otherwise assumed to be competitive, with homogeneous workers and firms, no frictions and perfect information, downwards rigidity can only be the result of government intervention.

If a minimum wage is set above the market-clearing level of the wage rate, for example, there will be an excess supply of workers. These workers would be willing to work at the going rate, which means that there would be involuntary unemployment. This very simple explanation, however, is not supported by the available evidence.[40] First, evidence does not support the finding that involuntary unemployment can only arise as a result of government intervention. Second, even assuming that unemployment arises because of governmental intervention, it is not clear that jobs would be available for the workers who would be willing to work. With perfect information, no one would be searching for jobs that are not available.

In the classical approach, which builds on the competitive model, there are three main reasons why the labour market may not clear, or, in other words, why the wage rate may not adjust to equalize labour supply and demand, which correspond to the three main categories of unemployment.

The first type of unemployment is the so-called "natural" or "frictional" unemployment, which is due to the fact that a significant number of people are between jobs at any point in time and that there is a natural asymmetry of information between the firms that post job vacancies (potential employers) and workers who are looking for a job (potential workers). Frictional unemployment will exist even when in the aggregate the demand for labour equals the supply.

The second type of unemployment is "cyclical" or "demand-deficit" unemployment. It arises because, when wages are rigid downwards, a decrease in labour demand during the downswing phase of a business cycle can generate unemployment.

The third type of unemployment is called "structural" or "transitional" unemployment. It arises in the presence of wage rigidities when there is a mismatch between the skills supplied and the skills demanded in a market or when there is excess demand for workers in one area and excess supply of workers in another area and workers cannot move across either occupations or regions because of mobility obstacles. Hereafter we examine the determinants of each of those three types of unemployment.

Natural or frictional unemployment is the unemployment that exists even when the labour market is in equilibrium with aggregate labour demand equal to aggregate labour supply. It results from the perpetual turnover of employment opportunities as employers adjust to changing economic conditions and workers move for jobs or other reasons, so that open job vacancies wait to be filled and workers search for new employment.

In an economy like the United States, for example, millions of workers move from job to job every quarter, in a process that economists call "churning". The US Bureau of Labor Statistics reports that the number of job openings was at 5.7 million on the last business day of March 2017, which corresponds to 3.8 per cent of the sum of employment and job openings.[41] Over the month, hires and separations were at 5.3 million and 5.1 million, respectively. Within separations, the quits and the layoffs and discharges rates were at 2.1 per cent and 1.1 per cent, respectively.[42]

This ongoing turnover in the labour market implies that, at any moment in time, a number of workers is naturally unemployed between jobs. Many workers have already found a new job when they quit and will not spend a transitional time in unemployment (so-called job-to-job transitions). Other workers who either quit or are laid off, however, enter unemployment and stay unemployed for a period of time before they re-enter employment. It may also take time for new entrants in the labour force to find their first job.

Natural unemployment arises because of the presence of search and matching frictions on labour markets. Search and matching frictions are discussed in more detail in subsection B.3(b).

Cyclical unemployment occurs when a decline in aggregate demand in the output market causes the aggregate demand for labour to contract in the presence of downwards rigidity in real wages.[43] Appendix B.2 graphically explains how cyclical unemployment may arise. In principle, cyclical unemployment should disappear when the economy moves to the upswing phase of the business cycle and aggregate demand for labour shifts back upwards, raising employment to its pre-downswing level.[44] On average, a complete business cycle can last from five to six years, and therefore the related temporary shifts in labour demand occur over the course of these years (for example see Watson (1992) for the United States). When the decrease in the demand for output is more predictable and follows a determined pattern over the course of a single year, the unemployment that arises due to wage inflexibility is usually referred to as "seasonal unemployment".

Transitional or structural unemployment arises either when job-seekers and job vacancies are in different regions and mobility frictions and wage rigidity impede adjustment, or in the presence of imbalances between the skills of job-seekers and the skills required for available job vacancies. When job-seekers and job vacancies are in different regions, wages, if they were flexible, would fall where labour supply exceeds labour demand which would increase demand and decrease supply until equilibrium is reached. Similarly, in the absence of frictions between market segments, unemployed workers could move to regions or sectors where labour demand is stronger. Mobility obstacles, however, can be significant and can raise adjustment costs, slowing down or even preventing the smooth transition of workers between regions.

When the demand for skills changes and skill development systems are not sufficiently responsive, structural unemployment may also arise. If, for example, the demand for low-skill workers decreases while the demand for high-skill workers increases, low-skill workers who lose their jobs will need to be retrained. This may take time and involve significant costs, potentially leading to significant skill mismatches. Box B.4 discusses mobility frictions, Box B.5 describes skill mismatches and Box B.6 discusses assessments of the adjustment costs induced by mobility frictions.

As already mentioned above, in a dynamic economy, labour markets are constantly in flux. Every day new workers enter the labour force while some exit and others change jobs. At the same time, firms lay off some workers and open new vacancies. Many of the changes that take place are planned in advance and can be anticipated by workers and firms.

Labour markets, however, are also affected by shocks that cannot always be anticipated. These shocks can take many different forms, can be far-reaching or more limited in their scope, and can occur over a limited or an extended period of time. The types of shocks that can but do not need to generate structural unemployment are those that lead to the simultaneous destruction and creation of jobs either in different regions or with different skill requirements.

- Technological innovation is an obvious example. When the automobile was invented, the car and the oil industry expanded while the horse "industry" (stable owners, feed producers, trainers, etc.) declined.

- Changes in consumer taste can have similar effects, often in combination with technological change. Favourite destinations for tourists keep changing, and the music industry has transformed significantly over the years with the replacement of vinyl records by CDs, MP3s and more lately online music streaming.

- For given tastes, changes in *per capita* income lead to a shift in consumer expenses towards services, such as health care, and non-food merchandise.

Box B.4: Mobility frictions

This box briefly discusses two forms of mobility frictions: geographical frictions and frictions related to labour market regulations.

Geographical frictions

Geographical frictions account for a substantial share of total mobility costs. They are barriers affecting the reallocation of workers between regions, and may be related to physical geography and social networks, family ties, cultural barriers, language, housing, etc. They exist either because of a country's physical and cultural characteristics or because they are brought about by laws and institutions. In the first instance, where countries are large or ethnically and culturally diverse, geographical frictions tend to be considerable. For instance, physical distances have likely played a role in limiting the movement of workers in rural India as documented by Topalova (2010).

Geographical frictions can also be caused by specific legislation and institutions. McGowan and Andrews (2015 p. 16), for example, note that: "high transactions costs on buying and selling of dwellings (e.g. stamp duties, registration fees, etc.) may create lock-in effects in the housing market, with implications for residential and job mobility". Along the same lines, if the new jobs are created in a region with stricter rental regulations, workers that might like to move to this region will have a hard time in finding housing.

Restricting regulations on land use can produce a similar effect. As another example, Zi (2016) shows how China's internal passport system (hukou) influenced labour reallocation between regions in the aftermath of China's WTO accession in 2001. Geographical frictions are also discussed under mobility costs in the subsequent discussion of search and matching theories.

Frictions related to labour-market regulations

Another category of mobility frictions relates to labour market regulations which include wage-setting institutions, mandatory social benefits, the unemployment insurance system and different aspects of labour legislation, such as laws on minimum wage, employment protection legislation (EPL), and the enforcement of the legislation. While frictions in this area are a normal part of how labour markets operate, there may be cases where labour-market regulations cause frictions that significantly impede adjustments. Note that the debate in this area is about the degree of regulation and the design of regulation rather than the existence of regulation.

One example of labour-market regulation which can cause significant frictions is employment protection legislation. The ILO recently launched a research programme designed to record and measure employment protection legislation throughout the world, as well as develop a nuanced understanding of its impact on labour markets and economic development. This programme has led the ILO to develop a database, EPLex (available at http://www.ilo.org/dyn/eplex/termmain.home), which contains comparative information on laws and collective agreements governing employment protection in 95 countries over the period 2009 to 2014. The database is continuously updated to cover more countries and years.

Another labour market regulation much discussed with relation to frictions is occupational licensing laws, which may represent a barrier for job matches between firms and workers, as job vacancies requiring specific licences can be filled only with workers holding those specific licences. Examples include lawyers, financial advisors, pharmacists, doctors and even plumbers. In the United States, approximately one-quarter of jobs requires a government licence. The Council of Economic Advisors (CEA) et al. (2015) shows that during the past five decades, "the share of U.S. workers needing a license to do their job has grown roughly fivefold" and that this was mainly due to the creation of new licensed professions (Council of Economic Advisors (CEA), 2016). As these licences can be expensive, they may represent relevant employment barriers for those who are unable to obtain one. These licences may also represent a barrier for the licence-holders, as the patchwork of state regulations and variability in state reciprocity make it harder for workers in licenced occupations to move across state lines (Council of Economic Advisors (CEA), 2016; Kleiner, 1990).

Box B.5: Skill mismatches

The diversity of skill requirements is a labour-mobility barrier that impedes workers' transition between jobs (see the discussion in ILO-WTO (2017)). This barrier leads to skill mismatches, which are imbalances between skills offered and wanted in the labour market. Such an imbalance between the supply of and demand for skills can appear in a number of different ways, and at various levels, including the individual, the employer, the sector and the economy. For example, there can be skills shortages or surpluses (quantitative mismatches), vertical mismatches (the level of education or qualification of applicants is less or more than what is demanded by firms), horizontal mismatches (the type/field of education or skills of applicants does not correspond to what is demanded), and others.

In making a comparison between developed and developing economies, a study by the World Bank argues that: "... their wider skill set in general, such as computer skills or greater reading and writing comprehension, makes it easier for [American workers] to move between jobs than for workers in developing countries like Mexico" (Hollweg et al., 2014).

Skill mismatches can either exist as a standalone characteristic of the labour market, such as when there is a diversity of skill requirements across the jobs offered, or, as discussed below, they can be brought about by laws and institutions. Stand-alone skill mismatches occur when firms encounter difficulties in filling up their job openings due to the skill characteristics of the pool of potential candidates presently available. The World Bank (2016) shows that among the most required skills in today's economy are ICT skills, foundational cognitive skills (such as the ability to learn, to process and apply knowledge, to analyse and reason, and to evaluate and decide), complex problem-solving, critical thinking and expert communication.

Some evidence for this trend in skill requirements is reported for economies as diverse as Brazil, Malaysia, and the former Yugoslav Republic of Macedonia. The World Bank study points out that employers in developing countries search for ICT skills but cannot find them because there is a shortage of high-skilled workers due to a skill mismatch. In the former Yugoslav Republic of Macedonia, "43 percent of firms say ICT skills are very important for workers, but more than 20 percent say that workers lack them". Similar shortages of skilled workers are present also in other European economies. For example, the Council of the European Union reports that "about 36% of firms in the EU-27 experienced difficulties in hiring staff for skilled jobs in 2009" and that the shortfall of ICT professionals amounted to 700,000 jobs by 2015 (European Commission, 2012).

In addition, it is important to note that vertical skill mismatches can occur in both directions. For example, Leuven and Oosterbeek (2011) calculate that 21 per cent of workers are under-schooled and 26 per cent of workers are over-schooled in Asia in relation to the jobs on offer. The corresponding respective figures are 31 per cent and 30 per cent for Europe, 16 per cent and 37 per cent for the United States and Canada, and 21 per cent and 17 per cent for Latin America.

Second, skill mismatches can be caused by laws and policies. For example, policies that support narrowly skill-specific education can affect labour mobility negatively, as workers who receive an education only on some very specific skills find it more difficult to move to other employment when they lose their jobs i.e. when skill-specific education can lead to over-specialization. According to Lamo et al. (2011), skill-specific education in Poland led to an overspecialization of the labour force, which caused "to a large extent the much higher and persistent unemployment compared to Estonia during the period of EU enlargement".

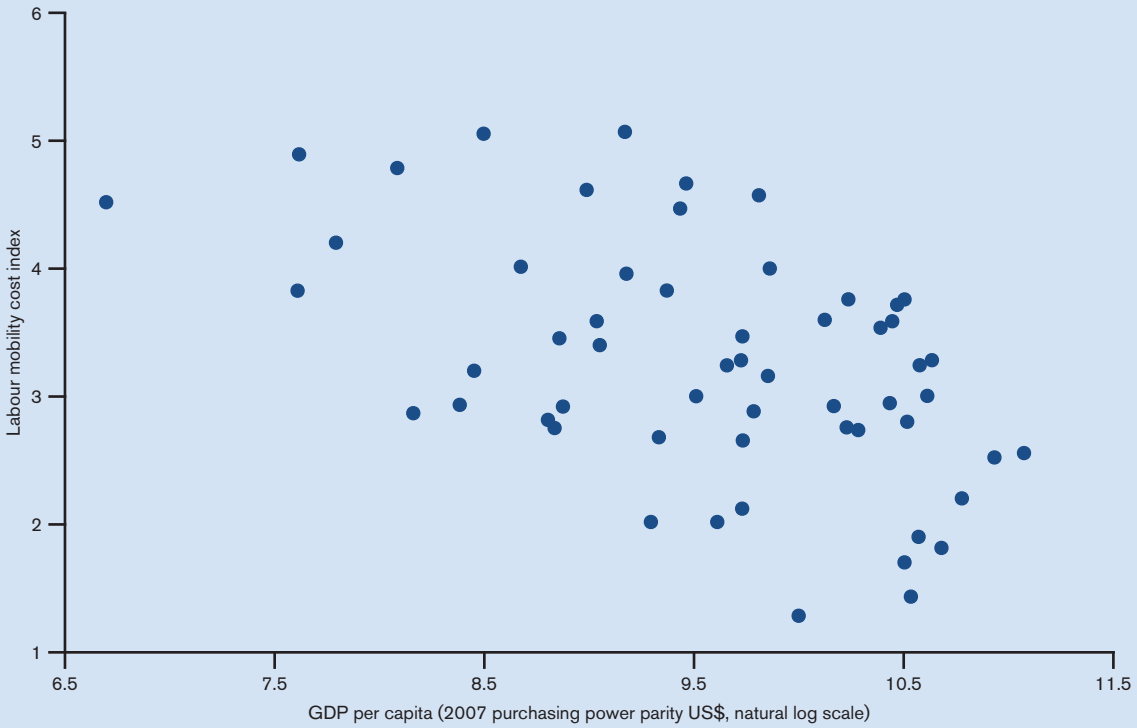
- Yet another example would be an increase in oil prices which affects the automobile industry negatively but prompts oil producers to search for new oil fields that are viable for extraction at higher oil prices and stimulates the sustainable production of energy.
- Government policies and regulations can also have similar effects. Stricter environmental and safety regulations have almost eliminated mopeds in some high-income countries replacing them with alternative means of transportation.
- Last but not least, trade policies or changes in comparative advantage, which will be discussed in more detail in section D, affect import-competing industries differently from export-oriented ones or from the non-tradeable sector.

Box B.6: Labour mobility costs

Recent cross-country empirical evidence suggests that, on average, the obstacles to labour mobility are twice as high in developing countries as in developed countries (Artuç et al., 2015). The highest costs are estimated to be in South Asia, Latin America, and Eastern Europe and Central Asia, followed by the Middle East and North Africa, Sub-Saharan Africa, and East Asia and the Pacific. Labour mobility costs are negatively correlated with *per capita* GDP, as shown in Figure B.17. They are also negatively correlated with tertiary educational attainments and schooling quality, but they are uncorrelated with primary and secondary education enrolment. Finally, mobility costs are positively correlated with other frictions, distortions and constraints in the economy, such as time to export.

More recent analysis also suggests that, on average, sector mobility costs are higher than regional mobility costs, as highlighted in Figure B.18. Costs of mobility between sectors suggest that workers have industry- or occupation-specific skills that lose value or become entirely unusable as they switch between economic activities. The costs of moving to a new sector and region are higher than the costs of moving only to a new sector or region (Cruz et al., 2017). Country characteristics and differences between sectors, including the presence of a large informal sector, are important determinants of labour mobility costs. For instance, Arias et al. (2013) report that the estimated entry costs from informal into formal employment are about twice as high as switching jobs within the formal sector and around ten times higher than switching from formal to informal employment in Brazil and Mexico. Mobility costs may also vary across workers depending on age, education or other characteristics. For instance, evidence for the United States shows that mobility obstacles increase with age due to the high return on sectoral experience. These findings are confirmed by Dix-Carneiro (2014), who also shows that female and less-educated workers face relatively larger obstacles in Brazil.

Figure B.17: Labour mobility costs by level of economic development

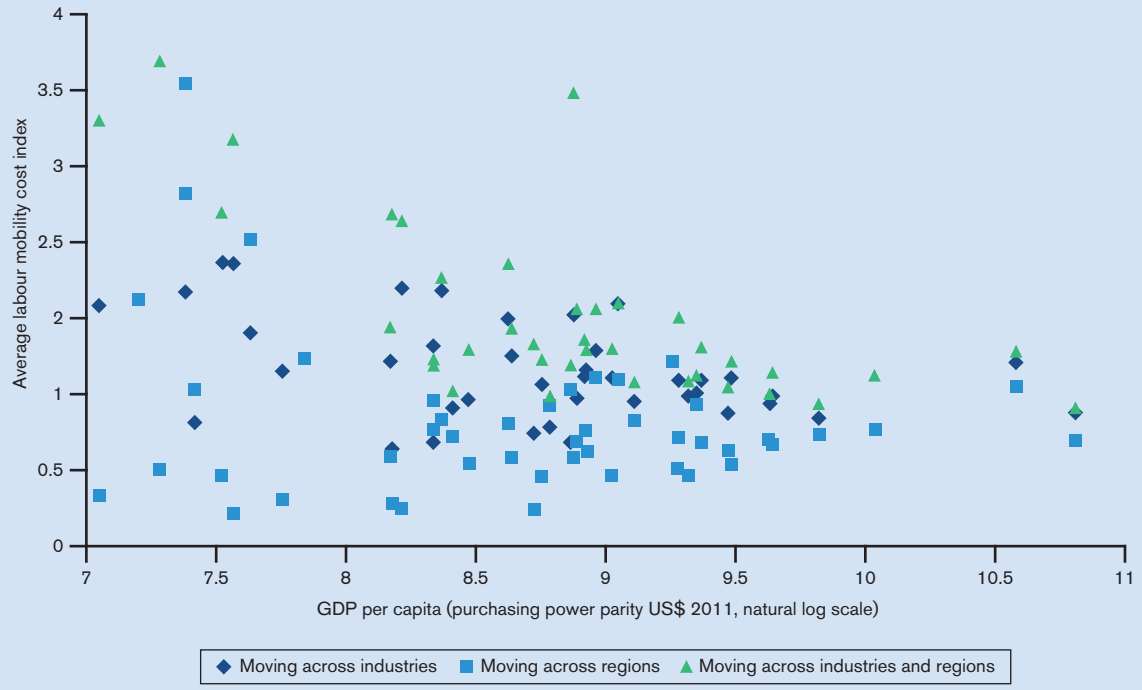


Source: WTO Secretariat based on Artuç et al. (2015), World Development Indicators (July, 2017).

Note: The labour mobility index measures a country's average labour mobility cost of moving industry. The index considers nine sectors: (1) non-manufacturing; (2) metals and minerals; (3) chemicals and petroleum products; (4) machinery; (5) food and beverages; (6) wood products; (7) textiles and clothing; (8) miscellaneous equipment; and (9) motor vehicles. The mobility cost index is measured in terms of average annual wage. Data range from 1990 to 2008 but vary from country to country depending on data availability.

Box B.6: Labour mobility costs *(continued)*

Figure B.18: Sectoral and geographical labour mobility costs by level of economic development



Source: WTO Secretariat based on Cruz et al. (2017), World Development Indicators (2017).

Note: The index of moving across industries measures a country's average labour mobility cost of changing industry while staying in the same region. The index covers ten industry affiliations: (1) agriculture; (2) mining; (3) manufacturing; (4) public utilities; (5) construction; (6) commerce; (7) transport and communications; (8) financial and business services; (9) public administration; and (10) other services. The index of moving across regions measures a country's average labour mobility cost of moving across regions but staying in the same industry. The number of regions varies between countries (from four to fifteen in general). The index of moving across industries and regions measures a country's average labour mobility cost of changing industry and moving region. Each mobility cost index is measured in terms of average annual real wage. For instance, a mobility cost of 1.5 means 1.5 times the average real wage. Data range from 1981 to 2013 but vary from country to country depending on data availability.

How labour markets absorb such shocks and whether skill mismatches and imbalances arise depends on how the labour markets work. If rigidities and frictions are not too significant, adjustment may be smooth. If, on the contrary, they are significant, structural unemployment may arise. In the presence of mobility frictions or skill mismatches, the labour market is not fully integrated and competitive, at least not in the short run. It can be viewed as consisting of many labour markets "segmented" by type of occupations, by geographical regions, by sectors, etc. If economic shocks affect different "segments" of the labour market differently, and if wages are rigid downwards, unemployment can arise in the segments which are affected adversely. Box B.7 explains how a technological shock can generate structural unemployment in the presence of skill mismatches.

One type of labour market segmentation of particular relevance to developing countries is the segmentation between the formal and the informal parts of the labour market. According to the World Bank (2013), available studies suggest that informality rates in developing countries range between 40 and 80 per cent of the employed labour force. In countries with limited social security, workers who lose a formal job and cannot find another job in the formal sector immediately may be obliged to take an informal job. This means that the informal sector may represent an important margin of adjustment to economic shocks affecting the labour market in developing countries. In the presence of wage rigidities in the formal segment and of mobility frictions, a contraction of the demand for formal labour may translate into an increase in informal employment rather than in unemployment.

It should be noted that not much is known about the mobility of workers between the formal and informal segments of the labour market. A recent paper by Arias et al. (2013), however, finds that entry costs into informal employment are significantly lower than the costs of entry into formal employment (see Box B.6).

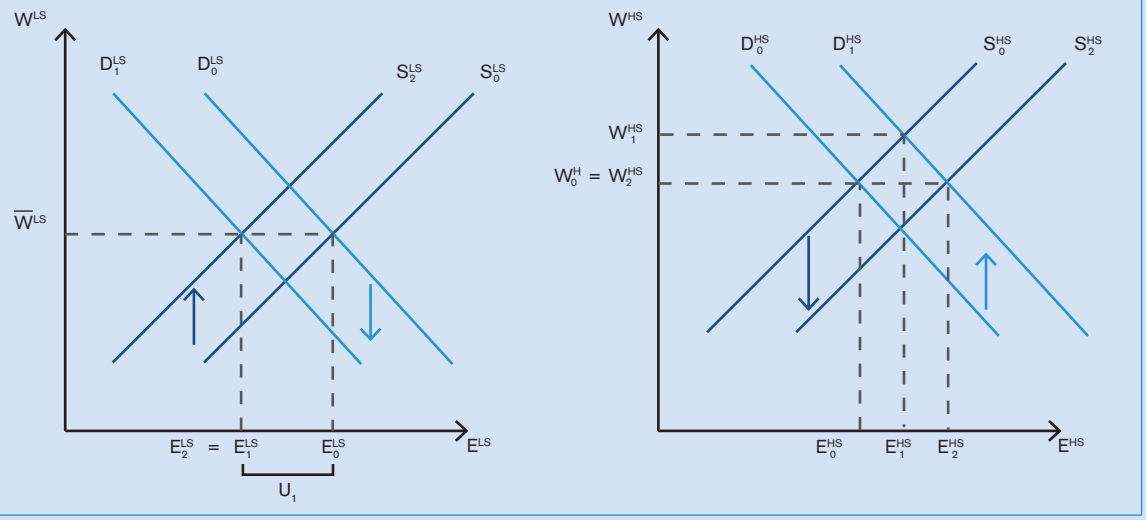
Box B.7: Structural unemployment due to skills mismatches

Figure B.19 represents the markets for low-skill and high-skill workers respectively. Initially, the two markets are assumed to be at their competitive equilibrium with the supply of low-skill workers equal to the demand of low-skill workers ($S_0^{LS}=D_0^{LS}$) and the supply of high-skill workers equal to the demand of high-skill workers ($S_0^{HS}=D_0^{HS}$). The equilibrium wage rate for high-skill workers W_0^{HS} is higher than the equilibrium wage for low-skill workers $\overline{W}^{LS}$. The difference between the two wage levels corresponds to the costs of acquiring skills. Starting from equilibrium, a technological shock such as the development of robots could be thought of as shifting down the demand for low-skill workers from D_0^{LS} to D_1^{LS} while simultaneously shifting up the demand for high-skill workers from D_0^{HS} to D_1^{HS}.

In the market for high-skill workers, the increase in demand will push up the wage from W_0^{HS} to W_1^{HS} in the short run. In the market for low-skill workers, the contraction of the demand would in principle push down the wage. If, however, the wage rate is not flexible downwards, unemployment will result. In the longer run, the wage difference and the unemployment should encourage more young people to invest in skills, and should encourage low-skill workers to upskill. This would shift the supply of low-skill labour up to S_2^{LS} and reduce low-skill unemployment. At the same time, the supply of high-skill workers would shift down to S_2^{HS}, accompanying the shift in demand which will contain the increase of the high-skill wage. This adjustment process may take time. And for some of the low-skill workers who lose their jobs, it may be difficult to acquire the skills that are in higher demand, particularly if they have been out of education for a long time.

The same figure can also be used to examine the effect of demand shocks on local labour markets in the presence of mobility frictions. Consider that Figure B.19 now represents the labour markets of two geographically separated regions. Assume that as a result of import competition, labour demand shifts down in the first local labour market while, as a result of an expansion in exports, labour demand shifts up in the second labour market. Assume again that because of wage rigidity, the contraction in labour demand results in unemployment in the first market, while the expansion in labour demand raises the wage in the second market. As in the previous case, this imbalance between local labour markets could quickly disappear if the unemployed workers in the first region can move to the region with the booming labour market. Unemployment in the first market would disappear while in the second market, the increase in labour demand would be accompanied by an increase in labour supply. In the presence of mobility obstacles, however, displaced workers will not relocate right away to a region with expanding export industries. For example, workers might not be able to move either because they do not wish to sell their house, or because different languages are spoken in the two regions.

Figure B.19: Structural unemployment due to skills mismatches



In the competitive labour market model, labour markets will converge towards equilibrium but frictions will slow down the adjustment process. How long it takes for workers unemployed in one particular market to find and get a job in another market depends on the nature and the size of mobility frictions. Certain mobility obstacles can be a short-run issue, for if workers are given time to move or train, they can be overcome in the long run. This means that in the short run, when frictions impede worker mobility across sectors, regions and occupations, economic upheavals that negatively affect some sectors, regions and/or occupations, but affect others positively, may have an impact on unemployment at the local level but not at the aggregate level. By contrast, in a "frictionless" long run, when workers move freely across sectors, regions and occupations, even the local effects should fade. The shocks may, however, affect the allocation of employment by region, by sector or by skill and they may have a persistent impact on earnings and job stability for some of those who are negatively affected.

(b) Search and matching theories

The competitive model which has been considered so far typically assumes that buyers and sellers in the labour market can find partners effortlessly (without transaction and/or search costs), and only introduces frictions to explain unemployment. Historically, the problem with these approaches has been that they cannot explain unemployment in situations where individuals are actively searching for employment but cannot find jobs. This evidence has called for a new approach to understanding labour markets and alternative frameworks for evaluating the determination of wages, employment and unemployment.

The change came in the form of the search and matching theories of the 1970s, which allowed for a richer comprehension of agent interactions and had a profound effect on the understanding of the labour market. By shifting the focus from the "macro" level to individual interactions between various agents, these frameworks allowed for a more comprehensive and holistic analysis of a range of features of interactions between various stakeholders in a labour market exchange. For example, one strength of this approach is that it can help model movement between different labour market states which include the informal sector.[45]

While this subsection does not exhaustively cover the impressive range of literature encompassing all the nuances of search and matching theories, it provides an overview of the major strands of that literature and examples of prominent models. It does so by relaxing the major assumptions of the competitive model of costless exchange, perfect information and homogeneity of workers and firms. It is important to note here that the delineation between different models is often difficult and is done for the sole purpose of clarifying the main ideas and concepts incorporated under them. In many cases, multiple models discussed below have significant overlaps in their theoretical constructions.

The main building blocks of contemporaneous models of labour markets are search and matching theories.

Search theory explicitly accounts for the fact that buyers and sellers have to find each other before they engage in a labour market exchange. Search theory models search as a process in which the actors are working under the constraints of uncertainty and imperfect information. Search theory emerged out of a need to base the explanation of employment and unemployment on solid microeconomic foundations.

Matching theory utilizes search theory to explain how individual labour market exchanges determine wage-setting, employment and unemployment at the aggregate level. Perhaps the most famous labour market matching model is the Diamond-Mortensen-Pissarides Model, which takes a demand side approach to unemployment and looks at the duration of unemployment for a worker as being determined by how long it takes for a worker to receive an offer.[46] This contrasts with the earlier supply-side approach of the literature, which calculated unemployment duration by how many offers an unemployed worker would reject before accepting one. It is a particularly realistic model explaining unemployment and is based on a combination of a stochastic model of labour turnover,[47] a model of labour-market tightness[48] and a bargaining model of wage determination[49] (Hall, 2012). The integration of the notion of labour-market tightness – in which employers choose job creation volumes in response to their returns – is an important innovation of the model. The job-filling rate and the job-finding rate are, in turn, determined by the tightness in the market.

The level of unemployment depends on the flow of individuals entering and exiting the labour market, the speed at which the unemployed find and accept new jobs and the conditions under which the bargaining over surplus (see below) takes place between employers and workers in the labour market exchange. Additionally, in the case of developing countries, the informal sector plays a critical role in modulating the flow of individuals between employment in the formal sector and unemployment. The theory of job search helps us understand what determines this speed and

the dynamics of the bargaining process. It suggests that labour market institutions and regulations (e.g. labour unions, minimum wage legislation) have an important influence on the cost of being unemployed, and ultimately on the duration of unemployment. If governments improve access to information on jobs for applicants and on applicants for employers, for example, the speed, efficiency and effectiveness of the search process tends to increase, which contributes to a reduction of unemployment. Similarly, the existence and the conditions of income support schemes for the unemployed affect the cost of being unemployed and thus also affect the speed at which they accept a new job.

Looking at exchange costs, contracts and imperfect information provides a way to visualize matching and search theories, as well as a framework to help understand how the labour market works, which will be useful for the discussion in the subsequent sections.

(i) Exchange costs

In the competitive model, it is generally assumed that exchange costs are trivial or insignificant. However, exchange in the labour market can be decomposed into three distinct activities: matching, negotiation and enforcement. Each of these contributes to the costs of undertaking labour market exchanges and has an impact on wage-setting through its effect on the volume of exchanges and on the distribution of gains from labour market exchanges.

Matching

Matching consists of the set of activities which are involved in bringing together prospective transacting parties (Jacobsen and Skillman, 2004). In terms of the labour market, this can involve a diverse set of parameters. This subsection focuses on the geographical relocation of workers or, in rare cases, of a firm, before extending the discussion to other dimensions of the matching process. In competitive models, costless matching means that if either party tries to modify wages to serve their interests, then they would lose all their prospective partners. However, empirical observations of existing labour markets show that exchange partners are not always available, immediately identifiable and instantaneously paired.

This means that there are significant costs attached to identifying suitable partners in a labour market exchange and then reaching them. In the simplest model, this has two main consequences in terms of the impact on wage-setting by influencing the distribution of market power and the volume of exchanges. First, if workers find it hard to come across suitable alternative employment, then firms have greater power in wage-setting and can lower their wage rates below competitive levels. If both parties face significant costs in finding alternatives, a situation of bilateral market power arises. Therefore, the gains to either party are partially determined by who faces the greater costs of no deal. Second, the existence of matching costs reduces the supply of labour by reducing the volume of exchanges, as some workers are discouraged from entering the market due to the prospect of these costs. Many workers also leave the market after becoming discouraged by the difficulties to find a job. This has an impact on the relative bargaining power of both parties in a labour exchange. A range of models incorporate matching costs in a theoretical and/or empirical framework in order to assess their impact on wage-setting.[50]

A range of models utilize matching costs under slightly different frameworks and provide a richer picture of their influence on labour market outcomes. These include the mobility cost model and the wage distribution model.

The **mobility cost model** provides a basic framework for evaluating labour market search costs by assuming that mobility costs exist for all market participants and are attributable to the spatial nature of market interactions. These costs are augmented by imperfect information and uncertainty. This framework consists of a "matching function" which links the total number of buyers and sellers to the number of successful employment matches per period. The equilibrium in this model occurs when all individuals have chosen the personally optimal search intensity. Three main results of this model include:[51]

i. a uniform wage rate where identical actors choose identical strategies if all actors are assumed to be homogenous;

ii. positive and negative externalities due to the fact that each actor's choice of search intensity affects others;[52]

iii. the possibility that the positive and negative externalities lead to a situation with multiple equilibria that are rankable on efficiency grounds.

The **wage distribution model** adds a non-uniform distribution of payoffs for a worker from job matches based on the assumption that workers and sellers are heterogeneous and that the returns to labour exchange are match-specific. In this case, choice is sequential and the worker needs to decide when to stop searching. The way to understand search behaviour of a representative worker in the

wage distribution model is through the concept of a reservation rate. This is the wage rate that is minimally acceptable to prospective workers given the expected costs and benefits of continued search. This reservation wage is affected by the underlying search conditions and this model enables testing links between search conditions and average search durations for workers. One main prediction of the model is that the expected duration of the job search increases in proportion to the magnitude of the reservation wage, so policies such as an increase in unemployment benefits therefore lead to a higher reservation wage and a higher rate of unemployment.

Negotiation

Once an employer and a worker have met, e.g. at a job interview, the terms and conditions of the exchange of labour services need to be agreed upon. These can range from a succinct discussion on wages or entire career paths for well-defined and observable labour services, or can include intricate examinations of various dimensions of the contract and how it will be monitored or bolstered though profit-sharing incentives (e.g. the number and time of work hours, the range of skills required, labour intensities,[53] conditions for profit-sharing or stock options and their vesting, etc.). These negotiations can be further complicated by an increase in the number of parties on both sides, and if the gains are realized after the deal. The latter situation can lead to a discussion of contingencies (i.e. future events that cannot be predicted with certainty), which can often lead to several complications, as explored further in the subsequent discussion.

As with the case of matching costs, negotiation costs affect the volume of labour exchanges and the distribution of gains from these exchanges, both of which have an impact on wage-setting. The process of negotiations can essentially be viewed as parties in the labour exchange bargaining over the total surplus generated by the agreement (Manzini and Snower, 2002). A range of theoretical models explores how bargaining over surplus and relative negotiating power is integral to wage-setting.[54] Within negotiation, the differential preferences of both parties can also affect wage-setting. Workers may, for example, prefer a fair wage including a premium as a condition of exerting effort because it is considered fair that a more profitable firm pays a higher wage (Akerlof, 1982).

The main difference when collective bargaining is introduced in a labour market is that firms must negotiate with or lay off groups of workers instead of individual workers. Under such models, collective bargaining arrangements increase the wages of a firm's incumbent labour force by eliminating the firm's option to replace individual workers during bargaining. This increase is conditional upon the existence of a net surplus to be shared,[55] the low costs of replacing individual workers, and the increasing average costs of replacing incumbents. Additionally, the ability of workers to coordinate work stoppage combined with an assumption that quasi-rents[56] exist leads to the situation where the right to strike increases worker payoffs, and the magnitude of this increase depends on the extent to which workers are able to exercise this right strategically (Jacobsen and Skillman, 2004).

Enforcement

Once negotiations are complete, the set of activities which involve ensuring that the terms of exchange are fulfilled are referred to as "enforcement". These activities might include monitoring and/or providing appropriate incentives for the fulfilment of the terms of agreement. One important instrument for achieving enforcement is a contract and it constitutes a specification of agreed-upon terms of exchange that can be enforced by an outside agency, which is usually a judicial body. Contracts can be implicit (unwritten) or explicit (written) and they provide a bridge between agreement and execution. We discuss contracts further in the next section. The presence of enforcement costs also has significant effects on the magnitude of gains from labour exchange and the distribution of these gains.[57] In terms of the literature, efficiency wage theories, which are discussed in more detail below, have postulated that an absence of explicit contract enforcement can lead to involuntary unemployment, thereby reducing the volume of exchanges.[58]

(ii) Contracts

Complications in labour exchange are often laid down in legally enforceable contracts for third parties who can ensure their enforcement. Transaction costs, therefore, often take the form of contractual difficulties and can be thought of as direct and indirect costs related to the creation and enforcement of contracts. One way to model contracts is through the representation of a set of efficient bargaining points as the "contract curve". An important consequence of using a contract curve is to note that as long as wage-setting and employment correspond to the contract curve, there are no market inefficiencies.

An implicit contract is understood to exist when, due to a variety of reasons, such as the transaction being routine and of little importance, it is not considered important or necessary to write an explicit contract. Implicit contracts are especially important

in understanding issues such as earning insurance, where workers commit to employers for a long period of time in order to be insured against earning risk caused by macroeconomic fluctuations. For example, German and Japanese employers expect their workers to remain loyal to their firms. This implicit commitment allows firms to invest in education and training without having to fear that those training costs will benefit competitors if workers quit and move. Conversely, workers expect their firms to be loyal and to keep their workforces largely employed even through temporarily adverse times, perhaps at reduced hours or wages. Self-enforcement is an important feature of implicit contracts and workers can also not be forced to accept wages lower than available market alternatives. This would mean that under this theory, wages would be downwards rigid and upwards flexible (Jacobsen and Skillman, 2004).

Despite their importance, contracts are often incomplete along a range of parameters and lead to losses for all parties in an exchange. They often fail to account for contingencies which affect the eventual realization of gains from exchanges. This may be due to the sheer number of potential contingencies or due to the fact that outcomes are not readily describable in ways that satisfy judicial rules. This can lead to contracts being "incomplete" due to their failure to specify the rights and obligations of exchange parties under a situation which would be verifiable by an external enforcement agency. Fehr and Falk (1999) show that under conditions of incomplete labour contracts, wage levels may positively affect workers' propensity to cooperate. Experimental double auctions[59] conducted as part of the study show that in the presence of complete labour contracts, employers accept and actively enforce wages close to the competitive level. Additionally, the issue of verifiability also arises when an external enforcement agent has to acquire a specialized ability in order to judge outcomes which are a function of the suitability and aptness of a given labour input rather than a quantity measured along a given dimension.

(iii) Asymmetric information

Asymmetric information is when exchange partners are not equally informed of all conditions that are relevant to the transaction. This is often the case when one party has private information that they do not share with the other party. The literature on the issue is divided between two forms of asymmetric information, hidden state and hidden action. Hidden state is when one party knows something about a condition that affects potential gains that is not known by the other party and hidden action is when one party chooses a set of actions that affect the magnitude of gains from exchange which is at least partially invisible to the other party. Hidden action creates the problem of incentive provision where it is hard to provide incentives for actions that cannot be observed by one of the parties and a good example of this is the choice of work intensity[60] by a worker. Hidden state leads to the problem of one of the parties not having complete information about the environment or characteristics of the other party which affects the gains and distribution from the exchange. In both of these cases, parties may gain from trying to learn about the condition or actions that are hidden from them. The two most common examples of the effects of the asymmetric information are adverse selection and moral hazard, as we will see hereafter.

Adverse selection

Adverse selection occurs when information asymmetry pertains to a prior condition and the possibility arises that the terms of the contract will affect the characteristics of the set of agents who seek an exchange relationship. Greenwald (1986) shows that when adverse selection is viewed in interactions between workers and current or future employers, job changers are primarily composed of lower-ability workers as firms court higher-ability workers. This will inhibit turnover by firms which are unwilling to hire from the job-changing pool except at low wages and by workers who, upon changing jobs, subsequently have less bargaining power and wages. An interesting observation from the literature is that workers who are laid off due to factors other than plant closures are likely to have lower earning losses in post-displacement employment as a group than workers who lose their jobs through plant closures because the former are of a higher quality because they are displaced from larger, higher-wage establishments (Krashinsky, 2002).[61] Additional evidence suggests that as firing costs increase, firms are increasingly likely to prefer hiring employed workers who are less likely to be low-performing (Kugler and Saint-Paul, 2004).

Moral hazard

Moral hazard may arise when workers can choose the level and amount of effort they put into a task but the employer can only observe the worker's output. If there is uncertainty about the output, then the employer cannot discern whether a good product is just luck or the result of effort and whether a low-quality output is the result of bad luck or lacking effort. It may arise in the context of software programming, for example, where malfunctions may be the result of bad luck due to unsuccessful interfaces with other software, or

may be the result of a lack of programming effort on the part of the worker. A general solution is to provide incentives to the worker through profit-sharing, stock options, franchising and the like. Moral hazard plays a central role in many models which depict contractual relationships in the labour market. Johansson and Palme (2005) explore the moral hazard problem in the Swedish national sickness insurance and find that the overall prevalence of work absence increased after the reform.

Within the literature, there are two main ranges of models which incorporate asymmetric information. These are the fair wage models and the efficiency wage models.

Fair wage models

Introduced by Akerlof and Yellen (1990), fair wage models assume that workers expect a premium as a condition for exerting effort when working in a more profitable firm. It explains persistent wage differentials within and between industries in the economy. The fundamental insight of the fair wage model is that workers might withhold effort if they perceive that they are being unfairly compensated. In these models, the existence of involuntary unemployment is explained by the fair wage exceeding the market-clearing wage. Firms will not hire unemployed workers at a lower wage because of the absence of a credible commitment mechanism to ensure that these workers will not have the same fairness considerations once hired.

An important innovation in the fair wage models has been the operationalization of the notion of fairness as aversion to inequity (Fehr and Schmidt, 1999). In this framework, workers are willing to give up some material payoff in order to resist inequitable outcomes. In Fehr and Schmidt (1999), the workers' reference outcome for judging the return to their work is the average of the wage rates of the peers of the other skill group and the own market-clearing wage instead of the payoff of the firm which was the case in Akerlof and Yellen (1990). In this framework, the main result is that inequity aversion leads to a positive correlation between wages and effort and provides an incentive to firms to pay workers above the competitive level. There has been strong empirical evidence from economics and experimental psychology backing up the importance of the notion of fair wages in determining wage outcomes.[62]

Efficiency wage model

In the efficiency wage model, imperfect monitoring and the incentive to shirk on the part of the workers leads to firms offering slightly higher (above-market) wages (Shapiro and Stiglitz, 1984). In efficiency wage models, firms use the number of workers to control the labour input and the wage rate as an instrument to ensure that each unit of effort from each worker is supplied at minimum cost (Pissarides, 2000). Efficiency wage models can be very useful in explaining involuntary unemployment, segmented labour markets and wage differentials across firms and industries for homogeneous workers. Empirical evidence has shown robust support for efficiency wage models in both developing and developed countries.[63]

(iv) Search and matching, trade and technology

Search and matching in the labour market feature prominently in many of the mechanisms linking trade to labour market outcomes that have been explored in the recent literature. One line of research continues to assume competitive labour markets and introduces assortative matching (i.e. positive matching between agents who have similar characteristics) between heterogeneous workers and employers, with wages varying across employers as a result of differences in workforce composition and bargaining over the incremental surplus that an additional worker adds to an employer's business. Pure bargaining models in the presence of search and matching frictions generate similar wage outcomes and market segmentation as fair-wage and efficiency-wage models, including wage premia between industries and employers for otherwise equally skilled workers. The basic mechanism is that employers that generate a higher surplus in the product market share a part of the surplus with workers through bargaining.

Another line of research introduces labour market frictions so that workers with the same characteristics can be paid different wages by different firms. For example, efficiency or fair wages can result in wage variation across firms when the wage that induces worker effort, or is perceived to be fair, varies with the revenue (surplus) of the firm. In addition, search and matching frictions and the resulting bargaining over the surplus from production can cause wages to vary across firms.

Models with labour market frictions can also account for varying equilibrium levels of unemployment as globalization or technology changes. These models predict that unemployment can rise or decline with globalization, depending on specific characteristics of the labour market. In these models, globalization and technology can operate in similar ways and reinforce each other: technology that results in

productivity improvements can be akin to a reduction in variable trade costs; technology that alters the product appeal to consumers is similar in its equilibrium consequences to both those changes; technology and product-market access abroad reinforce each other, with technology raising the surplus from exporting and export-market access boosting the returns to technology adoption. In general, technologically more advanced firms and exporters generate a higher surplus, employ more workers, share the surplus by paying higher wages than their competitors to similarly able workers, and hire more skilled workers.

Several studies highlight the trade-induced changes in match quality as a key aspect of trade in terms of welfare, employment and wage inequality. More recent studies have started to complement the analysis of cross-industry and cross-firm matches with an analysis of within-firm matches. Findings from this broad line of research are discussed in more detail in Section D and in Muendler (2017).

4. Conclusions

This section presents a number of major trends in labour market outcomes and introduces some basic insights from labour economics and macroeconomics. It provides a context for a discussion of the labour market effects of trade and technology. It shows that, while trade and technology are important sources of change to be considered in subsequent chapters, institutional and political conditions, as well as inherent mobility frictions, shape the labour market performance regardless of the origins of economic changes.

Trends in labour force participation, employment-to-population ratios, the unemployment rate and real wages have not shown dramatic changes in aggregate labour market outcomes over the past two decades, other than those related to the Great Recession. The overall labour force participation rate has, on average, remained relatively constant in both high- and low-income economies, but has decreased in middle-income economies. These broad trends, however, mask large differences across countries, including between economies in the same region or with a similar level of economic development.

These different evolutions in labour force participation are associated with differences in changes in output growth in response to business cycle fluctuations, with differences in population growth, or with differences in the extent of the relative increase in the female participation in the labour force. Similarly, unemployment rates do not exhibit any long-term trends but patterns remain highly country-specific, underscoring the diverse and idiosyncratic conditions prevailing in different countries. Also, while average hours worked decreased in higher-income countries, they increased in lower-income countries. Finally, real wages have been growing in recent years but at a slower pace than before the financial crisis. These broad trends, however, also hide large differences across countries, including between economies in the same region or with a similar level of economic development.

At a more disaggregated level, labour markets across many developed and developing countries have experienced profound changes in the last 25 years, with a sustained shift of employment from agriculture and manufacturing towards services. At the same time, the labour markets of many developed countries and several developing countries have become polarized due to the relative decline in the number of middle-skill/middle-paid jobs compared to the relative increase in the number of low-skill/low-pay and high-skill/high-pay jobs. Both phenomena may be relatively disruptive for workers who face the risk of job loss and having to switch jobs.

The diversity of outcomes across countries is in line with one of the main insights from labour economics introduced in Section B.3, which suggests that country-specific factors play an important role in explaining labour market outcomes. Section B.3 explains why the impact of technology and trade needs to be assessed in the context of the other major factors shaping supply and demand for labour and their influence on wages and employment, including macroeconomic conditions, labour market institutions and mobility frictions. The 2007/08 financial crisis, for example, delivered a profound shock to labour markets across many countries – irrespective of longer-term technology or trade-driven change – from which they are still recovering. This subsection examines in particular how search and matching frictions, mobility frictions or skills mismatches can prevent a smooth adjustment of the labour market, limiting the productivity gains from technology and trade, contributing to short-term unemployment, and widening the gap between the winners and losers from economic change.

Additionally, while the theoretical models and concepts discussed in this section broadly apply to all economies, it is important to note that there are salient differences between labour markets in developing and developed countries which may affect the analysis of the interlinkages between trade, technology and jobs. These include the higher segmentation of labour markets in developing

countries, high informality rates, ranging between 40 and 80 per cent of the employed labour force in developing countries, the larger share of employment in developing countries compared to developed countries and the different role played by self-employment in developing countries, where better employment is usually found in wage employment instead of self-employment.

Appendix B.1: Labour force participation rate

As discussed in Section B.1, the labour force participation rate is shaped by economic, demographic and social change. This appendix reviews some of these changes in detail.

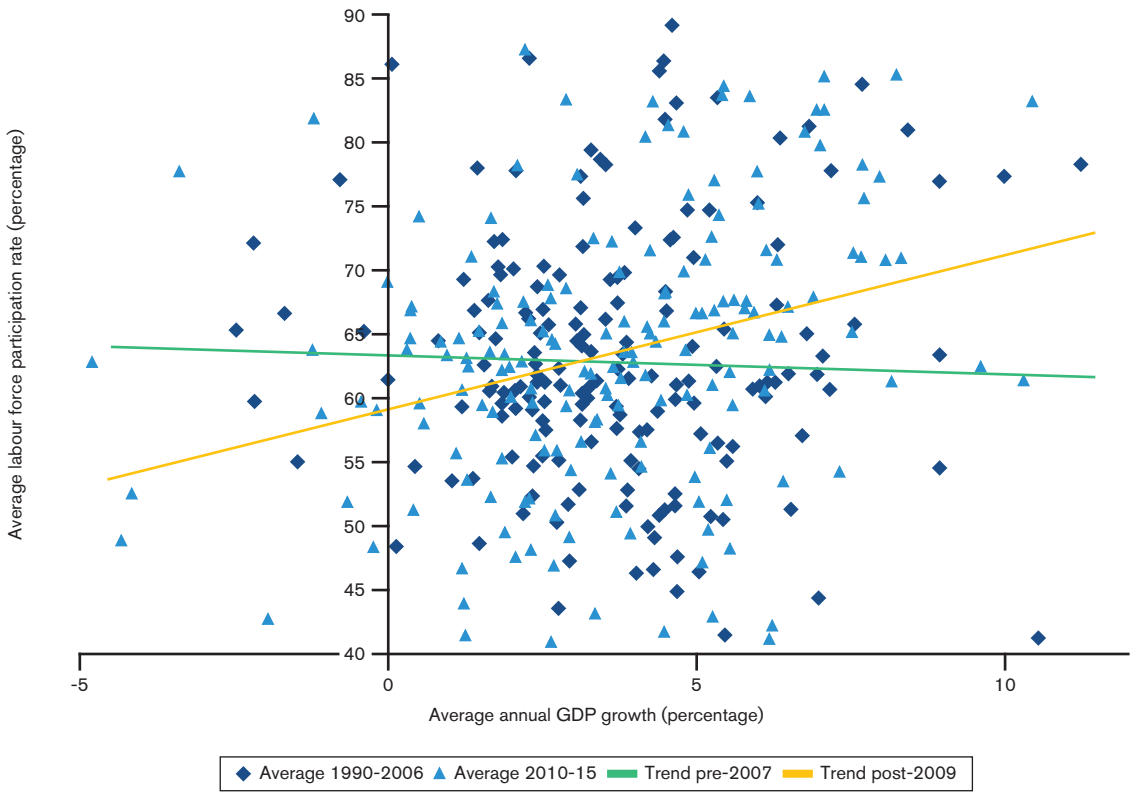
Appendix Figure B.1 documents the sharp increase of the correlation between GDP growth and labour force participation rate since the Great Recession measured by the linear trend. While the correlation was statistically not different from zero prior to the Great Recession in 2007, it has turned positive (and statistically significant) since the end of the Great Recession in 2011.

Besides business-cycle fluctuations, changes in labour force participation rate also reflect changes in population growth. As shown in Appendix Figure B.2, the correlation between the average annual change of labour force participation rate and the average annual change of prime working age population (aged 25-54), measured by the linear trend, is significantly stronger for economies with high total population growth (early and late demographic dividend countries) than those with lower population growth (pre- and post-demographic dividend countries). However, given that the demographic dynamic remains specific to each country, the relationship between labour force participation rate and population growth differs significantly across countries.

The evolution of labour force participation rate reflects also the relative decline in the labour force participation among the young aged 15 to 24 and the relative increase in the labour force participation among older individuals aged 54 to 64, as depicted in Appendix Figure B.3. Although the decline in the labour force participation among the young has been occurring in both developing and developed economies, the rise in labour force participation among older individuals tends to be larger in developed economies than in developing economies.

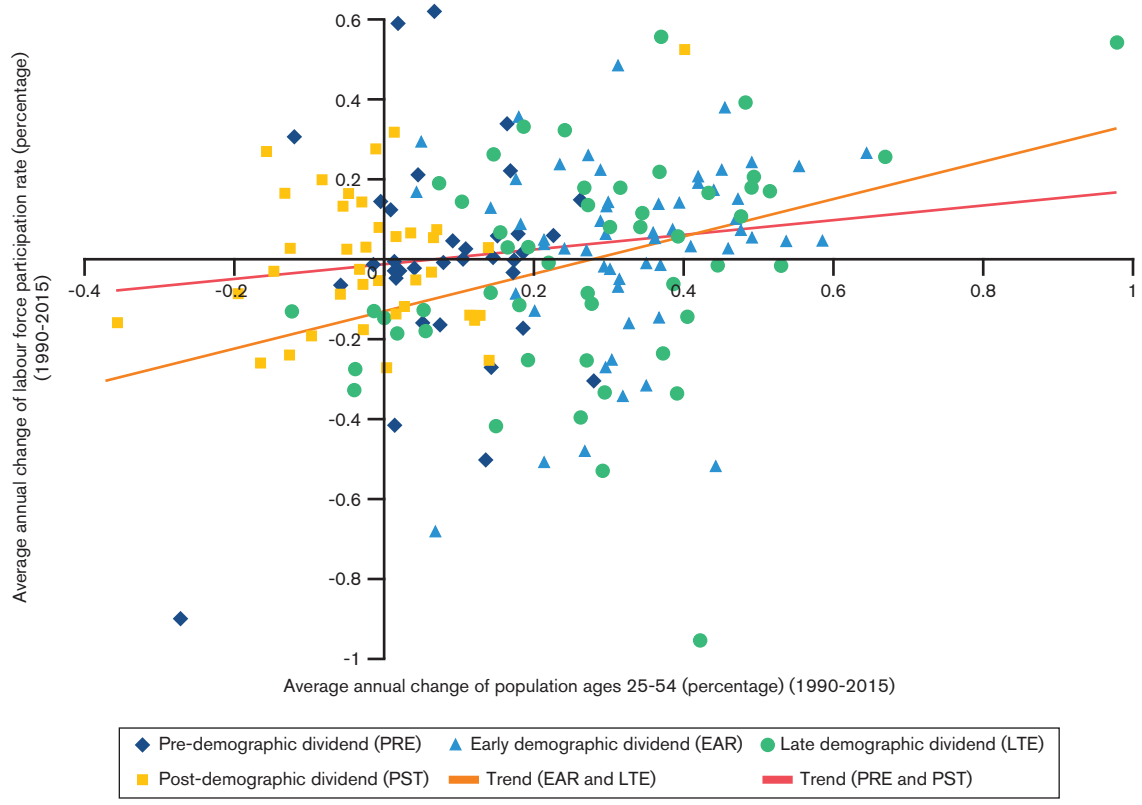
The expansion of secondary and tertiary education in the last 25 years explains also part of the different evolution of labour force participation rate across countries.

Appendix Figure B.1: Labour force participation rate and output growth (1990 to 2015)



Source: ILO, ILOSTAT database (July 2017), World Development Indicators (July 2017).

Appendix Figure B.2: Labour force participation rate and population growth (1990 to 2015)

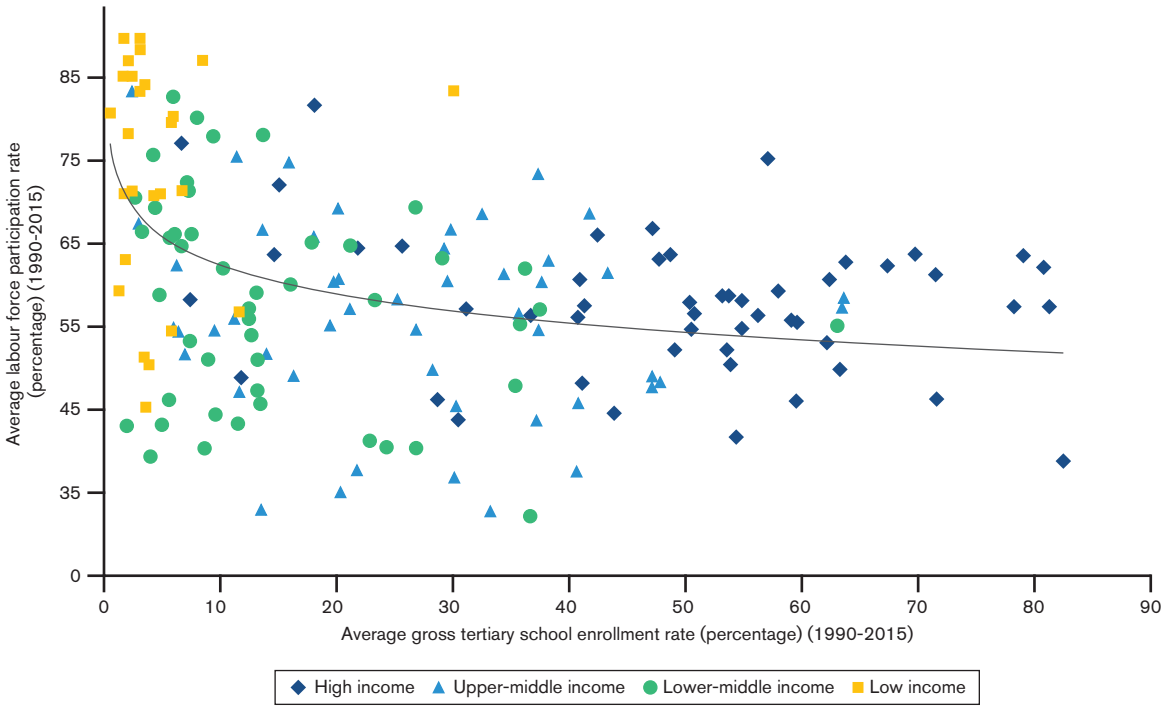


Source: ILO, ILOSTAT database (July 2017).

Appendix Figure B.3: Labour force participation rates for populations aged 15-24 and 55-64 years old (1990 to 2015)

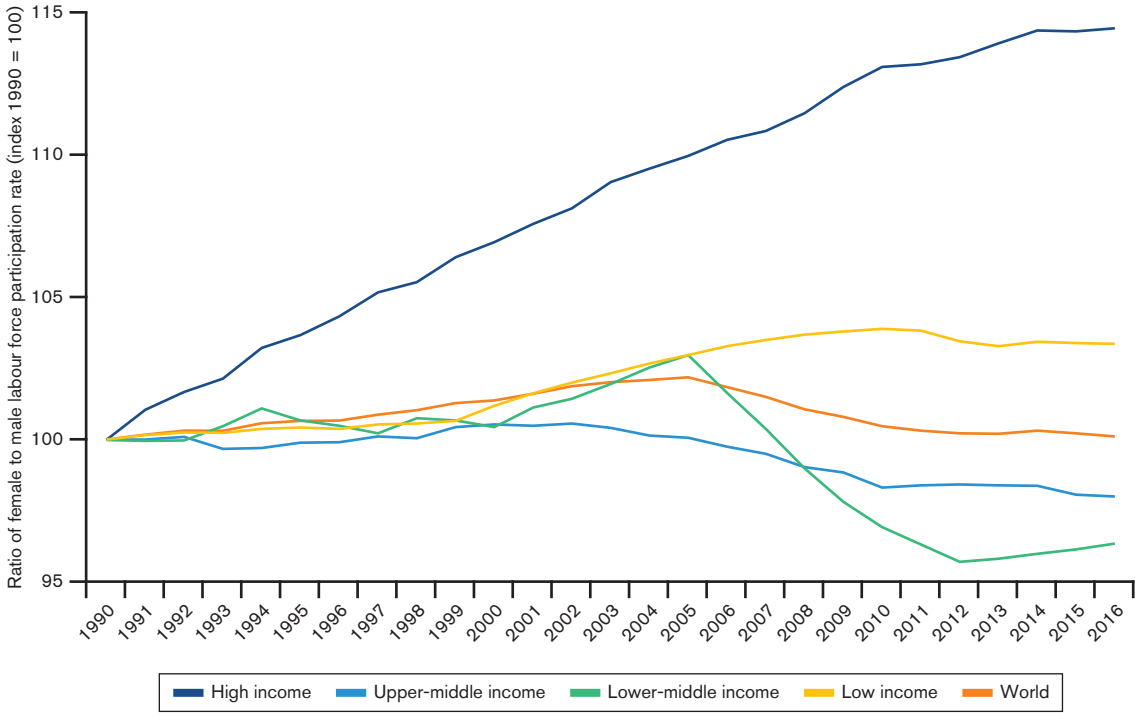
Source: ILO, ILOSTAT database (July 2017).

Appendix Figure B.4: Labour force participation rate and tertiary school enrolment (1990 to 2015)



Sources: ILO, ILOSTAT database (July 2017), World Development Indicators (July, 2017).

Appendix Figure B.5: Evolution of the ratio of female to male labour force participation rate (1990 to 2016)



Source: ILO, ILOSTAT database (July 2017).

As shown in Appendix Figure B.4, the labour force participation rate tends to be lower when the tertiary school enrolment rate is high, because part of the individuals pursuing higher education tends to be temporarily out of the labour market. However, the relationship between the tertiary education enrolment rate and labour force participation rate remains heterogeneous even among countries with a similar level of economic development.

The evolution of labour force participation rate is also driven by two opposite trends, namely the relative increase in the female participation in the labour force and the relative decrease in the male participation in the labour force. As depicted in Appendix Figure B.5, the ratio of female to male labour force participation has exhibited an upward trend in both low- and high-income countries, but a downward trend in middle income countries over the past 25 years.

Appendix B.2: The competitive labour market model

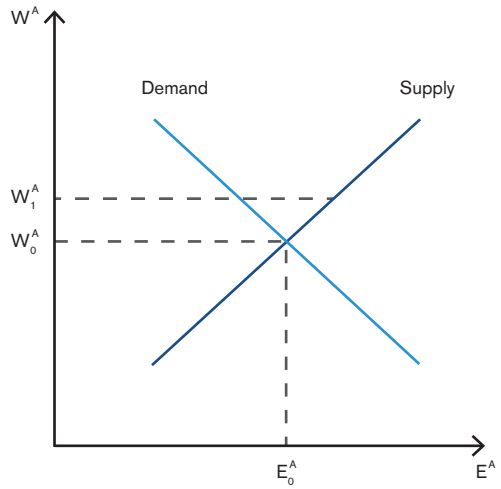
(a) The market for assemblers: a graphical analysis

Consider the market for a particular type of occupation, e.g. an assembler. To understand how the demand and the supply for assemblers react to changes in the wage rate and in their other determinants, and to see how they influence the competitive wage rate and employment on the market for assemblers, it is convenient to use a simple graphical representation of this market with the nominal wage rate of assemblers W^A on the vertical axis and the employment level E^A on the horizontal axis (see Appendix Figure B.6).

In Appendix Figure B.6, the labour demand schedule represents the number of assemblers that firms wish to hire at any level of the wage rate, assuming that all other factors that affect the demand (e.g. user cost of capital, product demand, product price, technology, and prices of intermediate inputs) are kept constant. The demand schedule is negatively sloped, as a given increase in the wage rate leads firms to reduce their demand for labour.

As for the labour supply schedule, it indicates the number of job-seekers who would be willing to work as assemblers at each level of the nominal wage rate, holding wages in other occupations constant. The labour-supply curve has a positive slope, as an increase in the wage rate of assemblers, keeping wage rates in other occupations constant, leads more people to be interested in becoming assemblers. The slope of the labour supply curve reflects the sensitivity of the supply of labour to a change in the assembler wage rate. If the labour supply schedule is relatively flat, it means that a small increase in the market wage rate would have an important effect on the number of people interested in becoming assemblers. On the other hand, if the labour supply is relatively steep, it means that relatively few persons would respond positively in their labour supply to an increase in the wage rate of assemblers. In the extreme, when the labour supply schedule is vertical, then an increase in labour demand (an upward shift in the labour demand schedule) will only result in a higher wage but no additional employment.

Appendix Figure B.6: Labour supply and demand for assemblers



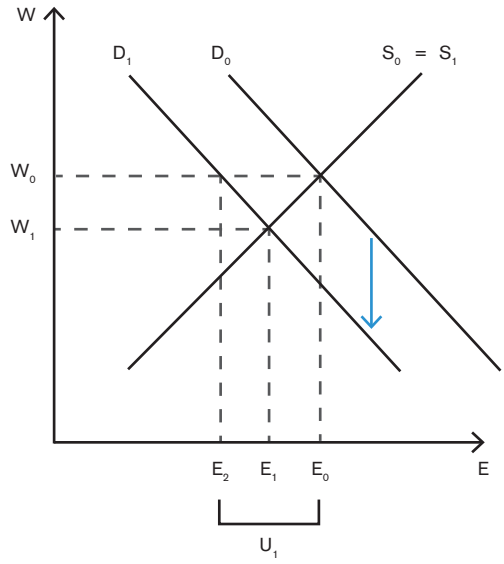
A similar principle holds for the slope of the labour demand, which represents how responsive firms are to a change in the wage rate. If the labour demand is relatively steep, it means that firms would not strongly reduce their demand for assemblers in response to an increase in the wage rate. The sensitivity of supply or demand to changes in the wage can also be captured through the notion of elasticity. The elasticity of the supply of assemblers, for example, is defined as the percentage change in the supply of assemblers in response to a 1 per cent increase in wage. A relatively flat supply schedule is often described as an elastic supply.

In a competitive labour market, with homogeneous workers and firms with no market power and with perfect information, the intersection of the labour supply and demand curves determines the equilibrium wage rate (W_0^A). If the wage rate were set just above the equilibrium level, say at W_1^A labour supply would exceed labour demand which would put downwards pressure on the wage level. Similarly, if the wage level were set just below the equilibrium wage rate, excess demand for labour would raise the wage rate. The equilibrium level of the wage rate is sometimes called the market-clearing wage.

(b) Cyclical unemployment in the competitive model

Appendix Figure B.7 represents the aggregate labour market, with aggregate employment and wages on, respectively, the horizontal and vertical axes. Initially,

Appendix Figure B.7: Cyclical unemployment



the labour market is in equilibrium, labour supply and demand meet to determine the equilibrium levels of employment, E_0, and wages, W_0. In this state of the economy, there is no unemployment other than frictional unemployment as, abstracting from natural churn, the workers that would like to work are all employed, while the rest have chosen to remain out of the labour force. Suppose now that the economy enters the downswing phase of a business cycle and that the demand for final goods decreases. Firms produce less output and demand less labour, thus leading to a downward shift of the aggregate demand for labour, as is shown in Appendix Figure B.7.

If the wage rate were flexible downwards, it would fall to W_1 and employment would decrease to E_1. However, for a number of reasons discussed in this report, wages may be rigid downwards. In the presence of wage rigidity, the wage rate would not fall to W_1 following the decrease in labour demand but would instead remain at W_0 while employment would shift to E_2. In this state of the economy, labour demand and supply do not clear and there is excess supply of labour. Indeed, at wage rate E_0, firms employ only E_2 workers, while E_0 workers would like to work for that wage. The difference between the level of employment in the economy, that is E_2, and the number of workers that would like to work at wage W_0, that is E_0, are the workers currently unemployed. As this unemployment is induced by the downswing phase of the business cycle, it is typically referred to as "cyclical unemployment".

Endnotes

1 Definitions of labour market indicators often differ across sources, making comparisons difficult. International organizations such as the Organisation for Economic Co-operation and Development (OECD) and the International Labour Organization (ILO) make efforts to harmonize data classifications to ensure cross-country comparability.

2 The International Labour Organization defines employment as persons of working age (typically aged 15 and older) who, during a short reference period, such as one week or one day, are engaged in any activity to produce goods or provide services for pay or profit. It encompasses paid employment (whether at work or with a job but not at work) and self-employment (whether at work or with an enterprise but not at work). The US Bureau of Labor Statistics defines employment as persons on the payroll who worked or received pay for the pay period that includes the 12th day of the reference month. Full-time, part-time, permanent, short-term, seasonal, salaried and hourly employees are included, as are employees on paid vacations or other paid leave. Proprietors or partners of unincorporated businesses, unpaid family workers, or persons on leave without pay or on strike for the entire pay period, are not counted as employed.

3 See WTO (2013) for a detailed discussion on the demographic transition and ageing.

4 Different factors can affect population growth and in particular the fertility rate, including rising incomes, higher educational attainment, family-friendly labour market institutions, and social and cultural changes such as increasing gender equality. Migration can also have an impact on population growth.

5 A similar pattern emerges when a population aged 16 and over is considered.

6 Over the last 25 years, education levels, including literacy rates, have continue to increase substantially in both developed and developing countries. Over the period 1950 to 2010, the average number of years of schooling among individuals aged 15 or over increased from 2.1 to 7.1 in developing countries and from 6.2 to 11.0 in developed countries (Barro and Lee, 2010). Countries in the Middle East and North Africa, Sub-Saharan Africa and South Asia achieved substantial, though uneven, progress in improving primary school access and increasing primary attainment rates.

7 See ILO (2017) for a discussion on female labour force participation over the past 20 years.

8 The unemployment rate is often criticized for providing a partial picture of the labour market. One shortcoming of the unemployment rate is that out-of-work individuals who stop looking for a job are counted as out-of-the-labour force, which reduces the unemployment rate in the particularly bad times. People in training are also not considered unemployed. Similarly, individuals in part-time employment may be looking for more work but their search goes unreported in the unemployment rate. That is why economists use at least two additional statistics: (1) the employment rate and (2) underemployment rate. Both variables are discussed in detail in the main text. See Sengenberger (2011) for a discussion on the issues related to the measurement of unemployment.

9 While employment growth in high-income countries is closely linked to the business cycle, (global) economic downturns often tend to have a limited impact on the employment growth in developing countries because of the relatively large incidence of self-employment or unpaid family work.

10 According to the ILO, employment in the informal economy is defined as the percentage of total non-agricultural employment, namely all jobs in unregistered and/or small-scale private unincorporated enterprises that produce goods or services meant for sale or barter. Self-employed street vendors, taxi drivers and home-base workers, regardless of size, are all considered enterprises (ILO, 2014a).

11 Although not discussed here, the informal employment rate also differs according to age groups and gender (ILO, 2016f; 2016g).

12 See Lee et al. (2007) for a discussion on the evolution of weekly working time trends in low- and middle-income countries.

13 As discussed next, workers can be broadly engaged in (1) wage employment, (2) self-employment and (3) unpaid family work.

14 Two main forms of underemployment can be distinguished: (1) invisible underemployment reflects a misallocation of labour resources, including the mismatch of occupation and skills; (2) visible (time-related) underemployment represents the involuntary part-time employment of individuals seeking or available for additional work. Invisible underemployment also encompasses the individuals partially unemployed because of a temporary, collective reduction in their normal work hours for economic, technical or structural reasons (Bollé, 1997).

15 In practice, an individual may fall in both categories.

16 General and specific human capital accumulation, such as the returns to employer, occupation, and industry tenure, has been identified as one of the main source of wage growth in high income countries. For instance, empirical evidence suggests that the main contributors to wage growth in the United States are the overall labour market performance and occupation tenure (Sullivan, 2010). Empirical evidence on the sources of wage growth in developing countries is scarcer and limited because of the lack of data availability. In a recent study on Indonesia, the returns to employer tenure are found to be higher than the returns to experience unlike in the United States. In addition, the returns to tenure in the formal sector are found to be relatively large representing the most important contributor of wage growth in Indonesia, while the return to tenure in the informal sector is not significant (Marinescu and Triyana, 2016).

17 The labour-income share has received increasing attention in the literature with a growing number of studies analysing the evolution and determinants of labour-income shares (ILO, 2011b; IMF, 2017; Schwellnus et al., 2017).

18 The ILO defines self-employment and unpaid work by contributing family workers as vulnerable employment because these forms of employment are less likely to have formal work arrangements, and are therefore more likely

to be associated with low or no employment protection, social security and effective representation, as well as low productivity and earnings, and higher uncertainty in income streams.

19 Although the number of working poor, defined as individuals living on less than US$ 3.10 per day, has declined globally over the last 40 years, the levels of working poverty remain relatively high in many low- and lower-middle-income countries. Progress in reducing working poverty has slowed down in recent years, in part due to the Great Recession which increased the number of working poor in many countries. The incidence of working poor is different across demographic groups and tends to be higher among women and young people in both developed and developing countries (ILO, 2016g; 2017).

20 Most countries exclude agriculture from their measurements of informal economic activities.

21 The trend of the industry sector, which includes manufacturing among other industries, has evolved slightly differently. According to ILO estimates, the world share of industry employment in total employment increased from 19.5 per cent in 2000 to 21.8 per cent in 2011 followed by a period of relative stagnation and even small decline to 21.5 per cent in 2016. The average share of industry employment in total employment is relatively similar across many income groups and regions, ranging from 21.4 per cent in low-middle-income countries to 22.3 per cent and 24 per cent in high- and upper-middle-income countries in 2016, respectively. However, the average employment share in industry remains particularly low in low-income countries (8.3 per cent in 2016) and in Africa (12.9 per cent), in particular Sub-Sahara Africa (10.7 per cent), and the Caribbean (14.7 per cent).

22 The contribution of the services sector to GDP has also increased in many developed and developing countries.

23 Other skills classifications distinguish between cognitive, non-cognitive, and technical skills or between cognitive/problem solving, learning, personal/behavioural/ethical, and social and communication skills (World Bank, 2013).

24 Additional skill measures in the labour and macro-labour literatures include schooling years, active years in the labour force (potential labour market experience since a person's last educational degree), observed ability from aptitude or intelligence tests, and estimates of unobserved ability that is reflected in wages. See ILO-WTO (2017) for a discussion on skills measurement.

25 Training and skills development typically encompass three main elements. First, basic education enables individuals to acquire a basis for the development of their potential, laying the foundation for their future employability. Second, initial training enables individuals to acquire the core work skills, general knowledge, and industry-based and professional competencies necessary to facilitate the transition from education into the world of work. Third, lifelong learning enables individuals to maintain their skills and competencies as work, technology and skill requirements change (ILO, 2011a).

26 In many countries, migrant workers often tend to be over-represented in low-skill sectors (OECD, 2008).

27 Tasks performed by workers in elementary occupations usually include: selling goods in streets and public places, or from door to door; providing various street services; cleaning, washing and ironing; taking care of apartment houses, hotels, offices and other buildings; washing windows and other glass surfaces of buildings; delivering messages or goods; carrying luggage; door-keeping and property-watching; stocking vending machines or reading and emptying meters; collecting garbage; sweeping streets and similar places; performing various simple farming, fishing, hunting or trapping tasks; performing simple tasks connected with mining, construction and manufacturing, including product-sorting and simple hand-assembly of components; packing by hand; freight-handling; pedalling or hand-guiding vehicles to transport passengers and goods; and driving animal-drawn vehicles or machinery (http://www.ilo.org/public/english/bureau/stat/isco/isco88/9.htm).

28 Maloney and Molina (2016) further shows at a more disaggregated occupation level how the evolution of the occupations structure in many developing countries differ substantially overt time and between countries. Some countries, such as the Dominican Republic, Ghana, Nicaragua, Viet Nam and Zambia, experienced an increase in employments in low-, medium-, and high skill occupations in the 2000s.

29 Different approaches have been used in the literature to estimate the skill premium. Some papers simply consider the relative wages between skilled and unskilled workers based on educational attainment (i.e., the ratio of highly to poorly educated wages). Yet, having a tertiary education does not necessarily imply that the tertiary education has caused the difference in pay. Other individual characteristics could explain the difference in wages. This is why the skill premium is often estimated econometrically by controlling for individual characteristics, such as gender, age, work experience and region. Different definitions of the skill premium have also been used, such as the wage ratios of non-production to production workers, of university to high school education or of high school to primary education.

30 Parro (2013) reports an increasing skill premium in China, Finland, Germany, India, Italy, Portugal, the Philippines, Spain, Sweden, Thailand, the United Kingdom and the United States between 1990 and mid-2000s, and in Colombia, Mexico and Uruguay between 1990 and 2000.

31 In the case of the United States, the skill premium also tends to be higher when the relative supply of skilled to unskilled workers is limited (Acemoglu and Autor, 2012).

32 Parro (2013) reports a declining skill premium in Austria, Canada, Denmark, France, Greece, Japan and the Republic of Korea between 1990 and the mid-2000s and in Chile between 1990 and 2000.

33 This subsection draws on a number of textbooks on labour economics including Ehrenberg and Smith (2012), Borjas (2013) and Jacobsen and Skillman (2004).

34 Workers choose the amount of consumption and leisure (and implicitly the amount of hours worked) that maximize their utility given a budget constraint, which depends on a given wage rate as the price of leisure and on non-labour income. Using this relationship, the optimal amount of leisure and the corresponding supply of labour can be expressed as a function of the wage rate.

35 In contrast to the labour demand, the relationship between the hours worked and the wage rate expressed by the labour supply is not unambiguous. Indeed, while we would expect that an increase in wages would lead workers to work more (substitution effect), an increase in wages could also lead workers to work less, as they might want to consume more hours of leisure once they are richer (income effect). Here

we consider only positively-sloped labour supplies, which is the standard case in which an increase in wages leads to an increase in employment, as the substitution effect dominates the income effect.

36 The discussion assumes that workers are linked to a single product in a specific production process. In multi-product firms, workers contribute to many products and labour demand effects of product innovations depend on economies of scope and cannibalization effects in the product market.

37 When a single employer faces an upward sloping labour supply schedule, its marginal expense curve lies above the labour supply curve reflecting the fact that marginal expense includes both the higher wage the firm pays to the extra workers and the additional cost of raising the wage for all other workers. The employer maximizes its profit by choosing the level of employment which equates its marginal expense to its marginal revenue and by setting the wage that allows it to get this optimal level of employment. In other words, the intersection of the labour demand curve and the marginal expense curve determines the optimal level of employment and the labour supply curve indicates the wage rate the firm needs to pay to get the optimal level of employment.

38 Many types of labour can contribute to production beyond the simple two factors case with labour and capital. Concretely, machinists and assemblers can enter the production process for the same product. Hence, there may also be a labour demand effect when the wage of machinists changes relative to the wage of assemblers.

39 Besides government interventions and the reasons discussed in the next subsection, other possible explanations of wage rigidity have been proposed. For example, if unions are strong enough, they may resist nominal wage cuts. Also, unemployment benefits and social welfare payments may serve as *de facto* nominal wage floors. As a further example, see the discussion in Ehrenberg and Smith (2012).

40 See the discussion of the available evidence in Jacobsen and Skillman (2004) for example.

41 See the definition of employment by the US Bureau of Labor Statistics in Box B.1. Job openings information is collected for the last business day of the reference month. A job opening requires that: 1) a specific position exists and there is work available for that position, 2) work could start within 30 days whether or not the employer has found a suitable candidate, and 3) the employer is actively recruiting from outside the establishment to fill the position. Included are full-time, part-time, permanent, short-term and seasonal openings. Active recruiting means that the establishment is taking steps to fill a position by advertising in newspapers or on the Internet, posting help-wanted signs, accepting applications, or using other similar methods. Jobs to be filled only by internal transfers, promotions, demotions or recall from layoffs are excluded. Source: US Bureau of Labor Statistics, Job openings and labour turnover, March 2017; https://www.bls.gov/news.release/archives/jolts_05092017.pdf

42 The quits count includes voluntary separations by employees (except for retirements, which are reported as other separations). The layoffs and discharges count is comprised of the following: involuntary separations initiated by the employer and includes layoffs with no intent to rehire; formal layoffs lasting or expected to last more than seven days; discharges resulting from mergers, downsizing, or closings; firings or other discharges for cause; terminations of permanent or short-term employees; and terminations of seasonal employees. The other separations count includes retirements, transfers to other locations, deaths, and separations due to disability. Source: US Bureau of Labor Statistics, Job openings and labour turnover, March 2017; https://www.bls.gov/news.release/archives/jolts_05092017.pdf

43 As discussed in the next subsection, another way to explain cyclical unemployment would be to argue that during a recession, vacancy postings decrease, while the number of workers searching for a job increases as a result of job losses in shrinking firms so that, overall, there are more unemployed workers in the search process.

44 In practice, workers unemployed for a significant period of time become less employable. Remedial measures may be required to keep them connected with the job market and prevent the rise of long-term unemployment.

45 In developing countries, the size and characteristics of the labour market make matching theories more realistic in their simulation of the labour market exchanges than the competitive models.

46 See a detailed description of the model in Mortensen and Pissarides (1994) and Shimer (2005).

47 This means that a random probability distribution which cannot be predicted precisely is used in order to simulate how workers get unemployed, find work and attain employment.

48 Labour market tightness is defined as the proportion of vacancies to unemployment. In a market where the proportion of vacancies to unemployment is relatively high, it is hard for employers to fill their vacancies. Hence we speak of a tight labour market.

49 The bargaining models of wage determination assume that wage levels are the result of negotiation between the relevant stakeholders in the labour exchange process (e.g. workers and employers).

50 Acemoglu (2001) analyses the effect of labour market regulation on the composition of jobs using a theoretical model where matching between firms and workers is dependent on the unemployment rate and the vacancy rate with the underlying assumption that search is undirected. Lise and Robin (2017) develop an equilibrium model of on-the-job search with heterogeneity of workers and firms, aggregate uncertainty and vacancy creation and assess the fit to US time series data in order to look at various labour market outcomes. Satchi and Temple (2006) develop a general equilibrium model with matching frictions in the urban labour market with the possibility of self-employment in the informal sector and the scope for rural urban migration in order to investigate the effects of different types of growth on wages and the informal sector.

51 See Jacobsen and Skillman (2004).

52 There could be strategic complementarities leading to coordination or negative externalities if a worker's increased search intensity reduces the prospect that other workers will achieve a match.

53 Labour intensity is the relative proportion of labour to other inputs in a production process.

54 See for instance Stole and Zwiebel (1996a; 1996b).

55 A worker's net surplus is revenue less expenses for intermediate goods and capital goods, or the labour-related part of value added.

56 Quasi-rents are defined as returns to a factor (for example labour or capital) which are in excess of what is needed in order to retain that factor in its current use (Jacobsen and Skillman, 2004).

57 A worker's or a manager's effort is hard to verify and enforce. However, observed results, such as output or success in the product market, can be used to design incentives that can be enforced.

58 See for example Shapiro and Stiglitz (1984) and MacLeod and Malcomson (1989).

59 A double auction is a process where buyers and sellers submit bids for the prices they are willing to buy and sell at respectively without the other's knowledge. An auctioneer then chooses a market clearing price. The buyers who bid higher than this price buy and the sellers who bid lower than this price sell.

60 Work intensity is a measure of the effort exerted in relation to the capacity of performing a particular job.

61 This labour market view is predicated on the idea that (i) the hidden state of a worker is his/her initially unobserved ability that can be learnt over time and (ii) the hidden state is a portable ability that matters to all employers to a similar extent. However, some initially unobserved abilities may be important matches for some employers, but unimportant for other employers. In that case, the type of layoff does not offer relevant information to the subsequent employer.

62 See for example Bewley (1998; 2002), Campbell and Kamlani (1997), Blinder and Choi (1990), or Kahneman et al. (1986).

63 See for example Velenchik (1997), Rebitzer (1995), or Rebitzer and Taylor (1995).

C Impact of technology on labour market outcomes

This section considers the effects of technology on the level and composition of employment and wages. Technological progress, by increasing the productivity of factors of production, expands an economy's production possibility frontier, so that the same amount of output can be produced with fewer resources, or more output can be produced with the same amount of resources.

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Some key facts and findings

- Technological progress can assist workers, through labour-augmenting technology, or replace them, via automation. In both cases, the overall effects on the market's demand for labour are ambiguous.
- Current technological progress has led to a higher relative demand for skilled workers and a lower relative demand for workers performing routine activities.
- The use of computers in the workplace has been the central force driving changes in the wages of skilled workers relative to the wages of unskilled workers.
- Various methodologies have been developed to estimate the share of jobs at risk from automation and computerization. According to these methodologies, the estimated share of jobs at risk tends to be larger in developing countries than in developed countries because of their larger share of employment in routine occupations.
- Automation does not necessarily equate with future unemployment because the development, adoption and widespread use of future technologies will hinge on a number of factors, including feasibility and affordability, as well as the legal and regulatory framework in particular countries and public acceptance of new technology. However, future automation is likely to be disruptive for workers whose skills will become obsolete and who face the risk of job losses and having to switch tasks and jobs.

1. Introduction

Technology can be broadly defined as "the state of knowledge concerning ways of converting resources into outputs" (OECD, 2011a) or as the "machinery and equipment developed from the application of scientific knowledge" (Oxford English Dictionary). There are two types of processes involved in producing a new technology: invention and innovation. Invention involves the formulation of scientific principles or processes. Innovation entails the direct application of this knowledge to a useful purpose in response to presumed profit opportunities. As argued in Section B of this report, innovation can take the form of new products or a new quality of a product (product innovation) or of new production techniques (process innovation). New technologies stemming from innovation have effects on the economy, and on society more generally, that are proportional to how widely they are adopted. General purpose technologies (GPTs) – technologies that transform both household life and the ways in which firms conduct business (Jovanovic and Rousseau, 2005) – have more widespread effects across firms and sectors than technologies destined for particular production processes or purposes.

Technology can complement workers (so-called labour-augmenting technology) or substitute for them (so-called labour-saving technology, or automation). If technology complements workers, this implies that it increases labour productivity. Autopilot technology on planes or statistical software for data analysis are good examples of labour-augmenting technologies. Automation technologies, in turn, complete cognitive or manual tasks without human intervention.[1] Repetitions (such as executing loops in a programme code or corking wine bottles in a winery) are good examples of automation.

Several recent studies show the positive effects of new technology on labour productivity. In the valve-manufacturing industries of the United Kingdom and the United States, the adoption of computer-controlled technology resulted in a substantial increase in productivity by reducing setup time, production time and inspection time (Bartel et al., 2007). Collard-Wexler and De Loecker (2015), who study the US steel industry, show that the (partial) displacement of older technology (vertically integrated producers) with a new production process (the minimill) was responsible for over one-third of the increase in the industry's total factor productivity, or 38 per cent in the period 1963 to 2002. Shifts to energy-efficient technology may increase workers' productivity, such as the move from standard fluorescent lighting to LED lighting in factories, which improves working conditions in hot humid climates in Bangalore (India) due to the lower heat emissions produced by LED lighting (Adhvaryu et al., 2016).[2] In the services sector, a travel agency in China which employs 16,000 workers saw a 13 per cent rise in labour productivity for home-based workers (Bloom et al., 2015). Box C.1 shows how technological change that raises labour productivity can be conceptualized in a production possibility frontier (PPF) framework.

Box C.1: Technological change in a production possibility frontier (PPF) framework

The production possibility frontier (PPF) of an economy describes the amount of output that can be produced for given amount of inputs, measured in efficiency units.

To see how technological change affects an economy's PPF, consider the simplest possible case of a two-sector economy (x and y), with production in both sectors being subject to diminishing returns to a single factor of production: labour. Diminishing returns imply that, in each sector, the marginal productivity of labour diminishes in the amount of labour employed in that sector. With diminishing returns, the PPF is concave (as plotted in Figure C.1). Another characteristic of production functions giving rise to concave PPFs are different factor intensities across the two sectors (even under constant returns) (see Snyder and Nicholson, 2010, pages 416-7).

Production functions for the two goods are $x=\sqrt{\widetilde{L}_x}$ and $y=\sqrt{\widetilde{L}_y}$, where $\widetilde{L}_i, i=x,y$ represent the efficiency units of labour allocated to each sector (physical units of labour multiplied by a sector-specific technology parameter A_i):

$$\widetilde{L}_x = A_x L_x \text{ and } \widetilde{L}_y = A_y L_y$$

Box C.1: Technological change in a production possibility frontier (PPF) framework *(continued)*

The PPF of this economy is represented by the following quarter circle:

$$y^2 = A_y L - \frac{1}{A_x} x^2,$$

where

$$L = L_x + L_y$$

is the total amount of labour in the economy. This is represented by the solid line in panels (a), (b) and (c) of Figure C.1 (the solid line in panels (a)-(c) of Figure C.1 is drawn assuming $A_x = A_y = 1$ and $L = 100$).

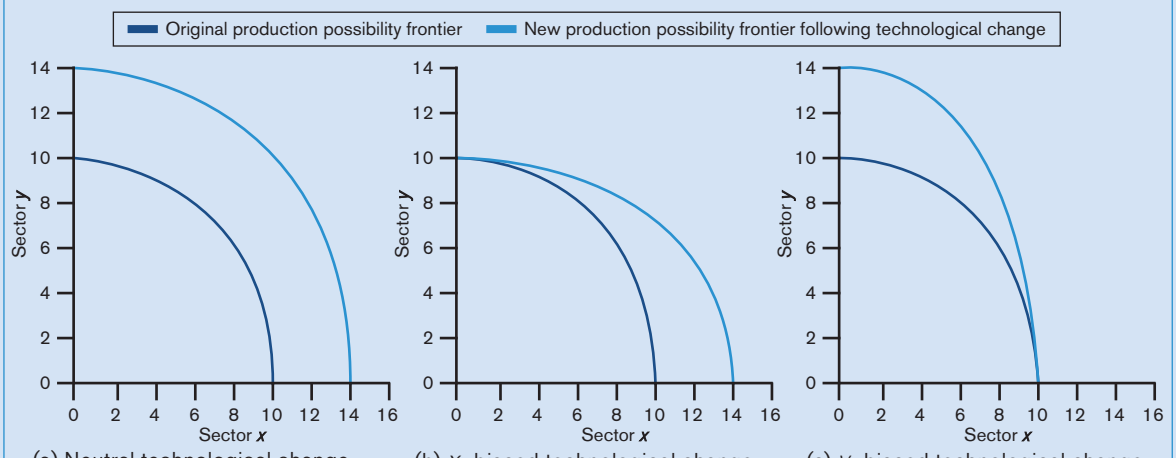
Technological progress – an increase in A – causes an outward shift in the PPF. This is due to the fact that an increase in A increases the marginal productivity of labour in the sector(s) where it occurs, so that the economy can produce more with the same amount of physical units of input (in this case, with the same number of workers). Marginal productivity of labour in sector i, $i = x,y$ is equal to $\frac{1}{2}\left(\frac{A_i}{L_i}\right)^{\frac{1}{2}}$. This increases in A_i and, due to diminishing returns, decreases in L_i.

Panels (a)-(c) of Figure C.1 represent three types of technological progress. In panel (a) such progress is neutral, since it increases labour productivity equally in the two sectors. This is referred to as Hicks-neutral or balanced productivity change. This type of technological progress could, for instance, be due to the introduction of a general-purpose technology (GPT), adopted in all sectors. This is represented by a parallel outward shift in the PPF from the solid to the dashed line – the dashed line is drawn assuming a doubling of productivity in each sector, so that $A_x = A_y = 2$, and keeping $L = 100$. In panel (b), technological progress is biased in favour of sector x: it is assumed that technology improves labour productivity only in x, and not in y. Panel (c) presents the opposite case of technological change biased in favour of sector y.

The dashed line in panel (b) is drawn assuming a doubling of productivity only in sector x, $A_x = 2$, and keeping $A_y = 2$ and $L = 100$. Conversely, the dashed line in panel (c) is drawn assuming a doubling of productivity only in sector y, $A_y = 2$, and keeping $A_x = 2$ and $L = 100$. Clearly, even if technological change occurred in both sectors, it would still be biased in favour of one sector if the increase in labour productivity was larger in that sector than in the other.

In all cases, technological change causes an outward shift in the PPF, allowing the economy to produce (and consume) more for a given amount of inputs. Note that the equilibrium of the economy (not shown in the figures) will be at the point of tangency between the PPF and the highest indifference curve representing consumers' preferences. The new equilibrium could also be reached with international trade. Trade, rather than shifting the PPF, changes relative prices and allows for a separation between production and consumption decisions. In this sense, trade and technology could have the same effects in general equilibrium.

Figure C.1: Technological change in a production possibility frontier framework



(a) Neutral technological change (b) x-biased technological change (c) y-biased technological change

Source: WTO Secretariat.

The use of computers, information technology (IT) and the internet has effects that go far beyond labour productivity. Digital trade and international e-commerce reduce transaction costs and boost the transparency of markets (Lippoldt and House, 2017). They allow consumers a more convenient and efficient shopping experience, raising living standards beyond real GDP growth (Hulten and Nakamura, 2017). More generally, the use of information and communications technology (ICT) increases the availability of market information, leading to a better and more stable functioning of markets (consider improved job matches in the labour market due to more readily available information on wages, job vacancies, skill requirements, and labour market conditions).

The effects of labour-augmenting and labour-replacing technologies on labour demand are ambiguous. An example is the introduction of technologies in agriculture. The related increases in agricultural labour productivity can be correlated with a reduction in agricultural employment if, as a result of falling relative prices of agricultural goods, economy-wide prosperity increases and household demand for agricultural produce grows less than demand for other goods. Automation, in turn, is intrinsically labour-saving, as it reduces labour requirements per unit of output produced. However, even labour-saving technology can be associated with rising labour demand due to lower production costs. The first part of this section reviews the mechanisms that give rise to the ambiguous effects of technology on employment, and discusses their empirical relevance.

By making some products or production processes obsolete, and by creating new products or expanding demand for products that are continuously innovated, technological change is necessarily associated with the reallocation of labour across and within sectors and firms. Such technology-induced reallocations affect workers differently, depending on their skills or on the tasks they perform. ICTs tend to be used more intensively and more productively by skilled workers than by unskilled workers. Automation tends to affect routine activities more than non-routine activities, because machines still do not perform as well as humans when it comes to dexterity or communication skills. In Section C.3, evidence is presented in favour of the hypothesis that the labour market effects of technology are relatively more favourable to skilled workers and to workers performing tasks that are harder to automate.

Advances in smart technology, artificial intelligence, robotics and algorithms, often referred to as the fourth industrial revolution, are taking place at unprecedented pace. Graetz and Michaels (2015) report that from 1993 to 2007, mean robot density increased by more than 150 per cent in 17 industrial countries. Boston Consulting Group (2017) reports that the number of industrial robots in operation could increase from the current figure of between 1.5 and 1.75 million to between 4 and 6 million by 2025. These significant increases in automation, and the potentially even wider use of robots in non-industrial sectors, have sparked a debate on the future of work, in particular on whether the demand for human labour might decrease permanently, leading to a "jobless future" characterized by artificial intelligence and robotics at a massive scale. Section C.4 reviews the evidence on the pace of technology adoption and the arguments of technology optimists and pessimists regarding the future of work. The section also discusses the implications for skills development.

2. Overall net employment and wage effects of technology

Throughout history, technological change has often been a source of anxiety for many workers. In England between 1811 and 1816, a group of workers who called themselves "Luddites" destroyed machinery which they believed was threatening their jobs, especially in cotton and woollen mills. Nineteenth-century economists like Karl Marx and David Ricardo predicted that the mechanization of the economy would worsen conditions for workers, ultimately condemning them to live on a subsistence wage. In the last century, too, prominent economists like John M. Keynes (in the 1930s) and Wassily Leontief (in the 1950s) expressed the fear that more and more workers would be replaced by machines, and that this would lead to technological unemployment.[3] More recently, Brynjolfsson and McAfee (2014) have claimed that such disruptive technologies reduce the demand for labour and put workers at a permanent disadvantage.

This section discusses the mechanisms behind the relationship between technological change and overall employment, and the empirical evidence related to those mechanisms.

(a) Theoretical mechanisms

As famously shown by Baumol (1967), technologically advancing sectors – that is, those experiencing more rapid productivity growth – tend to contract as a share of employment, while technologically lagging sectors – that is, those with slow productivity growth – tend to expand. This is because technological progress reduces labour requirements per unit of output

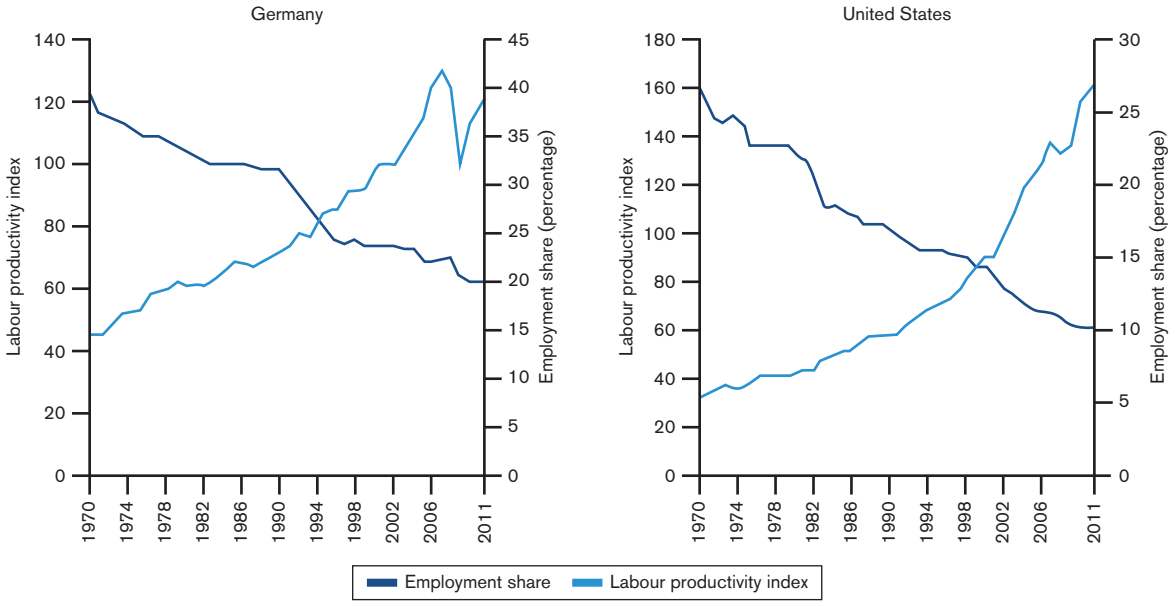
produced. Figure C.2 plots indexes of manufacturing employment (as a share of total employment) and labour productivity (output per employed person in manufacturing) between 1970 and 2011 for two major industrial countries (Germany and the United States). During the six decades covered by the data, manufacturing employment as a share of total employment fell substantially, but manufacturing labour productivity increased.[4]

These trends can be correlated with the evolution of one particular type of automation, namely the use of industrial robots, since the mid-1990s.[5] Between 1993 and 1997, robot density (defined as the number of robots per million hours worked) increased by 160 per cent in Germany and by 236 per cent in the United States.[6] Therefore, increasing automation is broadly correlated with lower labour requirements per unit of output in manufacturing adopting such labour-saving technologies. Graetz and Michaels (2015) estimate that, in their sample of 14 industries in 17 countries from 1993-2007, robot densification increased labour productivity by about 0.37 percentage points. According to the authors, this figure is fairly comparable to the estimated total contribution of steam technology to British annual labour productivity growth, which was around 0.35 percentage points, but was sustained over a period that was about four times longer, from 1850 to 1910 (Crafts, 2004, cited in Graetz and Michaels, 2015).

The deployment of labour-saving technologies is not a recent phenomenon. Without going back as far as the Industrial Revolution of the late eighteenth and early nineteenth centuries, one could mention the spectacular decrease in the share of agricultural employment in developed countries during the last century. Autor (2015), for instance, reports that in 1900, 41 per cent of the US workforce was employed in agriculture; by 2000, that share had fallen to 2 per cent, mostly due to a wide range of technologies including automated machinery, such as field machinery and irrigation systems.[7]

Labour-saving technologies, however, are not only deployable in the primary and secondary sectors. The introduction of earth-moving equipment and powered tools displaced manual labour from the construction sector, for instance (Autor, 2015). Occupations such as telegraph or elevator operators, which figured in the 1950 US Census, have been eliminated altogether, due to technological obsolescence in the case of the former and to automation of the latter (Bessen, 2017).[8] Thanks to advances in ICT, the automation of logistics and processing and of self-service (e.g. in document creation and management, which no longer require clerical support, or in retail self-checkout) and digitization (e.g. of data entry and of publishing/printing) are all services sector activities where labour-saving technologies can be deployed and can substitute for workers (see World Bank, 2016).

Figure C.2: Evolution of employment and output per worker in manufacturing of selected industrial countries (1970 to 2011)



Source: US Department of Labor Bureau of Labor Statistics (BLS) International Labor Comparisons (ILC) data.

Notes: Labour productivity measured as output per employed person (index, 2002 = 100 and percentage).

A simple conceptual framework to understand the effects of the deployment of new technologies on overall labour demand is based on the balance between substitution and compensation mechanisms (Vivarelli, 2015). It is argued in Section B that if technological change takes the form of a new product that is substituted for an older one, technological innovation lowers the demand for the old product while it raises the demand for the new product. This translates into an upward shift in the demand for labour used to produce the old product and a downward shift in the demand for the workers who produce the new products. In other words, the substitution mechanism at work operates via product displacement. While the resulting adjustment (with some jobs being destroyed and others being created) may not be without frictions, in this context it is worth noting that higher labour demand in the growing sector can partially or fully offset lower labour demand in the declining sector, a compensation mechanism that can produce ambiguous effects on overall labour demand.[9]

In the case of labour-replacing automation (analysed in Section B as a reduction in the price of capital), technological change induces firms to adopt more capital-intensive technologies and to substitute labour for capital, lowering labour demand at any given wage rate (substitution effect). There are, however, several compensation mechanisms that can counterbalance the initial labour-saving impact of automation, and of process innovation in general (Vivarelli, 2015). First, while workers are displaced in those industries that introduce the technology incorporated in the new machinery, additional workers are needed in the industries that produce the new machinery.

Second, automation (and process innovation more generally) reduces average costs. Acemoglu and Restrepo (2017) show that this leads: i) to a price-productivity effect (as the cost of production goes down, the industry can expand and increase its labour demand); and ii) to a scale-productivity effect (the reduction in costs due to automation results in an expansion of total output, raising the demand for labour in all industries). Similarly, Vivarelli (2015) argues that lower average costs can either translate into lower prices (if the industry market structure is perfectly competitive), stimulating product demand, or into extra profits (if the industry structure is not perfectly competitive). If these extra profits are re-invested in the firm, this investment can create new jobs.

A third compensating effect potentially leading to higher labour demand relates to local demand spillovers. Gregory et al. (2016), who study labour-saving technology in the form of routine-biased technological change (see Section C.3), argue that technological change creates high-tech jobs which generate additional demand in non-tradable sectors.[10] One could cite as an example the ICT sector, which includes manufacturing sectors, e.g. office machinery, and services sectors, e.g. telecommunications.[11] In terms of employment, the ICT sector is small, with ICT occupations accounting for 1 per cent of employment in developing countries, and 2 to 5 per cent in Organisation for Economic Co-operation and Development (OECD) countries (World Bank, 2016).[12] Moreover, the ICT sector only accounts for a minimal proportion of employment creation, because it is by definition capital-intensive.[13] For each job created by the high-tech industry, however, around five additional, complementary jobs are created in the local economy, mostly in the non-tradable services sector (Moretti, 2010; Moretti and Thulin, 2013; Goos et al., 2015).

Fourth, and most importantly, one should consider that technology adoption by firms is a decision affected by various factors, including changes in relative prices of production factors.[14] In the theoretical framework of Acemoglu and Restrepo (2016), as a factor becomes cheaper, the range of tasks allocated to it expands and also generates incentives for direct technologies that utilize this factor more intensively.[15] This implies that by reducing the effective cost of producing with labour, automation discourages further automation and generates a self-correcting force towards stability in the long run. Thus, it is possible that rapid automation need not disrupt labour, but might simply be a transitioning phase towards new technologies benefiting labour.[16]

The extent to which the compensation mechanisms described above can counterbalance the labour-saving impacts of technological change depends on several underlying assumptions and conditions.[17] In this context, it is sufficient to point out that the question of whether technological change increases or decreases overall employment and wages is, ultimately, an empirical one, which will be analysed in the next subsection.

(b) Empirical evidence

So far, the concerns expressed by prominent nineteenth- and twentieth-century economists like Marx, Ricardo, Keyes and Leontief, that the replacement of workers by machines would lead to technological unemployment, have not materialized. Although some individuals may have lost their jobs permanently, the past two centuries of technological progress have not made human labour obsolete.

The employment-to-population ratio rose during the 20th century, and there is no apparent long-run increase in the unemployment rate (Autor, 2015).

Case study evidence focusing on particular sectors and occupations shows that, even after the introduction of labour-replacing technologies, employment increased when those technological changes led to significant scale effects.

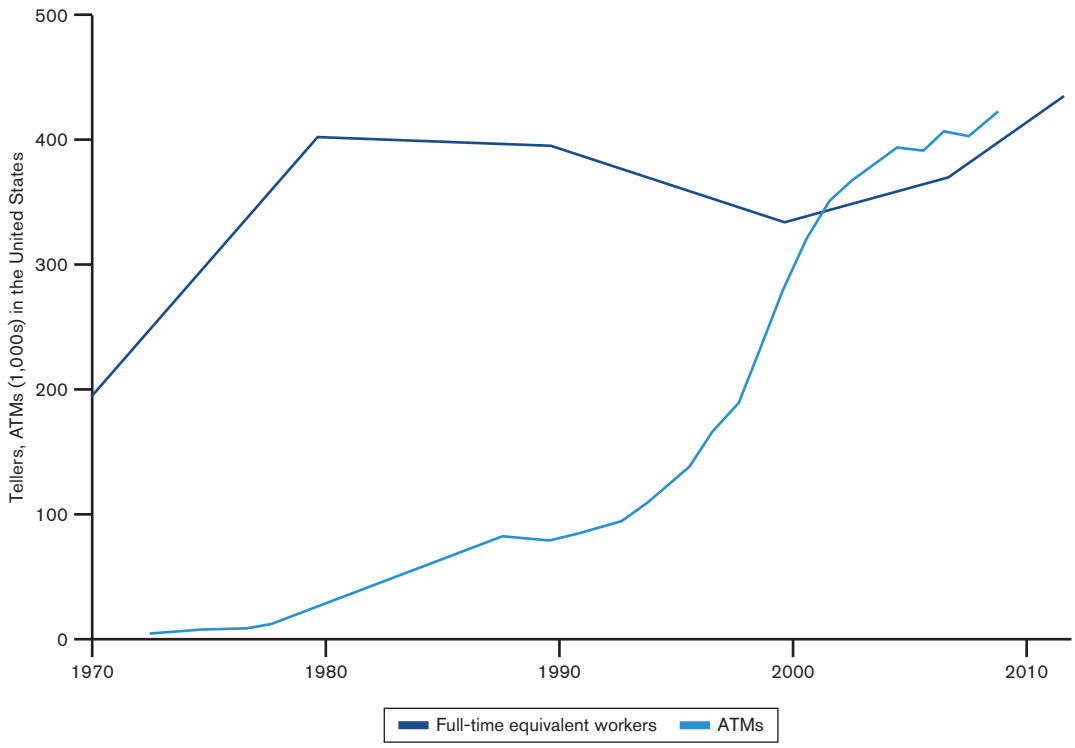
Bessen (2015) reports the telling examples of 19th-century cloth weaving and 20th-century cash-handling. During the 19th century, 98 per cent of the labour required to weave a yard of cloth was automated. However, the number of weaving jobs actually increased. Automation drove the price of cloth down, increasing the (highly elastic) demand for cloth, resulting in net job growth despite the labour-saving technology (Bessen, 2015).

In the United States, ATMs (i.e. automatic teller machines) were introduced in the 1970s, and their number rose fourfold (from 100,000 to 400,000) between 1995 and 2010. ATMs took over cash-handling tasks, yet since 2000 the number of full-time equivalent bank tellers has increased by 2 per cent per year, substantially faster than the overall US labour force (see Figure C.3). Employment did not fall because ATMs allowed banks to operate branch offices at lower costs. This prompted banks to open many more branches, offsetting the loss in teller jobs (Bessen, 2015).

There is abundant econometric evidence on the overall employment effects of technological change. The studies in this field can be classified according to the type of technological change considered (i.e. product innovation, process innovation, routine-biased technological change,[18] computerization or exposure to industrial robots), the income level of an economy (developed or developing) and the unit of analysis (firm, industry or local labour markets). The general conclusion from this literature is that technology has affected the structure of employment, but has had small (and mostly positive) effects on the overall level of employment (Vivarelli, 2014; Arntz et al., 2016b).

A positive link between technology and employment is especially evident when research and development (R&D) and/or product innovation are adopted as proxies of technological change, as well as when the focus turns to high-tech sectors (Bogliacino et al., 2012). There are, however, a few relevant exceptions, with studies showing negative labour-demand effects of technological change.

Figure C.3: ATMs and full-time equivalent bank tellers in the United States (1970 to 2010)



Source: Bessen (2015).

At the country and industry levels, in a sample of 32 industries in 19 developed economies between 1970 and 2007, Autor and Salomons (2017) find that productivity growth has been employment-augmenting rather than employment-reducing. In particular, the fall in industry-level employment as industry productivity rises (in line with Baumol, 1967) is more than offset by the rise in country-level employment as aggregate productivity rises. This indicates that productivity growth in each sector generates employment growth spillovers elsewhere in the economy. These spillovers are sufficiently large to more than offset employment losses in industries making rapid productivity gains.

In a similar vein, Bessen (2017) finds that between 1984 and 2007, computer use had a significant negative effect on manufacturing employment in the United States, but a mild positive employment effect on other industries. Ebenstein et al. (2015), conversely, argue that greater use of computers and capital equipment is associated with lower employment, higher unemployment and lower labour force participation across all US occupations. Graetz and Michaels (2015), using International Federation of Robotics (2012) data, estimate that across 17 countries over the period 1993-2007, while increased utilization of robots (robot densification) in a range of different industries – particularly in transport equipment, chemicals and metal industries – affected the composition of employment and wages across skill groups (see Section C.3), there were no adverse aggregate employment effects (i.e. no reduction in aggregate hours worked) of robot densification. Moreover, they estimate the positive and statistically significant effects of robot densification on mean wages. This implies that some of the productivity gains from robot densification were shared with workers (Graetz and Michaels, 2015).

Some recent studies consider the effects of technological change on local labour markets. In a study using commuting zones in the United States as units of analysis, Autor et al. (2015) find that exposure to routine task specialization had largely neutral overall employment effects between 1980 and 2007, only affecting the occupational composition within sectors. Acemoglu and Restrepo (2017) consider how exposure to industrial robots affected employment and wages in local labour markets between 1990 and 2007, and they estimate large and robust negative effects of robots on employment and wages across commuting zones. They suggest that an additional robot per thousand workers reduces employment to population ratio by about 0.18-0.34 percentage points (one more robot being associated with a reduction in relative commuting zone employment of 5.6 workers in their favourite specification) and wages by 0.25-0.5.[19]

Conversely, in a study focusing on 238 regions across 27 European countries over the 1999-2010 period, Gregory et al. (2016) find that routine-replacing technological change led to overall positive labour demand effects. In terms of the mechanisms they propose and that were discussed above, this suggests that the labour demand and the local demand spillover effects dominated the substitution effect. The authors argue that the net effect of routine-replacing technological change on labour demand was an increase of between 1.9 and 11.6 million jobs across Europe, depending on whether non-wage income (returns from technology investments) fed back into the local economy in terms of consumption or whether it was spent abroad.[20]

At the firm level, several studies contrast the effects of product innovation and of process innovation, finding negative employment effects of process innovation, which tend to be compensated by positive employment effects of product innovation. Using data on firms in the manufacturing and services sectors in France, Germany, Spain and the United Kingdom, Harrison et al. (2014) find that product innovation has a positive impact on employment, but that process innovation has a displacing effect on employment. However, the positive impact of product innovation generating employment is larger than the displacement effect of process innovation, and therefore the net effect of innovation on employment tends to be positive. Similarly, Hall et al. (2008) find a low but positive effect of product innovation on employment in Italy, and no displacement effect from process innovation.

Concerning developing countries, Ugur and Mitra (2017), who conduct a review of 43 qualitative studies and 12 empirical studies, report that the effect of technology adoption on employment is more likely to be positive when the evidence is related to skilled labour employment and product innovation. The qualitative studies included in the review by Ugur and Mitra (2017) further suggest that the employment effects of technology adoption are more likely to be positive in the presence of strong linkages between innovative firms/farms/industries and the rest of the economy, and in the presence of governance institutions that encourage and facilitate technology adaptation instead of relying on off-the-shelf technology only.

Most recent empirical work on the overall employment effects of technological change in developing countries uses firm-level data. The most

comprehensive study is that of Cirera and Sabetti (2016), who use a sample of over 15,000 firms in Africa, Central Asia, Eastern Europe, the Middle East and North Africa (MENA), and South Asia. They show that new sales associated with product innovations tend to be produced with just as much or higher levels of labour intensity. This positive employment effect of product innovation is largest in least-developed countries (LDCs) and in the African region, where firms are less advanced in terms of technological development.

Cirera and Sabetti (2016) also show that process innovations that involve the automation of production do not have a short-term negative impact on firm employment.[21] However, there is some evidence of a negative effect of automation on employment that is manifested in increases in efficiency that reduce the elasticity of new sales to employment (Cirera and Sabetti, 2016).

In developing countries, and especially in LDCs, most technological change occurs because of technology transfer. Trade and foreign direct investment (FDI) are important vectors of technological upgrading because developing countries can import technology embodied in capital goods, in particular machinery (Vivarelli, 2014). The qualitative studies surveyed by Ugur and Mitra (2017) suggest that the employment effects are more likely to be small or negative when technology adoption is dependent on imported technology. Vivarelli (2014) also suggests that technology transfers can reduce the domestic demand for labour in developing countries if they involve labour-saving process innovation.

While the existing empirical literature does not offer conclusive evidence on the overall labour demand effects of technology transfer, there is significant evidence that imports of capital-intensity technologies in developing countries are skill-biased (see the next subsection). Since technology transfer mainly occurs via trade, this is a case in which it is virtually impossible to distinguish between the effects of technology and trade in determining labour market outcomes.

To sum up the results of this subsection, the empirical literature has overwhelmingly found small and possibly even positive effects of technological change on aggregate labour demand and employment. There are, however, a few relevant exceptions, with some studies showing the negative labour demand effects of technological change. A common theme in the literature is that in developed and developing countries alike, the most relevant effects are found in the composition, rather than in the level of employment. These effects are analysed in the next subsection.

3. The impact of technology on skills and work tasks

The previous subsection considered the overall employment level effects of technology. Due to various mechanisms, including productivity effects and product demand spillovers, it was argued that labour-saving technologies need not reduce overall employment. This subsection considers the heterogeneous effects of technology on workers, depending on their skills and on the tasks they perform at work.

The basic consideration motivating the analysis is that technology can be biased in favour of certain groups of workers depending on their skills or on the tasks they perform. In particular, technology is skill-biased if it tends to complement skilled workers, increasing their productivity when using technology at work, and therefore increasing the relative demand for their labour services for given wages, with little or no direct effect on unskilled workers. Typical examples of skill-biased technical change (SBTC) are information technologies, which are used more intensively by skilled workers than by unskilled workers.[22]

Workers of all skill levels perform a variety of tasks at work. These tasks can be classified along two main dimensions: i) their degree of routinization; ii) whether they are manual or cognitive in nature. An example of a routine manual task is driving an underground train in a city. An example of a routine non-manual task is computing the average of a set of variables. An example of non-routine manual task is babysitting. An example of a non-routine non-manual task is organizing a wedding.[23] The substitution effects of labour-saving technologies discussed in Section C.2 mainly concern routine tasks. Therefore, technological change is routine-biased, in the sense that it decreases the demand for routine tasks (so called "routine biased technical change", RBTC).

The rest of this subsection presents the theoretical mechanisms behind SBTC and RBTC, and discusses their empirical evidence.

(a) Skill-biased technical change

In a set of developed and developing countries, one the most important labour market developments in the 1980s and the 1990s was an increase in the skill premium.[24] Autor et al. (2008) show that, in the United States, the skill premium, while declining

during the 1970s, rapidly increased in the 1980s and (less rapidly) in the 1990s. The increase in skill premium since the 1980s also occurred in many other high-income countries, such as Australia, Canada, Germany and Japan, although at substantially slower rates than in the United States (Pavcnik, 2011). Goldberg and Pavcnik (2007) show that increases in skill premium since the 1980s were not confined to developed countries. They also occurred, at different paces, in Argentina, Brazil, Chile, Colombia, Hong Kong (China), India and Mexico during the 1980s and 1990s. In economies such as the United States, in which the increase in the skill premium in the 1980s and 1990s occurred at the same time as an increase in the relative supply of college-educated workers, concurrent with the increase in the supply of skills, there has been an increase in the (relative) demand for skills (Acemoglu and Autor, 2011).

The rapid diffusion of ICTs in the work place is consistent with an increase in the (relative) demand for skills because of complementarity between ICTs and skills. Violante (2008) discusses three alternative formulations of the ICT-skill complementarity hypothesis.

First, a decline in the constant quality relative price of equipment investment, in particular in ICTs, leads to an increased use of equipment capital in production. Since skilled labour is relatively more complementary to equipment capital than is unskilled labour, growth in the equipment stock increases the relative demand for skilled labour and, in turn, the skill premium.[25]

Second, skilled workers are less adversely affected by the turmoil created by major technological transformations, since it is less costly for them to acquire the additional knowledge needed to adopt a new technology. Therefore, rapid technological transitions are skill-biased, as more able workers adapt better to change.

Third, ICTs induce an organizational shift which is skill-biased, because it leads to flatter hierarchical structures where workers perform a wide range of tasks within teams. Adaptable workers who have general skills and who are more versed at multi-tasking activities benefit from this transformation.

Throughout history, technological change has not always been biased towards skilled workers. Goldin and Katz (1998) provide evidence that manufacturing technologies were skill-complementary in the early twentieth century, but may have been skill-substituting prior to that time. Autor et al. (1998) suggest that there was an acceleration in the skill bias of technological change in the 1980s and 1990s in the United States. Acemoglu (1998; 2002) introduced the idea that the development and use of new technology may be directed or endogenous. An increase in the relative supply of skilled workers will make the development and adoption of technologies that complement skilled workers more profitable. In other words, technology will become more skill-biased following an exogenous increase in the supply of high-skilled workers.

According to this framework, technical change has been skill-biased in the twentieth century mainly due to the development of skill-complementary technologies in response to the rapid increase in the supply of skilled workers. In contrast, the early nineteenth century was mostly characterized by skill-replacing technological development because the increased supply of low-skilled workers in the cities made the introduction of technologies that complement unskilled labour profitable. Hence, the accelerating skill-biased technical change in the 1980s in several developed economies is also likely due to the rapid increase in the supply of skilled workers in the late 1960s and early 1970s.

(i) Empirical evidence

There seems to be a consensus that technological change has been skill-biased over the past few decades.[26] In their analysis of 450 US manufacturing sectors during the 1980s, Berman et al. (1994) find a positive relationship between employment shift toward skilled workers and investment in computers and research and development (R&D). Autor et al. (1998) extend the study to include non-manufacturing sectors. They also find that between 1979 and 1993, skill upgrading was larger in US industries with greater computer utilization, with a consequent steady increase in the skill premium.

Firm- or plant-level studies confirm these findings. In a specific plant-level study of the US valve-manufacturing industry, Bartel et al. (2007) show that between 1997 and 2002, the adoption of new computer-based IT equipment increased demand for more skilled workers, particularly those with technical skills. Bresnahan et al. (2002) also provide firm-level evidence that information technology, together with IT-enabled workplace organizational change, is key to skill-biased technological change in the US manufacturing and services industries.

Empirical studies for other OECD countries also produce results that are consistent with the SBTC hypothesis. For instance, Falk and Seim (1999) investigate the link between skill intensity and IT in the service sector of Germany over the period

1994 to 1996. They show that firms with a higher IT investment-output ratio employ a larger fraction of high-skilled workers. In another study, Falk (2001) also shows that ICT penetration in German firms is positively related to the employment share of skilled workers and negatively related to the share of both medium- and unskilled-workers. A study by Spitz-Oener (2006) further confirms that, in Germany, skill demand has increased greatly in occupations adopting technology more intensively. Skill-biased effects of technological change have been assessed in Canada (Gera et al., 2001), France (Greenan et al., 2001), Italy (Piva et al., 2005), Spain (Aguirregabiria and Alonso-Borrego, 2001) and the United Kingdom (Machin, 1995; Gregory et al., 2001). These studies document a positive relationship between employment of skilled labour and various measures of technological innovation, such as the use of computers, R&D intensity, and the number of innovations and patents.

Cross-country studies also confirm the empirical validity of the SBTC hypothesis in advanced economies. Machin and Van Reenen (1998) show that for seven OECD countries (Denmark, France, Germany, Japan, Sweden, the United Kingdom and the United States), the relative demand for skilled workers in the manufacturing sector was positively linked to R&D expenditure between 1973 and 1989. Berman et al. (1998) provide evidence that, for 12 developed countries in the 1980s, three manufacturing industries – machinery and computers, electrical machinery, and printing and publishing – where skill-biased technological changes are most pervasive, together accounted for 40 per cent of the within-industry increase in the relative demand for skills in manufacturing sector.

It is argued above that ICTs induce organizational changes – such as the flattening of hierarchies, the decentralization of authority, and increased multitasking – which are skill-biased. Caroli and Van Reenen (2001) provide evidence for a panel of British and French plants that organizational change and skills are complementary, as they reduce the demand for unskilled workers and lead to greater productivity increases at plants with larger initial skill intensities.

Evidence of skill-biased technological change exists also for developing countries. Using plant-level data for Chile, Pavcnik (2003) finds evidence of capital-skill complementarity. This might contribute to the increased within-industry relative demand for skilled workers during the 1980s, although there might not be a causal relationship. Fuentes and Gilchrist (2005) extend the analysis over an additional nine years (1979-95) to control for unobserved plant-level heterogeneity and find evidence of a robust association between skilled labour demand and technology adoption as measured by patent usage and other technology indicators.

In the case of developing countries, the adoption of new technologies occurs mainly through import flows and FDI inflows, which generate technological spillovers. In a sample of 28 manufacturing sectors for 23 LDCs and middle-income countries over the period 1980–91, Conte and Vivarelli (2011) discuss the occurrence of skill-enhancing technology imports, namely, the relationship between imports of embodied technology and widening skill-based employment differentials. They show evidence of capital–skill complementarity as a possible source of skill bias, and of imported skill-enhancing technology as an additional driver of increasing demand for the skilled workers.

A number of country-level studies provide similar evidence of relative skill bias emerging through embodied technological change in several developing countries, such as Brazil (Fajnzylber and Fernandes, 2009), Costa Rica (Robbins and Gindling, 1999), Ghana (Görg and Strobl, 2002), Mexico (Hanson and Harrison, 1999; Meza, 1999; Fajnzylber and Fernandes, 2009), Turkey (Srour et al., 2013; Meschi et al., 2016) and the Middle East and North Africa region (Mnif, 2016).

Evidence that is common across both industrialized and developing countries is often considered as suggestive of common technological change across the world. Berman et al. (1998) find that in the 1970s and 1980s, across industrialized countries, most industries increased the proportion of the high-skilled (non-production) wage bill to the low-skilled (production) wage bill, despite rising or stable relative wages for high-skilled workers. Berman and Machin (2000) document that relative wage bills of high-skilled workers jointly increased in the manufacturing industries of 37 high-, middle-, and low-income countries during the 1980s. They find that industry-level skill upgrading in all countries was positively correlated with US computer usage and OECD R&D intensity. In summary, changes in skill intensity were similar and widespread across countries at different income levels, and they were closely related to technology usage in industrialized countries. This is consistent with simultaneous global SBTC.

(ii) Quantification of the effects of skill-biased technical change

Some studies quantify the contribution of technology to observed changes in relative employment or relative wages of skilled versus unskilled workers.

These quantification exercises, however, are subject to the important caveats that the results are highly dependent on the definition of technology and vary significantly across different studies.

For the United States, Japan and nine European countries, from 1980 to 2004, Michaels et al. (2014) argue that ICTs can account for up to a quarter of the cross-country variation in demand growth for highly skilled workers. In their study of relative wage and employment outcomes among US workers in the 1980s, Feenstra and Hanson (1999) show that the share of the wage differential paid to non-production workers during the 1980s attributable to technology is equal to around 30 per cent when using high-tech equipment measured with an *ex ante* rental price. When the authors alter their measure of high-tech equipment to place more weight on more recently installed (and thus arguably more advanced) equipment, the contribution of technology to wage outcomes increases substantially, more than tripling. Using US data for the period 1984 to 2003 in a rich structural model, Burstein et al. (2015) find that computerization is the central force driving changes in the skill premium, accounting for 60 per cent of its rise.[27]

(iii) Can technological maturity lead to "de-skilling"?

It has recently been documented that, in about the year 2000, the demand for skills (more specifically, the demand for cognitive tasks that are often associated with high educational skills) underwent a reversal in the United States (Beaudry et al., 2016; Charles et al., 2016). According to Beaudry et al. (2016), in response to this demand reversal, high-skilled workers moved down the occupational ladder and began to perform jobs traditionally performed by lower-skilled workers. This de-skilling process, in turn, resulted in high-skilled workers pushing low-skilled workers even further down the occupational ladder and, to some degree, out of the labour force altogether.

Charles et al. (2016) link these developments to technology. They argue that during the initial adoption phase of a general-purpose technology such as an ICT, demand for cognitive tasks grows fast because the associated machinery and equipment need to be built and installed. However, once the general-purpose technology has been widely adopted, demand for cognitive tasks partially drops because at the maturity of the technology, those activities are still needed for the maintenance and occasional replacement of the technology, but are no longer necessary for its adoption. In absolute levels, demand for cognitive tasks at the technology's maturity still exceeds demand before the introduction of the general-purpose technology, but it is no longer as high as during the initial adoption phase.

The link between de-skilling and automation is even more general. One of the most salient characteristics of automation is the breaking down of complex operations into simple tasks. That was what Ford did in the first car factories at the beginning of the twentieth century. Instead of employing skilled artisanal workers to build cars, as Daimler Benz did in Germany, Ford hired unskilled workers, which were in abundant supply due to large inflows to the United States of immigrants from overseas, to perform simple tasks. In analysing the impact of technology on the future of work, Section C.4 will discuss artificial intelligence (AI). By first recognising patterns in information before the human eye and analytics can, and then breaking complex cognitive tasks into simple tasks that require little or no skills, AI makes the link between automation and de-skilling clear

(b) Routine-biased technical change

While fully consistent with labour market developments in the 1970s and in the 1980s, models of SBTC are less successful in explaining more recent developments. The evolution of the skill premium has been very heterogeneous across countries since the mid-1990s. As detailed in Section B.2, while in some countries there has been a reduction in the skill premium over the last 15 years, in other countries the opposite occurred. An important recent labour market development in many developed countries, such as Germany and the United States, during the last two or three decades has been the hollowing out of middling occupations (employment polarization), as discussed in Section B.2. Several developing countries have also experienced such polarization in the last two decades (World Bank, 2016; de Vries, 2017).

Drawing on the seminal contribution by Simon (1960), Autor et al. (2003) present a theoretical framework linking employment polarization to technology. In this framework, technology affects specific tasks, rather than specific skills.[28] Autor et al. (2003) classify work tasks along two main dimensions: i) their degree of routinization; ii) whether they are manual or cognitive in nature. Technological progress tends to replace routine tasks and to complement cognitive skills. This is represented in Table C.1. The ease of automation is determined by the routine versus non-routine nature of work tasks. The skill complementarity is determined by the cognitive versus manual nature of work tasks. Technology is predicted to improve relative employment prospects for workers in the

Table C.1: How technology and skills at work interact

		Skill complementarity	
		High	**Low**
Ease of automation	**High**	Routine cognitive	Routine manual
	Low	Non-routine cognitive	Non-routine manual

Source: World Bank (2016).

Table C.2: Expected effects of technology on employment and earnings by types of occupation

Type of occupation (by skill intensity)	Expected impact on employment	Expected impact on earnings
Non-routine cognitive	Positive	Positive
Routine cognitive and manual	Negative	Negative
Non-routine manual	Positive	Negative

Source: World Bank (2016).

bottom left quadrant, because they perform non-routine tasks (which are not easily automated)[29] and involving cognitive skills, where ICT technologies make them more productive. Workers in the upper quadrants perform tasks subject to automation, and their relative employment prospects are reduced by labour-saving automation technologies. Finally, workers in the bottom right quadrant are the least affected by technology, because they perform non-routine manual tasks, which are neither easily automated nor subject to ICT-skill complementarity.

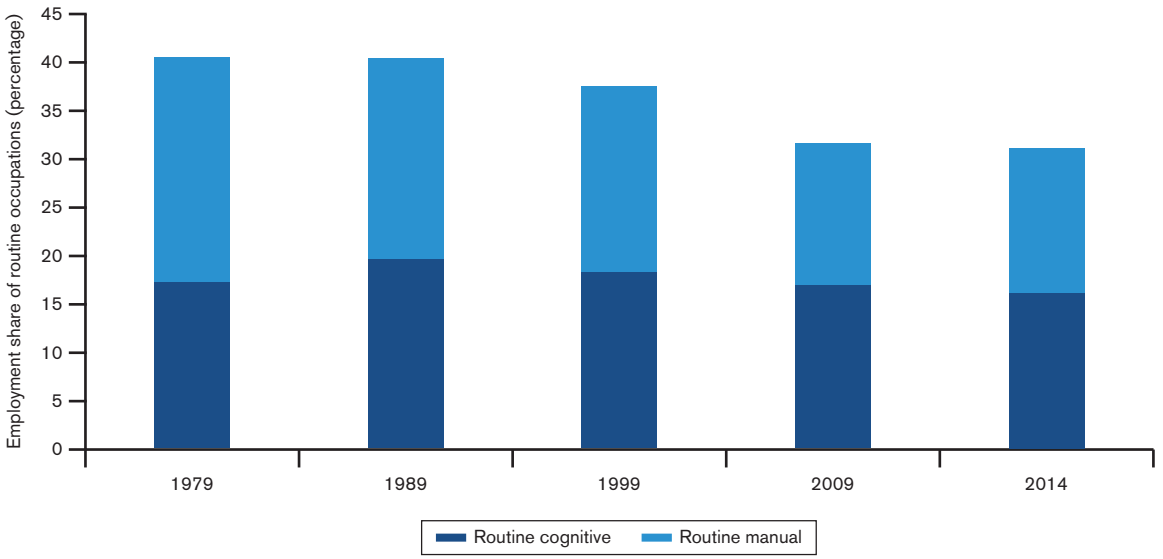
The framework proposed in Table C.1 helps to explain why technology can lead to employment polarization (Autor et al., 2003; 2006; 2008). Non-routine cognitive tasks which – given current technological feasibilities – are difficult to automate and are complementary to ICTs, are typical of skilled professional and managerial jobs, which tend to be assigned to skilled workers. The non-routine manual tasks which are not directly affected by technology are typically unskilled jobs such as housecleaning and tend to be assigned to unskilled workers; routine cognitive or manual tasks, in which technology has the potential to substitute for human labour, are typical of jobs performed by middle-skilled workers.

The discussion so far has focused on relative demand for workers depending on their skills, or on the nature of their work tasks. How changes in relative demand translate into changes in relative earnings crucially depends on labour supply. In particular, the extent to which workers in the lower quadrants of Table C.1 (those performing tasks less susceptible to automation) see their relative earnings increase or decrease depends on the elasticity of labour supply (Autor, 2015).[30] If the elasticity of labour supply is high enough, new entry of labour can partially or fully offset average wage gains that would have occurred. As argued by the World Bank (2016), workers in non-routine cognitive occupations are likely to see their higher productivity rewarded as higher earnings because entry barriers are high (therefore the elasticity of labour supply is low). Conversely, low-skilled workers in non-routine manual occupations are likely to see their earnings fall over time, as middle-skilled workers in routine occupations are displaced by automation and start competing for the available jobs in low-paying occupations, where entry costs are low and the elasticity of the labour supply is high.[31] These insights are summarized in Table C.2.

(i) Empirical evidence

Recent shifts in the nature of work include a strong decline of occupations that are intensive in routine work steps. For the United States, Cortes et al. (2016) document a decrease in routine employment from 40 per cent of the population aged 20-64 in 1979 to 31 per cent of the population aged 20-64 in 2014 (see Figure C.4).[32] At the same time, non-routine manual employment expanded by 3.9 percentage points and non-routine cognitive employment expanded by 6.7 percentage points (Cortes et al., 2016, Table 2).

Figure C.4: Evolution of employment shares of routine occupations in the United States (1979 to 2014)



Source: Cortes et al. (2016).

Notes: Employment shares based on individuals aged 20-64 from the monthly Current Population Survey (US Bureau of Labor Statistics), excluding those employed in agriculture and resource occupations.

With few exceptions, the empirical literature confirms the idea that technological change in developed economies is a major driver in the decline in routine occupations, and in the consequent employment polarization. Conversely, for developing economies, there is limited empirical evidence consistent with the RBTC hypothesis. As already emphasized above when discussing the overall employment effects of technology, comparisons across studies are only meaningful for studies that use the same definition of technological change.

At the level of local labour markets in the United States, Autor and Dorn (2013) show that between 1980 and 2005, local labour markets that specialized in routine tasks differentially adopted information technology, reallocated low-skill labour into service occupations (employment polarization), experienced earnings growth at the tails of the distribution (wage polarization), and received inflows of skilled labour. Similarly, Autor et al. (2015) show that local US labour markets more specialized in routine occupations have experienced employment losses in routine task-intensive occupations. These losses are, however, largely offset by local employment growth in abstract and manual task-intensive occupations.[33]

At the industry level, Goos et al. (2014) estimate that routine-biased technological change is mostly responsible for observed patterns of employment polarization in a sample of 16 Western European countries over the period 1993 to 2010. Focusing on automation in the form of industrial robots, however, Graetz and Michaels (2015) do not find that this type of technology is biased against middle-skilled workers. On the contrary, they find that robot density shifts demand from the low-skilled towards the high-skilled. This result could depend on the definition of skills, or on the different ways in which routine jobs are affected by general purpose technologies, like ICTs, as opposed to industrial automation.

In the case of developing countries, there is limited empirical evidence consistent with RBTC. Job polarization in the labour markets of Colombia and Mexico in the 2000s was shown to occur due to reductions in the cost and increased adoption of computer technology (Medina and Posso, 2010). The same, however, does not apply to several other developing countries (Brazil, China, India and the Russian Federation), nor to LDCs (Medina and Posso, 2010; Gimpelson and Kapeliushnikov, 2016; Maloney and Molina, 2016).

(ii) Quantification of the effects of routine-biased technical change

Quantification of the contribution of technology to the decline in middle-skilled employment can be found in Goos et al. (2014) for 16 Western European countries over the period 1993-2010, and in Cortes et al. (2016) for the United States over the period

1979-2014 (or just 1989 to 2014 in an alternative specification). Goos et al. (2014) estimate a model where the routine task intensity index (the standard proxy for RBTC used in the literature) explains most of the observed employment polarization. In particular, for the group of the eight highest-paid occupations, the model predicts an increase in employment shares (hours worked as a share of total hours) of 79 per cent of the increase actually observed (with the estimated increase equal to 4.45 and the increase actually observed equal to 5.62). For the group of nine middling occupations, the model predicts a decrease of 74 per cent of the total observed employment share decrease (with the estimated decrease equal to 6.86 per cent and the increase actually observed equal to 9.27). Lastly, the model predicts an increase for the group of the four lowest-paid occupations of 66 per cent of the observed increase (with the estimated increase equal to 2.41 and the increase actually observed equal to 3.65).

Cortes et al. (2016) calibrate a structural model of the US economy which matches observed occupational reallocations. They find that automation shocks (measured as the deviation of ICT capital from a balanced growth trend) explain at most one-third of the decline in middle-skilled employment. It should be noted, however, that these figures do not provide a quantification of the contribution of technology to the decline of manufacturing employment, because not all manufacturing employment is middle-skilled, and not all middle-skilled employment is in manufacturing.

(iii) The nature of adjustment to RBTC

Recent empirical work on labour market adjustments related to RBTC is available for the United States. Cortes et al. (2014) show that during the 30 years preceding their study, the decline in middle-skilled jobs in the United States was driven mainly by the paucity of transitions from out of the labour force and from unemployment into routine employment, rather than by job losses. In other words, it was very difficult to find employment in routine jobs.

Further insights on low entry rates into routine jobs are provided by Cortes et al. (2016). They document that the decline of middle-skilled occupations in the United States between 1979 and 2014 was primarily driven by the disappearance of routine jobs among workers in specific demographic groups: male high school dropouts of all ages and male high school graduates under the age of 50 in the case of manual employment, and young (20-29) and prime-aged (30-49) females with either high school diplomas or with some degree of post-secondary education in the case of cognitive employment. On the labour supply side, increasing educational attainment and population ageing in the United States have reduced the fraction of workers with these demographic attributes.

However, labour supply alone cannot account for the labour market experience of these demographic groups. Within each group, the propensity to work in routine occupations has decreased dramatically. For instance, while more than 60 per cent of low-educated young men worked in routine manual occupations in 1979, this figure dropped to one-third in 2014 (Cortes et al., 2016). The decline in the probability of routine employment (equal to 8.1 percentage points between 1979 and 2014 for manual employment, and to 1.2 percentage points for cognitive employment in the same period, as shown in Figure C.4) was offset by increases in non-employment and in non-routine manual employment.

The results of Cortes et al. (2016) suggest that, on average, it has been very difficult for US workers employed in routine occupations to find employment in high-paying non-routine cognitive occupations. Cortes (2016) shows that the outcomes vary across workers, depending on their abilities. In particular, he provides theoretical and empirical evidence showing that low-ability routine workers are more likely to switch to non-routine manual jobs, while high-ability routine workers are more likely to switch to non-routine cognitive jobs.

(iv) Can RBTC explain "jobless recoveries"?

Routine-biased technical change has also been linked to so-called "jobless recoveries" (periods following recessions in which rebounds in aggregate output are accompanied by much slower recoveries in aggregate employment). In particular, the argument has been made that routine-biased automation might be responsible not only for job losses during downturns, but also for sluggish employment growth during economic recoveries. In this connection, Brynjolfsson and McAfee (2011; 2014) refer to a "great uncoupling", in which economic growth has become detached from employment growth for the first time in the modern era.

There is, however, no consensus on this issue, since the empirical evidence is mixed. In the case of the United States, the disappearance of employment in routine occupations has been concentrated in economic downturns (Jaimovich and Siu, 2014). Specifically, 88 per cent of job losses in routine occupations since the mid-1980s have occurred within a 12-month window of recessions (all of which have been characterized by jobless recoveries). The displaced workers have then been forced into time-

consuming transitions to different occupations and sectors, resulting in slow job growth during the recovery. Jaimovich and Siu (2014) and Graetz and Michaels (2017) provide empirical evidence of a link between the hollowing out of middle-skill routine occupations and jobless recoveries for the United States.

However, Graetz and Michaels (2017), using data on 71 recessions which took place in 17 developed countries other than the United States from 1970 to 2011, do not find evidence that industries that make more intensive use of routine jobs, and that are therefore more susceptible to technological change, have had particularly slow employment growth during periods of economic recovery. The same result holds for industries in which labour was more exposed to automation by industrial robots. They also find that middle-skill employment grew similarly in routine-intensive industries and other industries during recent recoveries. Graetz and Michaels (2017) therefore conclude that technology is not causing jobless recoveries in developed countries outside the United States.

Summing up the results of Section C.2, it can be argued that technological change impacts workers differently, depending, among other conditions, on their skills and on the work tasks they perform. Current technological change tends to be skill-biased, in the sense that it increases the relative demand for skills, and routine-biased, in the sense that it decreases demand for routine tasks. Therefore, relatively skilled workers performing non-routine tasks tend to benefit from technological change, which can be disruptive for relatively unskilled workers employed in routine tasks.

The next subsection will provide insights into whether these conclusions might still apply in the near future, or whether, with the upcoming wave of advances in smart technology, artificial intelligence, robotics and algorithms, technological disruption might affect ever-increasing numbers of workers at all levels of skills and work tasks.

4. Technology and the future of work

As discussed in Section B, the level and structure of employment depends on the supply and demand of labour. The future of jobs is no exception and hinges on the future of both the labour supply and demand. The future of labour supply depends, among other things, on demographic developments, the future level and distribution of wealth, as well as the meaning and enjoyment of working attributed by workers and the availability and attractiveness of alternatives to working. Similarly, the future of labour demand depends, among other things, on the relative cost of investment goods and financing conditions, product demand, and the existence as well as the affordability of specific technologies.

The ongoing and upcoming wave of advances in smart technology, artificial intelligence, robotics and algorithms, often referred to as the fourth industrial revolution, is gathering increasing expert and media attention. In this context, a debate has emerged about the impact that these emerging technologies will have on the future of jobs. Some experts argue that history will repeat itself and the transformative processes brought by the next wave of technological advances will replace many existing jobs but eventually create new jobs and opportunities. Other experts argue that the impact of the new wave of labour-saving technological change and innovations on jobs will be different this time around, with the replacement of human jobs by artificial intelligence and robotics on a massive scale, leading to a "jobless future". This subsection will review the main arguments put forward by both sides regarding the impact of technology on future jobs, and discuss the implications for skills development.

(a) Moving with or against technological advance?

The view that the new technological advances in artificial intelligence and robotics will not lead to a "jobless future" is based on historical experience. Although each wave of technological change has generated technological anxiety and led to temporary disruptions with the disappearance of some tasks and jobs, other jobs have been modified, and new and often better jobs have eventually been developed and filled through three interrelated mechanisms (Autor and Handel, 2013; Autor, 2015; Bessen, 2015; Mokyr et al., 2015).

First, new technological innovations still require a workforce to produce and provide the goods, services and equipment necessary to implement the new technologies. Recent empirical evidence suggests that employment growth in the United States between 1980 and 2007 was significantly greater in occupations encompassing more new job titles (Berger and Frey, 2017).

Second, the new wave of technologies may enhance the competitiveness of firms adopting these technologies by increasing their productivity. These firms may experience a higher demand for

the goods or services they produce, which could imply an increase in their labour demand.[34] Several empirical studies reviewed in Section C.2 above find that the adoption of labour-saving technologies did not reduce the overall labour demand in European countries and other developed economies (Goos et al., 2014; Graetz and Michaels, 2015; Bessen, 2016; Gregory et al., 2016).

Finally, as discussed in Section C.2, the upcoming technological advances may complement some tasks or occupations and therefore increase labour productivity, which could lead to either higher employment or higher wages, or both. The new workers and/or those benefitting from a pay rise may increase their consumption spending, which in turn tends to maintain or raise the demand for labour in the economy. Recent empirical evidence suggests that the use of industrial robots at the sector level has led to an increase in both labour productivity and wages for workers in Australia, 14 European countries, the Republic of Korea and the United States (Graetz and Michaels, 2015).

Conversely, the proponents of a future rise in unemployment due to technological advances recognize that the fear of such unemployment has been proven wrong many times in the past, but consider that the new wave of technological progress represents a sharp departure from earlier innovations. Advances in robotics, artificial intelligence, self-driving vehicles, "big data" (i.e. data sets too extensive for traditional data processing software to process) and 3-D printing are likely to continue to erode lower-skilled employment specialized in routine tasks, but also to impact on medium- and high-skilled jobs involving physical, cognitive and non-routine tasks requiring knowledge, judgment and experience, which were once thought to be exclusively human domains (Brynjolfsson and McAfee, 2014; Ford, 2015).

In particular, they argue that the upcoming technological advances in digitalization and algorithms empowered by big data will continue to reduce the marginal costs of (re)production to a near zero level, making human workers more expensive than the additional costs of using the new technologies (Rifkin, 2015). This would ultimately result in a shrinkage of the total number of available human jobs in the medium to long run.[35] The impact of the new and upcoming wave of technologies on future job losses is, in their view, also distinct from previous ones in terms of speed, scale, and force (Schwab, 2016).

Firstly, empirical evidence suggests that previous technological advances were adopted at a slower pace, providing individuals with more time to adjust (Comin and Hobijn, 2010). For instance, the United States took 30 years to achieve a 10 per cent adoption rate of electricity, while it took less than five years for tablet devices to reach the same level of adoption rate (DeGusta, 2012).

In comparison with previous innovations, the new technological advances are evolving at an exponential pace. Although some experts argue that Moore's Law, according to which the number of components in a specific size integrated circuit has doubled every 18 months since 1965, is approaching its end, it has enabled greater computing power and the ability to automate increasingly complex tasks (Brynjolfsson and McAfee, 2014; Waldrop, 2016). Graetz and Michaels (2015) report that from 1993 to 2007, mean robot density increased by more than 150 per cent in Australia, 14 European countries, the Republic of Korea and the United States. Boston Consulting Group (2017) reports that there are currently between 1.5 and 1.75 million industrial robots in operation, a number that could increase to between 4 and 6 million by 2025. The pace of progress in certain areas, such as biotechnology, has even exceeded Moore's Law (Autor, 2015). According to the World Economic Forum (2016), around 65 per cent of pre-school children will be expected to undertake tasks and jobs that do not currently exist. The speed of technological acceleration could imply that individuals, even those who are flexible and well-adjusted to the labour market, may need to retrain and update their skill sets so as to keep up with the occupational rearrangements and new additional skills that will be required.

Secondly, most previously ground-breaking technological innovation, such as light bulbs and telephones, did not necessarily occur in every industry of the economy at the same time, which allowed affected individuals to look for job opportunities in until then undisrupted industries. For instance, during the agricultural revolution in the 1700s, many individuals who lost their jobs in the countryside moved to cities in search of work. Previous technological revolutions often took a long time to exhibit significant impacts on the entire economy. While investments in railroads generated initially relatively limited benefits and spillovers, the latter have gradually expanded thanks to improvement in railroad productivity and an increase in the share of rail output in economic activity.

Similarly, the speed of adoption of ICT has been different across sectors. Some sectors, such as manufacturing, agriculture, forestry and fishing, hotels and restaurants, and the wholesale and retail trades,

have experienced a very rapid increase in the use of ICT capital services per hour worked, while other sectors, such as construction and transport, have recorded a lower ICT intensity growth rate (OECD, 2017). Some experts argue that technological progress in ICT has been less transformative than any of the three main technologies that emerged during the second Industrial Revolution at the end of the nineteenth century and beginning of the twentieth century (namely electricity, cars and wireless communications) (Gordon, 2014). However, a recent study comparing US labour productivity in the electrification era (1890 to 1940) and the ICT era (1970 to 2010) finds that productivity growth in both eras exhibited remarkably common patterns: an initial relatively slow growth in productivity, followed by various decade-long accelerations and then a slowdown in productivity growth (Syverson, 2013). Unlike previous important technological innovations, the new and upcoming ones are not limited to one specific area but combine various elements, such as energy storage, quantum computing, mobile networks, biotechnology, nanotechnology and material science, potentially affecting all areas of the economy at once, including the services sector as well as the agricultural and manufacturing sectors.

Finally, the breadth and depth of these new complex technologies have the potential to transform entire systems of production, management, and governance. For instance, the phenomenon of digitalization has already led to the emergence of new business and employment models, often referred to as the "platform economy", "sharing economy", "peer-to-peer economy", "gig economy" or "on-demand economy". In particular, the establishment and development of new digital transportation, accommodation, and on-demand and freelance labour platforms have enabled the creation of new types of jobs as well as temporary and flexible contracting arrangements.[36] Some experts also anticipate a surge in superstar-biased or talent-biased technological change associated with many digital technologies, where a limited number of firms and individuals capture most of the market share and financial benefits stemming from the adoption and diffusion of these technologies (Brynjolfsson and McAfee, 2014). The emergence of such winner-take-most or -take-all markets could have consequences on the degree of competition of different sectors of the economy and on perceptions of equity and fairness of the consequences of technical change.

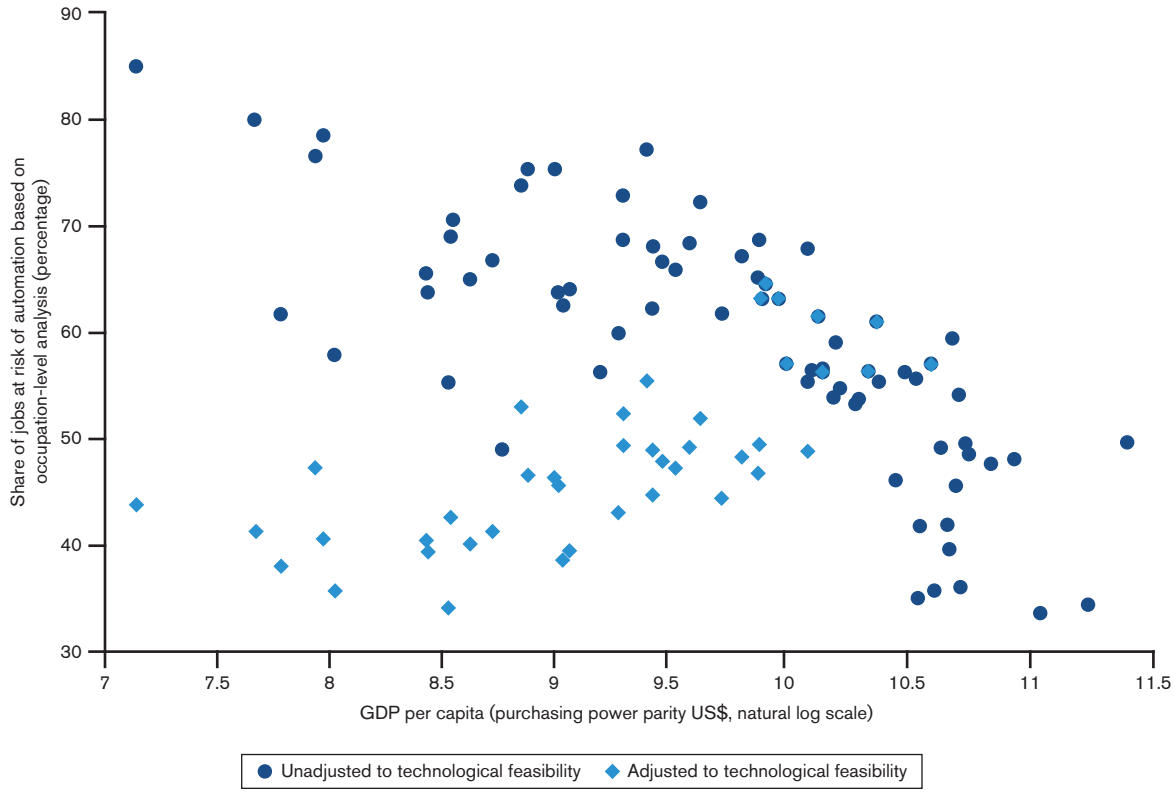
Besides the speed at which the new and upcoming waves of technologies could change the systems of production, distribution and consumption in almost every industry and economy, these new complex technologies will also unfold in a different setting in terms of demographic and life expectancy compared to previous technological revolutions (Clark, 2017). Previous significant innovation occurred in a world characterized by its growing population. Nowadays, an increasing number of developed and emerging countries face an ageing and shrinking working-age population with the potential additional pressure to use non-human labour to compensate for the fewer working-age workers that used to finance the social safety net. Conversely, most developing countries are still experiencing a growing population and face the challenge of creating conditions in which to provide new jobs in addition to existing jobs unaffected by the new technological innovation. Similarly, the improvement of the average life expectancy, thanks to scientific and technological innovations in health and medicine, implies that individuals will, on average, be able to work longer, potentially putting additional pressure on the labour market.

(b) Prospects of automation

One of the studies that reignited the debate about the new wave of technologies, in particular automation, and employment was a 2013 research paper by Frey and Osborne (2017), who classify 702 occupations in the United States in terms of skills that are likely to be automated. The authors conclude that 47 per cent of these occupations are at risk of automation and computerization over the next two decades. In particular, the study identifies retail salespeople, administrative assistants, food counter personnel, cashiers, and transport truck drivers as working at occupations that are at a greater risk of automation.[37] A number of consultancy firms and academics have replicated the analysis for various European countries, Australia, Canada, Japan and New Zealand, and report that the share of jobs susceptible to automation ranges from 30 to 49 per cent (Baert and Ledent, 2015; Deloitte, 2015b; Bouée and El Karoui, 2014; Sproul et al., 2015; Pajarinen and Rouvinen, 2014; Brzeski and Burk, 2015; Citibank, 2016; David, 2017; Durrant-Whyte et al., 2015).[38]

The risk of automation is not only confined to developed economies. As highlighted in Figure C.5, estimates of the share of occupations at risk from automation actually tend to be higher for developing and least-developed countries than for high-income countries. According to the World Bank's *World Development Report 2016*, two-thirds of all jobs could, on average, be vulnerable to automation in developing countries in the next decades. The estimated share of jobs at high risk of automation ranges from 55 per cent in Uzbekistan, 65 per cent in Nigeria and 67 per cent in Bolivia and South Africa,

Figure C.5: Proportion of jobs at risk of automation by economic development



Source: WTO Secretariat based on occupation-level analyses published by Baert and Ledent (2015), Bouée and El Karoui (2014), Brookfield Institute for Innovation + Entrepreneurship (2016), Bruegel (2014), Brzeski and Burk (2015), Centre for Strategic Futures (2015), Chang and Huynh (2016), Chartered Accountants Australia and New Zealand (2016), David (2017), Deloitte (2015a), Deloitte (2015b), Durrant-Whyte et al. (2015), Frey and Osborne (2017), Pajarinen and Rouvinen (2014), Pajarinen et al. (2015), Stiftelsen för Strategisk Forskning (2014), Unionen (2014) and World Bank (2016).

to 74 per cent in Angola, 77 per cent in Bangladesh and 85 per cent in Ethiopia. The estimated share of jobs at risk of automation is also substantial in emerging economies, such as Argentina (65 per cent), India (69 per cent) and China (77 per cent). A recent International Labour Organization (ILO) study estimates also that about three in five jobs face a high risk of automation in Cambodia, Indonesia, the Philippines, Thailand and Viet Nam (Chang and Huynh, 2016).

According to the World Bank, the high share of jobs susceptible to automation could impact negatively on developing economies' ability to develop further. However, the adoption and diffusion of automation could be slower and more limited in developing countries given the higher prevalence of barriers to technology, lower wages, and the number of jobs based on manual dexterity (see Box C.2). Adjusted for the slower pace of technology adoption in developing countries, the World Bank's estimates of the share of jobs at risk of automation decrease significantly for most developing countries analysed. As shown in Figure C.5, the estimated shares adjusted to technological feasibility in low- and middle-income countries range from 34 to 65 per cent, which is relatively similar to the estimates for many high-income countries.

According to more recent studies, the relatively high share of jobs vulnerable to automation estimated and reported in the above-mentioned studies stems from the failure to account for the fact that occupations tend to adjust to technology by adapting their task structure. In fact, most occupations adapt regularly to technological innovation by reallocating routine tasks to automation and refocusing human work on management and on non-routine social, interpersonal and creative tasks. This is what happened with many bank tellers following the introduction of ATMs, as discussed in the previous subsection.

Taking into account the difference in the ability to automate specific jobs and tasks within occupations, a recent study estimates that 12 per cent and 9 per cent of the jobs in Germany and the United States, respectively, could be fully automated (Bonin et al., 2015). Based on the same methodology, an OECD

Box C.2: The future impact of automation on developing countries' labour market

While there is a growing literature on the potential impact of automation and artificial intelligence on the labour market in developed economies, the impact in developing countries has received much less attention. The few occupation-based studies that estimate the share of employment at risk of automation in developing countries conclude that the latter have a larger share of employment in routine occupations that could be automated and computerized (World Bank, 2016; Citibank, 2016). Yet, as pointed out in World Bank (2016), the impact of automation on the labour market of developing countries could occur later and be slower for two main reasons. First, although the speed of technology adoption has increased in developing countries, it remains slower than in developed countries. Second, lower wages and a relatively high share of manual non-routine jobs, which are currently more difficult to automate, could make investment in automation in developing countries less profitable (at least in the short run). However, regardless of the timing, automation raises several issues for developing countries.

First, by reducing the labour content of the production process, automation in developed countries could compete with countries in which labour costs are low (UNCTAD, 2016). Firms in high-income countries could decide to bring specific manufacturing operations located in developing countries back in order to minimize production costs and enhance their competitiveness. Reshoring could also apply to business process outsourcing in financial services (e.g. accounting), telecommunications (e.g. call centres) and medical services. In such a situation, developing countries may experience a reduction in production and employment opportunities in certain industries (Citibank, 2016). These potential changes could be particularly challenging for those developing countries that are already facing deindustrialization and are becoming service economies sooner and at much lower levels of income compared to countries that were industrialized earlier (Rodrik, 2016). The continuous real wage growth in emerging countries could provide further incentives for potential re-shoring and the adoption of automation. However, for the time being, empirical evidence suggests that reshoring is limited, occurring in specific industries and relatively slowly (UNCTAD, 2016).

Second, the new wave of technologies could provide entrepreneurs and firms in developing countries with the opportunity to establish new business models and offer new goods and services. For instance, additive manufacturing (i.e. industrial 3-D printing) could, thanks to its mobility, flexibility, energy efficiency and increasing affordability, enable small-scale manufacturing to become more competitive and efficient in developing and least-developed economies (Naudé, 2017). However, such opportunities are likely to be challenging for economies without reliable access to electricity and the internet, as well as to relevant skills in the workforce.

Third, automation and advances in ICT could also create new job opportunities in developing countries through the development of online work platforms bringing together potential employers and employees (World Bank, 2016). Such online platforms could provide workers in developing countries, including young people and women, with opportunities to monetize skills which might have limited demand in the local labour market. However, access to and use of these platforms tend to be higher among young people and highly skilled workers, and this, along with automation, could further contribute to the polarization of the labour market, with employment growth at the bottom and top of the skill and income distribution. As discussed in Section B, recent empirical evidence shows that many developing countries, except those with a large share of low-skill employment, large natural resources and commodity endowments, are already experiencing job polarization (World Bank, 2016).

Finally, individuals with low educational attainments and low incomes are most vulnerable to technological changes in the labour market. It is, however, unclear how the informal sector, which, as discussed in Section B, accounts for a large share of the total workforce in many developing countries, will adjust to automation and advances in ICT. Empirical evidence suggests that informal firms tend to innovate or adopt technologies at lower rates than formal firms (Harris, 2014). The literature further shows that as previous technological innovations have improved energy access, telecommunications, and transport systems, they have enabled certain informal workers to make productivity gains by improving their work efficiency and organization, as well as to take advantage of new work opportunities (Casey and Harvey, 2015; 2016). However, for other informal workers who do not have the financial means to acquire the new technologies and/or are unable to upgrade their skills to implement them, the disruptive impact of technologies is much more negative. Several case studies report that informal workers who organize and collaborate with other groups manage to improve considerably their capacity to upgrade and expand their technology options gradually, to keep up with the pace of technological change, and to mitigate the setbacks from the negative impacts of technology disruption in their sector (Casey and Harvey, 2016). Limited and uneven access to future technologies among informal workers, including the most vulnerable, could therefore exacerbate the "digital divide".

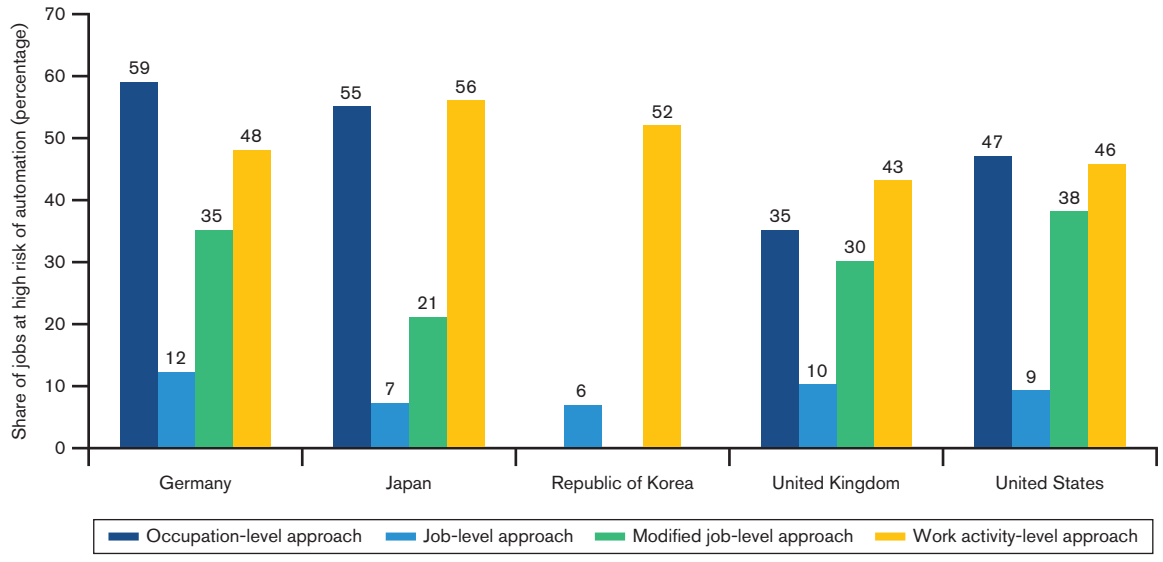
study reports that, on average, 9 per cent of jobs in 21 OECD countries are susceptible to full automation, ranging from 6 per cent or less in Estonia, Finland and the Republic of Korea to 12 per cent in Austria, Germany and Spain (Arntz et al., 2016b). The authors of the study conclude that occupation-level approaches overestimate automation potentials, because three out of four jobs in a particular occupation are, on average, less automatable compared to the median job of the particular occupation, suggesting that workers specialize in non-automatable tasks within their professions (Arntz et al., 2017).

A more recent report prepared by PricewaterhouseCoopers (2017) modifies the methodology used by Artnz et al. (2016b) by applying additional data and developing an algorithm linking automatability to tasks' and workers' characteristics. It estimates that 35 per cent, 30 per cent and 38 per cent of the jobs in Germany, the United Kingdom and the United States, respectively, face a potentially high risk of automation. Two recent studies by McKinsey Global Institute (2016; 2017), based on a different methodology which analyses work activities, suggests that even though 46 per cent of all current tasks in the United States are at risk of automation, and 60 per cent of occupations could encompass 30 per cent or more automated activities, only 5 per cent of occupations could be entirely automated using currently available technologies. At the global level, the estimated percentage of work activities that could be automated ranges from 41 per cent in Kuwait and South Africa to 50 per cent in Brazil and the Russian Federation, 52 per cent in Kenya and Mexico, 55 per cent in Thailand and 57 per cent in Japan. Given the sectoral structure of their economy, the activities mix within these sectors, and their workforce size, China, India, Japan and the United States account for almost two-thirds of the number of workers whose activities could technically be automated by currently demonstrated technologies (McKinsey Global Institute, 2017).

New research also suggests that the future impact of automation could vary significantly across regions and areas within a given country (Morgan et al., 2017; Institute for Spatial Economic Analysis (ISEA), 2017). While digital technologies have enabled firms to enhance their means of communication and further segment their production processes, companies still tend to cluster specific skills and occupations in certain geographical locations to capitalize on the availability of inputs, including labour force and suppliers, and potential spillovers. As a result, areas with a relatively larger concentration of tasks and jobs vulnerable to automation, which tend to be small cities, could be impacted more than other larger metropolitan areas.

Overall, as shown in Figure C.6, the estimated share of country's employment that could be replaced by automation differs significantly depending on the methodology and underlying assumptions considered. Yet, independently of the methodology used, the estimated probability of automation is not equivalent to future unemployment but could still have

Figure C.6: Comparison of approaches to estimate the share of jobs at risk of automation



Source: WTO Secretariat based on occupation-level analyses (Brzeski and Burk, 2015; David, 2017; Deloitte, 2015b; Frey and Osborne, 2017); job-level analyses (Arntz et al., 2016b); modified job-level analyses (PricewaterhouseCoopers LLP, 2017); and work activity-level analyses (McKinsey Global Institute, 2017).

important labour adjustment implications because of compositional changes in the labour market. These estimates should therefore be interpreted with caution for various reasons (Arntz et al., 2016b; McKinsey Global Institute, 2017).

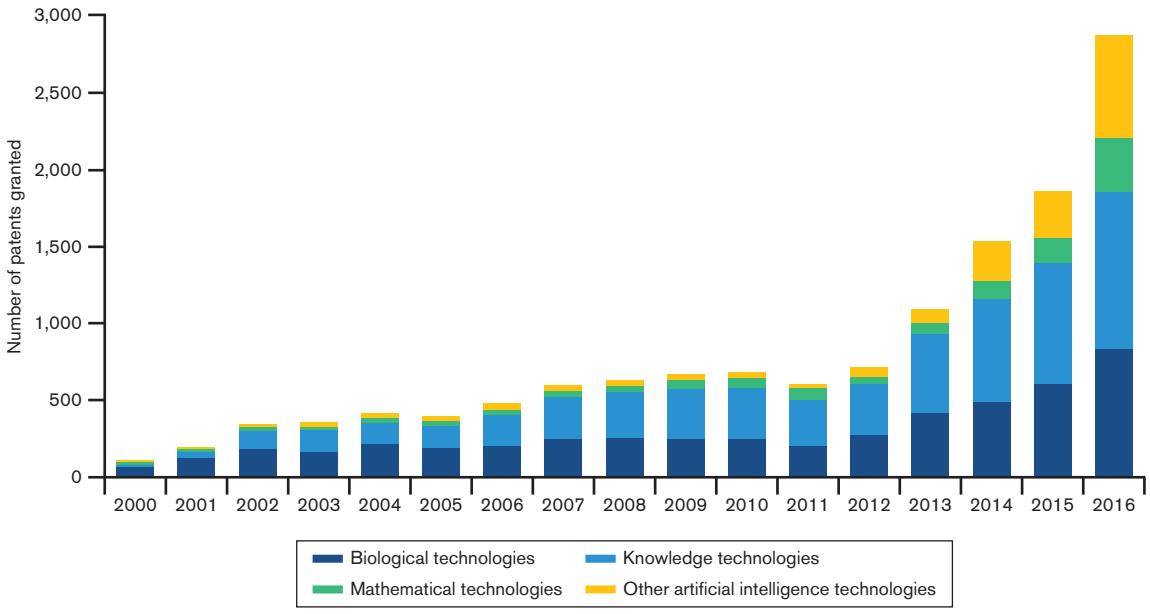
Firstly, the projections of future technological capabilities are based on subjective assessments by experts, who are not certain of how much and at what pace technological progress will eventually be achieved. Technology experts are sometimes viewed as overly optimistic about the forthcoming technological feasibilities in their area of expertise and as potentially overestimating their likely progress (Autor, 2015). A recent survey analysis suggests, however, that experts in artificial intelligence and robotics tend to be more cautious than non-experts when predicting the number of occupations at risk of automation in the next decades (Walsh, 2017).

Many technologies, including artificial intelligence and automation, as shown in Figure C.7, have developed in spurts. Very often, occasional technological advancements are followed by a period of slower progress because of the presence of certain challenging obstacles. As discussed in Section C.2, some scholars also argue that one cannot discard the possibility that rapid automation might also be a transitioning phase towards new technologies benefiting labour by discouraging further automation (Acemoglu and Restrepo, 2016).

Secondly, projections of the development and adoption of future technologies often underestimate the challenges encountered during the development of experimental prototypes and the adjustment of the production process. The degree of stability of a given automation process obtained under laboratory conditions is often difficult to achieve in practice. The automation process very often needs to be tailored and adjusted to the firm's structure and practices. During that process, the firm has to run tests, develop prototypes and adjust and improve the automation system until it can be embedded in the production process. A recent survey analysis of German firms reports that, although the share is increasing, only 5 per cent of firms' production equipment and 8 per cent of firms' office and communication equipment, on average, are based on smart technology, artificial intelligence and robotics (Arntz et al., 2016a). The risk of potential disruptions caused by machine breakdowns, broken or mis-specified parts and worker mistakes can further slow down the adoption process. As a result, the implementation speed of new technologies remains often uncertain and volatile.[39]

More generally, the adoption of a new technology by a firm depends on the cost of software and/or hardware required to implement it and on whether the firm has the necessary financial resources to invest in it. Other factors influencing the decision to adopt the new technology include the availability of relevant skills in the workforce and whether the potential

Figure C.7: Evolution of patents on artificial intelligence granted (2000 to 2016)



Source: Fuji and Managi (2017) based on WIPO Patentscope database.

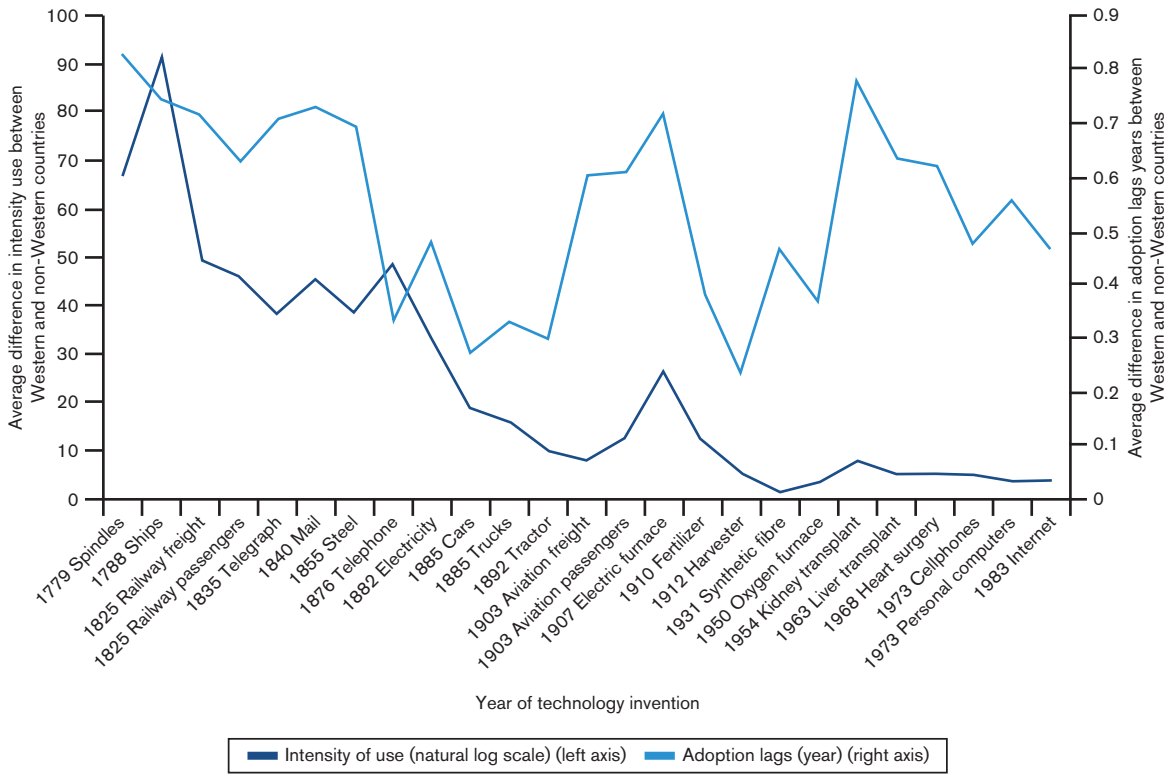
economic benefits in terms of greater efficiency outweigh the costs.

Past experience suggests that the adoption of specific technology, such as the use of personal computers, can be relatively slow and challenging, because firms adopting new technologies frequently need time to learn and become familiar with specific practical implementation. For instance, although cloud computing was first commercialized in the 1990s, less than 30 per cent of small and medium-sized enterprises in OECD countries have currently adopted it (OECD, 2016d). An economy's level of economic development and firms' absorptive capacity also seem to play an important role. Although technology adoption lags across countries appear to have declined significantly over the past two centuries, the degree to which new technologies diffuse across firms and consumers following their initial adoption seems to have widened between developed and developing countries over the same period, as shown in Figure C.8 (Comin and Mestieri, 2017).

Thirdly, and as discussed in the previous subsection, even when new technologies are increasingly being adopted and used, their effects on employment prospects depend to a large extent on whether the firms adjust to new divisions of labour made possible by these new technologies. Each industry, and in some cases each firm, develops its own set of job roles over the years, which often also encompass their own sets of tasks. While some of these tasks can potentially be automated or digitalized, others cannot. Moreover, different production tasks can often involve different types of automated functions, some of which may require more complex and expensive automated systems than others.

The impact of new technologies on employment also depends on a firm's managerial and corporate culture, including its human resource management, as well as on organizational and social constraints. The adoption of a new labour-saving technology could result in a reduction in the number of hours worked and not necessarily in a reduction in the

Figure C.8: Average difference in adoption lags and penetration of significant technological innovations between Western and non-Western countries (1779 to 2008)



Source: WTO secretariat based on Comin and Mestieri (2017).

Notes: Western countries include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, New Zealand, Norway, Sweden, Switzerland, the United Kingdom and the United States. The right axis represents the average lags (expressed in years) with which significant technological innovations arrived to developing countries compared to Western countries from 1780s to the present. The left axis represents the average difference in the penetration of significant technological innovations between Western countries and developing countries from 1780s to the present. Penetration is defined on the basis of the intensive margin of adoption for each new technology (expressed in logarithm).

number of jobs. Workers might also adjust to the new technologies by increasingly performing tasks complementary to the new technologies. Empirical evidence suggests that most of the adjustments caused by technological innovation tend to occur within, rather than between, occupations through tasks-restructuring (Spitz-Oener, 2006). The mechanisms by which technology complements human work are, however, less well understood in the literature than those by which technology substitutes for human work. A recent survey-based analysis of Japanese firms operating in the manufacturing and services sectors suggests that the surveyed firms with a relatively larger share of high-skilled workers tend to express more positive views on the impact of artificial intelligence and robotics on the prospective number of their employees, while firms with a larger share of low-skilled workers tended to anticipate a negative impact on employment (Morikawa, 2017a).

Fourthly, the studies attempting to quantify the share of jobs vulnerable to automation consider only existing jobs. They omit to analyse the new jobs that these new technologies could create. According to the World Economic Forum (WEF) (2016), a large number of today's most in-demand jobs did not exist 10 years ago. For instance, technological progress in digitalization has created requirements for app developers, big data analysts and social media managers. The upcoming wave of new technologies could thus support the growth of different types of jobs, including those in charge of developing the new technologies, implementing them, and/or supervising and repairing them (Executive Office of the President of the United States, 2016). In addition, new technologies are likely to require changes in legal frameworks and physical infrastructures, which would create specific new occupations and jobs.

New technologies may also have positive effects on labour demand by raising the demand for existing and new products and/or services if they lead to improve firms' productivity and increase workers' wage and income. As discussed in Section B, frictions in the labour market can alter the process of allocating individuals to jobs and increase unemployment. In this context, further advances in ICT could also facilitate the matching of the labour demand and supply by reducing the time and resources spent by firms and individuals and improving firms' efficiency (Dehaze, 2016).

Fifthly, the adoption and diffusion of new technology does not take place in a vacuum but in a specific legal and regulatory framework. Some labour market regulations may make it difficult and costly for firms to replace workers with new labour-saving technologies, such as robotics. The decision to adopt a new technology may also be resisted by those who expect to be negatively affected. Recent empirical research suggests that individuals in European countries and in the United States facing economic positions that are more likely to be negatively affected by robotics are more likely to be fearful of robots at work (Dekker et al., 2017; McClure, 2017). Similar findings were found in the case of Japan, where workers with limited professional experience, non-regular contracts, and who were engaged in clerical and manufacturing occupations, tended to perceive a higher risk of being replaced by artificial intelligence and robotics (Morikawa, 2017b).

Empirical evidence further suggests that the perceptions of workers in the services sector in New Zealand regarding potential changes in their workplaces due to artificial intelligence and robotics seem to be negatively related to their commitment and career satisfaction and positively related to their turnover intentions and pessimism (Brougham and Haar, 2017). In that context, some experts argue that some professional occupations, such as those of engineers, lawyers and doctors, may have a greater negotiating power in a firm than other types of occupation to ensure that new technologies extend and complement their work (Brynjolfsson and McAfee, 2014; Hughes, 2017).[40]

More generally, public acceptance of technologies can be a key factor in determining their impact on society, including on the labour market. Acceptance of new technologies encompasses political acceptance by public and key stakeholders, but also by consumers and investors, and by the communities and regions in which the new technologies are being developed and implemented. Past experiences show that high public concern can determine the direction, speed and diffusion of technological advances and, in some cases, impede their progress even when technical and economic feasibility have been established, the rationale for adoption seems sound, and important investments have been made. Empirical evidence shows that public ignorance about the true benefits of particular technologies is often not the main reason for public opposition to these technologies. Other, more important, factors include value conflicts and distributive concerns related, among others, to jobs and welfare, as well as failures of trust in institutions, such as regulatory authorities and technical advice bodies (Winickoff, 2017). Public opposition to technologies can, in some cases, lead to the adoption of new regulations that improve trust and confidence, and orient technological progress along pathways that become acceptable to the public (Davis, 2014).

(c) Implications for skills development

While a definitive conclusion on the exact outcome of the new wave of technological innovation on labour markets remains elusive at the present time, the upcoming technological advances will certainly continue to have an effect on the labour supply, especially skills development through changes in labour demand, work organization and skills requirement. In particular, technological advances are likely to continue to be disruptive by rendering specific qualifications and skills less relevant and obsolete whilst requiring and enhancing other and new ones.

Several recent studies, many of which are based on the methodology used to estimate the share of jobs at risk of automation, attempt to identify the types of skills less likely to be subject to automation. Some of these studies identify the jobs least vulnerable to automation as those occurring in dynamic and changing environments and involving non-routine manual and cognitive skills that have so far been proven difficult to automate. These skills include perceptual judgment and manual dexterity skills (used by nurses and surgeons, as well as housekeepers and cooks), social-emotional intelligence skills, such as empathetic and negotiating skills (used by educators, managers and social workers) and creative skills (used by scientists, designers and artists) (Frey and Osborne, 2017; McKinsey Global Institute, 2017).

As explained above, some experts also anticipate that automation will be applied to tasks and jobs located at increasingly elevated levels of the skills ladder (Susskind and Susskind, 2016). For instance, the "Internet of things", which enables smart devices to send and receive data, could apply to higher-skilled and complementary tasks undertaken by skilled workers, such as providing online instructions to workers. Where complex digital technologies increase the importance of experiential knowledge, some specific experiential knowledge could also be eroded or become obsolete. Given the potentially shorter life cycle of skills, the development of deep soft skills, such as adaptability and learnability, defined as the desire and ability to learn new skills, has been identified as essential to grasp complexity, handle unexpected situations under time pressure, and take the right actions in those situations without necessarily having clear information (OECD, 2016c). In other words, the ability to get and keep certain types of jobs is likely to depend less on what the individuals already know and more on how and what new knowledge and skills they are likely to learn.

Empirical evidence shows, however, that the demand for some of the skills that are considered by many experts to be immune to automation, such as perceptual and supervisory skills, has been experiencing a decrease in the United States (MacCrory et al., 2014). This seemingly contradictory result could be explained by the fact that workers may take on more managerial and organizational responsibilities within the same occupations. On the other hand, interpersonal skills and workers' facility with technology have gained importance in the last few years. Recent empirical research further suggests that individuals who are more intelligent and show an interest in the arts and sciences during high school in the United States are less likely to select jobs that are more likely to be automated in the future (Damian et al., 2017).

Many of the skills potentially less exposed to automation are already being highlighted as important by many firms. A recent survey of employers conducted by the WEF (2016) highlights an important increase in the future demand for cognitive abilities, systems skills and complex problem-solving skills, such as mathematics and logical reasoning, visualization, systems analysis and creative thinking, by 2020.[41] As discussed in section E, access to higher education, digital literacy and quality training have been identified by some countries as important means to providing individuals with the responsive, flexible and complementary skills needed to alleviate and respond, at least in part, to the current and future challenges of the labour market.[42]

5. Conclusions

This section has considered the effects of technology on the level and composition of employment and wages. Technological progress is the ultimate source of economic growth, as it allows for the production of the same amount of output with fewer resources, or more output with the same amount of resources.

Technological progress has ambiguous effects on aggregate employment. When such progress takes the form of a new product (such as flat screen televisions) which replaces an old product (such as cathode ray tube televisions), firms producing the old product go out of business, but labour demand may increase due to additional demand from firms producing the new product. When such progress takes the place of labour-replacing automation, technological change leads firms to adopt more capital-intensive technologies and to substitute labour for capital. However, various compensation mechanisms (e.g. price-productivity effects, scale-productivity effects, additional demand in other sectors of the economy) can counterbalance this type of reduction in labour demand. The evidence

reviewed in this section shows, with some exceptions, few overall effects of technology on the level of employment.

While having few effects on the level of employment, technology strongly affects its composition. This is because technological change has different effects on different workers, depending, for example, on their skills and on the work tasks they perform. This section has presented theoretical and empirical evidence showing that current technological change tends to be skills-biased, in the sense that it increases the relative demand for skills, and routine-biased, in the sense that it decreases demand for routine tasks. Therefore, skilled workers performing non-routine tasks tend to benefit from technological change, while the latter can be disruptive for unskilled workers employed in routine tasks.

Technological progress is ever-increasing. There is indication that advances in smart technology, artificial intelligence, robotics and algorithms, often referred to as the fourth industrial revolution, are taking place at an unprecedented pace. However, technological revolutions often take a long time to have significant impacts. The maximum impact of steam power on British productivity growth was not felt until the third quarter of the nineteenth century, nearly 100 years after James Watt's patent. The benefits of railroads were fairly small initially, but grew as railroad productivity improved and rail output rose as a share of economic activity. Similarly, investments in electrical capital equipment did not have important spillovers until the 1920s. Initially, factory owners simply replaced large steam engines with large electric ones. It took nearly 40 years after electricity was widely available in the United States for organizational methods to catch up and develop more efficient decentralized production lines.

This implies that current technological change is likely to have long-lasting and potentially disruptive effects on the world of work. This section has evaluated the arguments put forward by both technology optimists and by technology pessimists. Technology optimists recognize that each wave of technological change in the past generated technological anxiety and led to temporary disruptions with the disappearance of some occupations and jobs, but note that other jobs were modified and new, and jobs which were often better were eventually developed and filled. Technology pessimists, while recognizing that the fear of technological unemployment has been proven wrong many times in the past, consider that the new wave of technological progress represents a sharp departure from earlier innovations in terms of speed, scale and force. Definitive conclusions on the exact outcome of the new wave of technological innovation on labour markets, however, remain elusive for the present.

Endnotes

1 Automation refers to the use of technologies and automatic control devices that results in the automatic operation and control of production processes (Electrical Technology, 2017).

2 In this case, labour productivity increases go hand in hand with improvements in working conditions.

3 The expression "technological unemployment" was coined by Keynes.

4 Evidence of a declining share of manufacturing employment in several other developed economies is presented in Section B.

5 Industrial robots are defined by the International Organization for Standardization (ISO) as "automatically controlled, reprogrammable multipurpose manipulator programmable in three or more axes" – see the website of the International Federation of Robotics (IFR) at www.ifr.org

6 IFR data, as elaborated by Graetz and Michaels (2015).

7 Other factors behind the falling shares of employment but ever-increasing output in agriculture include more effective land use through crop cycling and fertilization, following soil analysis.

8 Another typical reason why occupations disappear is lack of demand, such as in the case of boarding-house keepers (Bessen, 2017).

9 Similarly, Harrison et al. (2014) show that product innovation has an ambiguous labour displacement effect (which depends on productivity differences between old and new products), and a positive compensation effect (related to demand enlargement). Overall, product innovation can therefore have net positive or negative employment effects.

10 Non-tradable sectors are those which do not trade internationally. Typically, the non-tradable sector comprises services where the demander and producer must be in the same location, such as electricity, water supply, all public services, hotel accommodation, real estate, construction and local transportation. Commodities which have low value relative to either their weight or volume can also be non-tradable if the transportation charges prevent producers from profitably exporting their goods (Jenkins et al., 2011). Due to advances in ICTs, however, the distinction between tradable and non-tradable sectors becomes ever thinner, particularly if one considers all the modes of services supply contemplated in the General Agreement on Trade in Services (GATS).

11 A list of ICT sectors is provided by OECD (2002, Annex 1).

12 A list of ICT occupations is provided in ILO (2006).

13 Brynjolfsson and McAfee (2014) report the telling example of Instagram, a photo-sharing app. When it was bought by Facebook in 2012, Instagram had just 13 employees, while Facebook had 5,000. These numbers are only a tiny fraction of the number of people employed by Kodak (around 145,000) at the peak of its success in photographic film in the 1990s.

14 Among the various other factors affecting technology adoption by firms, there is uncertainty over future profit streams, sunk costs, the opportunity to delay (Hall and Khan, 2003) and the structure of incentives within firms (Atkin et al., 2017).

15 Lewis (2004) investigates the technology adoption effects of the Mariel boatlift. The Mariel boatlift, which occurred in April 1980, authorized Cubans to leave their country for a limited period of time. It brought 125,000 Cubans from Mariel to Miami, creating a 7 per cent increase in the local labour force in five months in the American city (see Card, 1990). Lewis finds that post-boatlift computer use at work was lower in Miami than in other cities with similar levels of computer-based employment before the event. This suggests that the boatlift induced Miami's industries to employ more unskilled intensive production technologies and supports the idea that markets adapt production technology to local factor supplies.

16 For other theoretical contributions on the overall employment effects of labour-saving technologies, showing that the net effects are indeed ambiguous, see Blien and Ludewig (2016), Benzell et al. (2015), Sachs et al. (2015) and Nordhaus (2015). Blien and Ludewig (2016) show that although labour-saving technology may generate unemployment initially, it may also attract higher product demand. The relative strength of the two forces depends on the demand conditions on product markets. Benzell et al. (2015) and Sachs et al. (2015) show that a rise in robotic productivity which substitutes for labour can result in declining product demand if the output produced by robots is sufficiently substitutable for the output produced by humans. In the paper by Nordhaus (2015), a situation in which technological change makes human labour obsolete, denoted "economic singularity", can arise either if product demand is elastic, so that demand restructures to only ICT-produced goods, or if production is elastic, shifting production to ICT-inputs only.

17 For instance, demand rigidities may prevent product demand to increase as prices fall. For a more detailed discussion, see Vivarelli (2015) and Ugur and Mitra (2017).

18 Equating technological change with routine task specialization has advantages and disadvantages. If the aim is to measure automation technologies, routine task measures capture such technologies more broadly than robotics data, as the former include computers, machines, algorithms, robots and the like. However, task allocation is affected by several factors other than technological change, including offshoring, migration and organizational change.

19 These results are subject to the same methodological critiques as those of Autor et al. (2013), which are detailed in Section D of this report, and should be interpreted with caution. In particular, only differential effects between locations, and not a national effect, can be identified by the underlying "difference-in-differences" econometric approach.

20 Put differently, the labour demand effects of technology substantially depend on who owns the capital, as highlighted by Benzell et al. (2015) and by Sachs et al. (2015).

21 Several single-country firm-level studies for developing countries also find that introduction of new products is associated with employment growth. Moreover, they find no negative employment effects of process innovation (see Crespi and Tacsir, 2013 for a comparative analysis of firm-level studies for Argentina, Chile, Costa Rica and Uruguay).

22 Technology can also have an impact at the level of other individual characteristics. For instance, it has been argued that younger cohorts are more productive than older ones because they are more adept in using new technologies and keeping up with technological change (Meyer, 2011). In this sense, technology might be biased in favour of young generations. There are also some studies on gender showing that, especially in developing countries, women are much less likely to work in ICT sectors or occupations, which are well paid, because they are less likely to receive education in subjects such as science, technology, engineering and mathematics (World Bank, 2016, Box 2.10). Technology can, therefore, also be biased in favour of male workers.

23 Goos and Manning (2007) introduce a finer distinction in the sphere of non-routine non-manual tasks, distinguishing between cognitive tasks (e.g. testing hypotheses) and interactive tasks (e.g. managing others). This distinction is not crucial for the results discussed in this section and will therefore not be considered here.

24 The skill premium is the wage of skilled (or production) workers relative to the wage of unskilled (or non-production) workers.

25 Evidence that computer technology is complementary with human capital is presented by Krueger (1993), who shows that more skilled workers, especially those with higher educational attainment, are more likely to use computers on the job.

26 It should be emphasized that different technology indicators have been used in the literature, making it difficult to directly compare the different studies.

27 The combination of computerization and occupation demand shifters explain roughly 80 per cent of the rise in the skill premium, and almost all of the rise in inequality across more disaggregated education groups (Burstein et al., 2015).

28 For an alternative theoretical approach to the routine-biased nature of technical progress, see Jung and Mercenier (2014). Cortes et al. (2016) demonstrate analytically that advances in automation cause workers to leave routine occupations in favour of non-routine manual jobs and non-employment.

29 Recall from Section C.2 that labour-saving technology substitutes labour for capital (substitution effect). This substitution effect operates mostly in the upper row of Table C.1, because it mostly applies to workers that perform routine tasks.

30 The elasticity of labour supply is the percentage change in labour supply following a 1 per cent change in wages. The more elastic the labour supply, the more employment responds to wage changes. Graphically, an elastic labour supply is flatter than an inelastic labour supply. A perfectly inelastic labour supply, represented by a vertical curve, implies a fixed supply of labour at any wage rate.

31 Middle-skilled workers displaced from routine occupations can also compete with middle-skilled workers in non-routine occupations with cognitive content and low market entry barriers. Hsieh and Moretti (2003) show socially inefficient new entries into the occupation of real estate broker (a non-routine cognitive occupation with low entry barriers) in response to rising house prices in the United States. Some middle-skilled workers may also compete with high-skilled workers, conditional on getting adequate training (Autor and Dorn, 2013; Brynjolfsson and McAfee, 2014).

32 For the United States, evidence that routine employment has declined, while non-routine manual employment has expanded, is also provided by Autor and Dorn (2013) and Mazzolari and Ragusa (2013). The World Bank (2016) shows that employment is shifting away from occupations that are intensive in routine tasks in most countries, both high-income and low- and middle-income.

33 Autor et al. (2015) conclude from this that technology affects local labour markets only by shifting occupational composition within sectors. This is in line with the conclusions of Section C.2 that the overall employment effects of technological change are very small and even positive.

34 According to "Baumol's disease", industries with occupations for which it is difficult to enhance workers' productivity or in which productivity does not increase as fast as the economy's growth, tend to capture a larger share of the economy's workforce.

35 Besides the fear that many jobs could be lost to automation and robots, other forms of anxiety related to technological advancements have been discussed in the literature. One of them relates to the potential risk of dehumanization of work and society. Conversely, another fear expressed by some experts is that technological progress is too slow because the greatest technological advances have already occurred. The lack of technological progress could limit the prospect of future productivity gains and ultimately of economic growth.

36 Recent literature also discusses how the changes associated with the "gig economy" offer opportunities for some individuals, including those excluded from traditional work modes, such as economically inactive or long-term unemployed individuals, but also present a series of challenges for other individuals (De Stefano, 2016).

37 Driverless vehicle technology is one area that has attracted increasing research interest given its potentially large disruptive impact on the labour market of truck drivers (Executive Office of the President of the United States, 2016; Davey and Toney, 2016).

38 A different approach was adopted in a 2016 report published by the WEF (2016), in which the results of a survey of the main global employers in 15 developed and emerging economies were used to estimate the expected level of changes in job families. The report concludes that technological advancements, including automation, could lead to a net loss of more than 5.1 million jobs between 2015 and 2020 (WEF, 2016). Similarly, Willcocks and Lacity (2016) surveyed a large number of firms in the United Kingdom and conclude by extrapolation that for every 20 jobs lost through robotic process automation, 13 new ones would be created. In addition, the authors estimate that robotic process automation is expected to change at least 25 per cent of each job in the economy in the next five to seven years. Combining the projected likelihood of skills becoming outdated with survey information regarding the occurrence of previous technological change in workplaces, the European Centre for the Development of Vocational Training Combining (2016) estimates that about 10 per cent of the jobs of EU employees could be at risk of technological skill obsolescence. Another approach, adopted by Elliott (2017), is based on a literature review of recent computer science research studies in order to

identify the IT capabilities related to skills used in different jobs that have already been demonstrated to work. The author estimates that occupations representing 82 per cent of current employment in the United States could be vulnerable to displacement by IT over the next few decades.

39 From a labour market perspective, uncertainty and volatility in technology adoption may create an additional burden on the labour market as it needs to absorb excess labour turnover beyond the long-term trend.

40 A strand of the literature also analyses the attitude of trade unions towards technological changes, including with respect to the risk of job displacement, reorganization of work routines and wage formation (Lommerud et al., 2006), and the mechanisms by which trade unions can influence a firm's technology choices (Haucap and Wei, 2004; Addison et al., 2017).

41 Some governments and firms already lament a current labour supply shortage in some science-, technology-, engineering-, and math-related skills required to fill the new job openings fostered by the recent technological developments (Dehaze, 2016). However, several academics and experts have questioned the validity of the claim of these particular labour market shortages, in particular in the United States, by noting the increasing number of studies that directly contradict such claims (Charette, 2013). In particular, the real wage evidence in the United States over the past decade is not suggestive of a strong increase in skill demand in science and engineering occupations. If skill demands were strong and matching skill supplies weak, wage growth should have been faster over the past decade.

42 Some experts argue that while education and training have made it possible to adapt to previous disruptive technological innovations, they are unlikely to mitigate the impact of future automation, because the new wave of technologies are likely to substitute rather than complement skills, implying that that the number of jobs requiring an advanced degree could become limited. In addition, increasing educational attainment, which is already high in many developed and emerging economies, would increase the supply of highly skilled workers and potentially reduce the wage levels of highly skilled workers because of greater competition in the labour market. Lower high skill wages could further reduce the incentive to actually acquire higher education (Avent, 2016; Brynjolfsson and McAfee, 2014).

D Impact of trade on labour market outcomes

This section looks at the empirical evidence on the effect of trade on wages and employment and addresses the following key questions: what is the evidence of the impact of import competition and offshoring on the level of wages and employment? What is the impact of increased market access for exports and the availability of cheaper imported inputs on employment? How can varied empirical evidence across countries be reconciled? How does the functioning of the labour market affect outcomes? How large are trade-induced adjustment costs? This section focuses particularly on wages and employment because research on other dimensions of labour markets, such as employment stability and security, is much less developed due to lack of cross-country data and thus does not allow for a comparison of how trade and technology play out on these other variables.

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Some key facts and findings

- Globally, millions of jobs depend on international trade. Imports support jobs by improving the competitiveness of firms, while exports allow firms to reach larger markets. The share of export-related jobs in domestic employment can reach up to 30 per cent in some countries.
- Importers and exporters pay higher wages than firms focusing on the domestic market. Indeed, firms that both export and import pay workers around 30 per cent more than firms not engaged in international trade.
- Trade opening tends to increase wages and employment, but not all workers benefit, as regional and individual differences determine how widely gains are shared. Domestic policies, macroeconomic conditions and barriers to worker mobility play an important role in shaping how the benefits are shared.
- Trade increases the demand for skills and can accelerate structural change. This is the case even in economies with a comparative advantage in low-skill activities because trade leads to the upgrading and wider use of technology.
- Trade has supported the participation of women in the workforce in developing countries thanks to the expansion of sectors and services which generally employ a higher share of women.
- By creating opportunities for skilled workers, trade can increase incentives for schooling. This can be especially beneficial for women in some developing countries where they traditionally receive less education.

1. Introduction

The discussion in Section B on labour markets highlights that employment and wages are affected by many different factors, of which trade is only one. Section B shows that in a theoretical model where wages are flexible and workers are mobile, balanced trade does not affect aggregate employment levels of an economy. However, in the real world there are considerable wage and job search rigidities. Trade imbalances and obstacles to labour mobility and thus to trade can affect the aggregate number of jobs in an economy. Since trade comes in many forms, it is not clear whether the upfront expectation about the sign of the impact should be positive or negative. An empirical analysis of the effects of trade on employment and wages is therefore key to understanding what factors play a role in shaping the impact of trade on employment and wages.

The effects of technology discussed in Section C and the effects on trade on employment that we will discuss in this section are often similar and difficult to disentangle. Much in the same way that there are gains from innovation, so there are gains from trade (see Box D.1). With increased productivity, a country can produce more using the resources available to it, gross domestic product (GDP) increases, and the prices of consumer goods fall, improving consumers' welfare. Trade allows each economy to specialize and export goods and services that it can produce more cheaply and to import those it cannot. This fosters the growth of the most competitive sectors and firms in the economy, while at the same time allowing consumers more choice at cheaper prices. These gains from trade are significant. Some estimations have indicated that they can be as high as one-third of a country's GDP compared to autarky (Ossa, 2015). Trade can also enhance growth and productivity by allowing firms to import more technologically advanced inputs and exploit greater economies of scale, and it can provide incentives to innovate. In such cases, the effects of trade mirror even more closely the effects of technological change.

As with skill-biased or routine-biased technological change, if gains from trade are to materialize, workers must adjust to change. Imported inputs may be used by local business to increase their productivity and become more competitive in international markets. These imports, however, may be in competition with goods produced by local producers. Hence, trade results not only in the growth of some domestic firms that take advantage of the access to new markets but also the decline of other domestic firms that shrink and go out of business. As firms adjust, so do workers that may leave less productive firms to seek employment in more productive ones. In the presence of frictions in such reallocation of workers, workers may experience temporary or permanent spells of unemployment.

This section is organized as follows: Section D.2 provides some facts and figures about jobs supported by trade, and about wages in trade-related versus non-trade-related occupations. Section D.3 reviews the impact of international trade on the level of employment and wages, and discusses the factors that affect this relationship. Section D.4 looks at the effects of trade on the long-term structure of employment for skilled and unskilled worker in manufacturing and services jobs. It also examines the impact of trade on women's employment opportunities.

2. Jobs supported by trade

Many people work on trade-related activities. Jobs are created not only to fulfil an economy's domestic demand, but also to produce goods and services that are directly exported across economies, or inputs that are used to produce goods and services that will be exported. Not only export, but also import-related activities produce jobs. If trade is disrupted, these jobs are put at risk and workers need to look for alternative occupations.

(a) Both imports and exports support employment

Figure D.2 represents the share of jobs that were supported by exports in 2011. The figures take into account not only the number of people employed in exporting firms, but also those that are employed to produce inputs that will be sold domestically and processed for exports by other firms in the country. In 2011, jobs supported by export production amounted to almost 15 million in the United States, 66 million in the EU and 121 million in China.[1] In terms of total employment, the importance of jobs supported by exports varies from 10 per cent in the United States or Japan up to 28 per cent in the European Union, the Republic of Korea or New Zealand.

In the context of global value chains (GVCs), in which goods and services are produced by combining inputs from different countries, access to the cheapest and best quality inputs is essential to achieve export competitiveness and also to produce goods and services for the domestic market at affordable prices. Both exporting and non-exporting firms benefit from increased import opportunities that lower their costs and help them to expand. Protectionism in the form of higher domestic tariffs

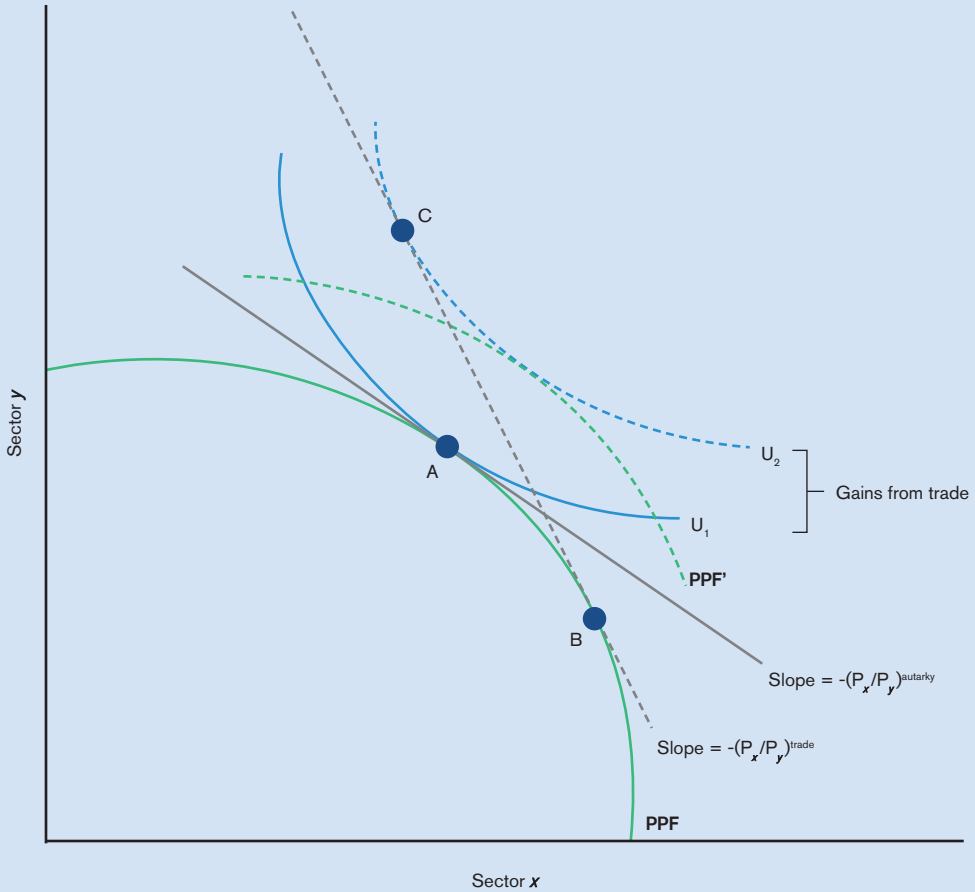
Box D.1: Welfare equivalence between technological change and international trade

As described in Box C.1, the production possibility frontier (PPF), represented by curves PPF and PPF' in Figure D.1, shows the quantity of good *x* and good *y* that can be produced in an economy with a given endowment of labour. The slope of the PPF at a given point represents the amount of good *y* that can be redirected through the reallocation of productive resources into the production of one more unit of good *x* given a certain level of technology. If the productivity of labour increases (when there is a technological innovation for example), the PPF shifts outwards.

According to economic theory, the quantity of good *x* and *y* that an economy will actually produce depends on consumers' preferences. A way to represent consumer preferences is by drawing indifferences curves (curves U_1 and U_2 in the figure below). Each indifference curve represents the various combinations of quantity of goods *x* and *y* consumed that give consumers the same level of utility. Higher indifferences curves represent higher level of utility for the consumers. In the absence of trade, the PPF acts as a budget constraint for the country. Under perfect competition, the economy will produce at the point of maximum utility for the country, that is, at the point where the highest indifference curve is tangent to the PPF, represented by point A in Figure D.1. The tangent to the indifference curve in point A is the relative price of good *x* in terms of good *y* in autarky: $(P_x/P_y)^{autarky}$.

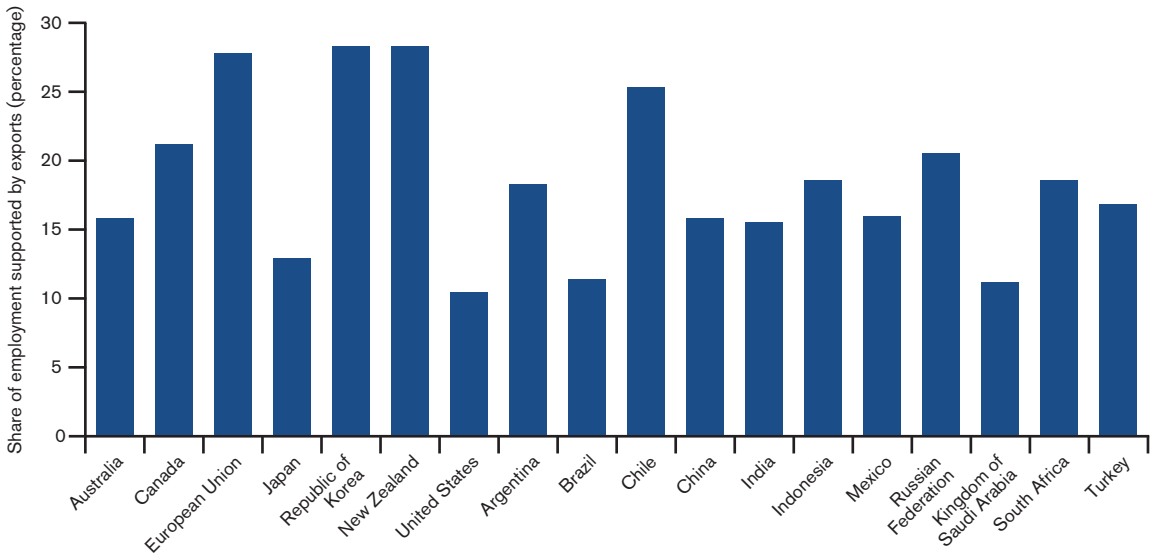
When the country opens to trade, relative prices of good *x* and *y* will change (represented by $(P_x/P_y)^{trade}$) because the country will be able to produce more of the good for which it has a relative comparative advantage and to import and consume more of the goods for which consumers have a relative greater preference. In such a situation, the economy is able to produce at point B and consume at point C. The increase in the utility from the indifference curve U_1 to the indifference curve U_2 represents a measure of the gains from trade. An equivalent increase in the level of consumers' utility can only be reached if the PPF expands outwards to a higher level PPF', following for instance technological change.

Figure D.1: Trade openness and technological change in a production possibility frontier



Source: WTO Secretariat.

Figure D.2: Share of total employment supported by exports (2011)



Source: WTO calculations based on Trade in Value Added Database (TiVA)

Note: The numbers take into account jobs supported by exports directly, i.e. jobs in the exporting industry, and jobs supported indirectly in the upstream industries that provide intermediate inputs to the exporting industries. Increased revenue from the export sector can also support domestic jobs through increased spending, but this channel is not captured.

or other forms of non-tariff barriers tends to decrease the competitiveness of domestic firms both at home and abroad. By enhancing firms' competitiveness in foreign markets, imports therefore sustain domestic jobs too. Antràs et al. (2017), focusing on the United States, illustrate this point by showing that firms that import intermediate inputs from several foreign countries at high intensity have lower input costs and sell more than firms in which all inputs are domestic. Specifically, a firm that imports 47 per cent of its input purchases presents cost savings of 30 per cent and has 176 per cent higher sales due to global sourcing. Similarly, Colantone and Crinò (2014) find for the European Union that new imported inputs have a strong positive effect on product creation and give a substantial boost to output growth in manufacturing. Other studies also support similar findings for developing countries, for example Kasahara and Rodrigue (2008) for Chile and Goldberg et al. (2010) for India. Furthermore, Antràs et al. (2014) find evidence from the United States suggesting that firms that increase their imports of intermediate inputs also start sourcing more from domestic suppliers and thus may support more employment in those firms.

(b) Both exporters and importers pay higher wages

Workers generally earn higher wages in exporting firms. Data on firm-level wages show that there is considerable variation across firms even in the same industry. A large body of work has provided evidence that exporting manufacturing firms are different in a number of ways compared to firms that sell only domestically: they are larger, more productive and more capital-intensive and they pay higher wages. In a pioneering study, Bernard and Jensen (1997) found that average wages are between 5 and 7 per cent higher in exporting plants compared to non-exporting plants of the same size and skill composition. Other studies have supported the existence of this exporters' wage premium for other countries, including China, Denmark, Germany, the Republic of Korea, Spain, Sweden and the United Kingdom.[2] More recently, the availability of data on worker-level wages allows taking into account worker characteristics such as age, gender and education when estimating the exporter's wage premium. The results confirm that workers with similar characteristics earn higher wages when working for an exporting, rather than a non-exporting, firm (Dai and Xu, 2017; Irarrazabal et al., 2013).

Importing firms also pay higher wages. Using highly detailed firm-level data for the Indonesian manufacturing sector in the period 1991 to 2000, Amiti and Davis (2012) find that exporters pay wages that are higher by 8 per cent, importers pay wages that are higher by 15 per cent, and firms that both import and export pay wages up to 25 per cent higher than firms that are not engaged in international trade.[3]

3. The impact of trade on employment and wages

A careful assessment of the research on trade and labour market outcomes suggests that the impact of trade is likely to be positive for overall employment and real wages in an economy, at least after a period of transition. Like technology, trade affects individuals, firms, regions and sectors unevenly, and while some regions may benefit, others may lose. Depending on the specific characteristics of an individual and if no adequate accompanying policies are in place, some workers may not gain from trade even when the welfare of the majority increases.

(a) Trade's overall effects on employment and wages

The main question in any assessment of the labour market effects of trade is how trade affects a country's overall employment rate and average wages. In particular, are there net labour market gains from increased trade openness when all sectors are considered?

It is important to clarify here that even if there were net labour market losses from trade, this would not imply that the net overall effect of trade is negative, because the effect on wages and employment is only one way in which trade affects an economy's welfare. Trade also affects welfare through its effect on other markets. For instance, trade reduces prices in product markets, thus increasing real wages and lowering the prices of inputs. Amiti et al. (2017) show that imports from China have decreased the manufacturing price index in the United States by almost 8 per cent between 2000 and 2006. According to Handley and Limao (2017), the additional policy certainty alone that China's WTO accession has given to US investors is responsible for a price drop equivalent to a 13 per cent tariff decrease. In line with this, Box D.2 discusses evidence showing that when all channels are considered, the welfare gains from trade considerably outweigh adjustment costs from trade.

When looking at the issue of the impact of trade on wages and employment, ideally, one should consider both direct and indirect effects of trade on these two labour market outcomes. On the one hand, there is a direct negative substitution effect of import competition on employment. On the other hand, there are many, often positive, indirect effects.

One of these effects relates to the impact of trade on the prices of imported intermediate inputs used by domestic firms. When these inputs become cheaper, domestic firms can increase production and hire more domestic workers. The importance of these international production linkages has increased considerably over the recent decades and should thus be included in any assessment of the labour market effects of trade (e.g. Hummels et al., 2001). Another important indirect effect involves disposable income. Cheaper imports can increase the disposable income of consumers and, thus, increase spending on domestically produced goods. These indirect effects are usually referred to as general equilibrium channels while the direct effects are so called partial equilibrium channels.

A large body of the literature, however, does not account for these indirect effects. Studies that analyse the effects of trade using units of analysis below the national level often miss certain general equilibrium effects and are unable to capture the full impact of trade because of their fairly specific focus on regions, industries, firms or individuals (see Box D.3). It is important to keep this in mind to properly interpret the evidence on the impact of trade on the labour market.

Recent studies on the effects of trade at the country level that take into account general equilibrium channels paint a positive picture for trade. Independent of the exact identification strategy behind the estimates, an increase in openness to trade tends to decrease (although only slightly) the national unemployment rate.

For instance, cross-country studies that estimate econometrically the effect of changes in tariffs or trade openness on changes in employment suggest that, while unemployment can initially increase after a trade shock, it then decreases below its initial level. For tariffs it is estimated that a 1 per cent decrease lowers unemployment by about 0.35 per cent, while for trade openness a 10 percentage point increase reduces aggregate unemployment by about three-quarters of a percentage point (Dutt et al., 2009; Felbermayr et al., 2011).

This is in line with Figure D.3, which correlates changes in trade openness with changes in unemployment and shows that the correlation at the aggregate level is close to zero. Regarding the trade-related adjustment period, various studies suggest that a time-frame of seven to ten years is necessary for economies to return to their new steady states (Arias et al., 2013; Artuç et al., 2010).

The evidence that trade decreases unemployment has recently been confirmed by studies that use an alternative approach to capture the indirect effects of

Box D.2: The benefits of trade outweigh the costs

Most of the literature on the gains from trade does not take into account the costs of adjustment to opening up to trade, i.e., the costs borne by those workers who have to change jobs and may be temporarily unemployed. Typically, economic literature assumes that such adjustment is smooth and costless. However, various factors can slow down the reallocation of resources following a trade shock. As discussed in Section B, key determinants of the ease and speed of adjustment to trade are obstacles to labour mobility, often called "frictions" in the economic literature. Economic theory and quantifications that include these obstacles and their implications for unemployment or wages therefore allow for a more complete cost-benefit analysis of trade.

While this work is still in its early stages due to severe data limitations, initial results suggest that the gains from trade are considerably larger than the adjustment costs. With an estimated cost of 80 per cent of the gains from trade, Davidson and Matusz (2009) provide an upper bound of the share of the benefits that trade costs may represent. But they also show that this share can be as low as 5 per cent when retraining costs are low and the import-competing sector is small.

Other works have generalized the determinants of adjustment costs beyond retraining costs and the size of the import-competing sector, and typically estimate adjustment costs to be between 15 per cent and 40 per cent of the gains from trade. For instance, Kambourov (2009) finds that Mexico's gains from trade opening were reduced by 30 per cent due to inflexible labour market laws, and Dix-Carneiro (2014) finds that, depending on the additional mobility of capital, adjustment costs amount to not more than between 16 and 32 per cent of the gains from trade in Brazil.

An alternative approach to estimating the welfare effects of trade net of adjustment costs is to consider the impact of raising trade barriers instead of the effects of trade opening. Just like opening up to trade, higher trade barriers are likely to trigger adjustment costs. Firms that rely on imported inputs tend to shrink, although additional protection may allow some less productive domestic firms to survive. Estimates suggest that the costs per saved job are usually highly disproportionate and that downstream job losses outweigh the number of saved jobs.

For instance, while Hufbauer and Lowry (2012) put the costs of US safeguard tariffs on Chinese tyres at around US$ 900,000 per saved job in 2011, they also argue that while 1,200 jobs in the tyre industry might have been saved, they cost 3,700 jobs in downstream sectors. This is broadly in line with earlier estimates by Hufbauer et al. (1986) from 31 US case studies, which put the average cost per job saved at above US$ 500,000.

This literature thus points almost unanimously to the fact that there are net overall gains from trade when all aspects are considered. However, it is important to keep in mind that as long as there are no actual data on key variables like aggregate retraining costs or geographical mobility costs, these numbers can only be treated as indications.

trade. The approach relies on structural estimation by explicitly spelling out the different channels through which trade affects the labour market, including indirect effects, and then simulates the overall impact based on actual observed changes in trade flows. In this way, a wide variety of obstacles to goods and labour mobility may be accounted for, and researchers can capture general equilibrium effects stemming from input-output linkages, geographic factors or other mechanisms.

A recent study by Caliendo et al. (2015) based on this alternative approach (simulations rather than econometric analysis) finds that aggregate US employment and real wages have benefitted from the increased trade exposure to imports from China since the 1990s. However, the study also stresses that the distribution of these gains within the United States was very uneven, with some manufacturing sectors, like electronics or textiles, contracting while others expanded, including services or food and beverages. This will be discussed in more detail in the next subsection.

In a similar study, preliminary results suggest that the net United States-wide labour market effect extends to the manufacturing sector and is even more positive. The main difference is that this work incorporates a potential positive response of the labour supply to the increased real wage. That is, trade increases wages

Box D.3: Pros and cons of partial versus general equilibrium analysis of trade and employment links

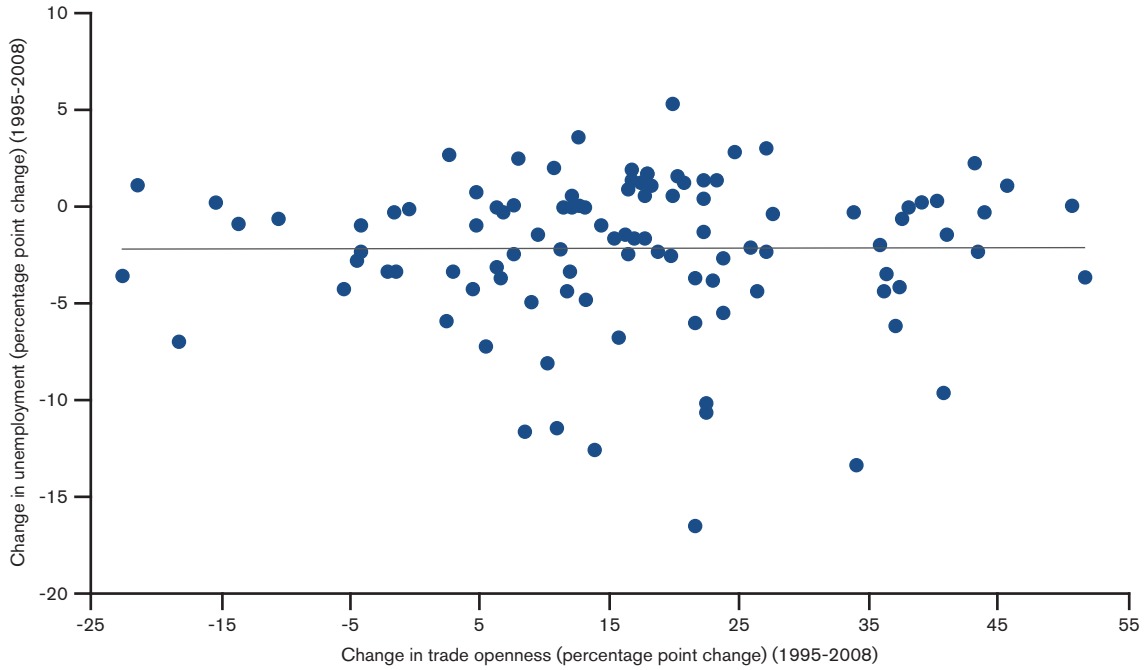
Estimates of the effects of trade on employment have been made in the context of both partial and general equilibrium analysis – in other words, in terms of the direct and indirect effects of trade. The methodology used to assess the impact of trade on employment determines the way in which results can be interpreted and how they can be used.

Studies of the effects of import competition on employment based on partial equilibrium (PE) analysis generally explore the effect at the level of a sector or geographical area (e.g. a community zone or state) within a country. This approach has the advantage of requiring a more limited amount of data than a general equilibrium (GE) analysis and can therefore be used to identify individuals who are likely to lose their jobs to import competition. Hence, these results can be used to put in place policies that can ease adjustment and address costs.

However, PE analyses miss a part of the story of resources reallocation. PE studies do not take into account that when imports displace domestic production in a certain sector, the capital and the labour formerly used in the production of that good are freed and can shift to another sector. Similarly, if the unit of analysis is a certain geographical area, partial equilibrium analysis does not account for the possibility that resources freed in one area can flow to another area and increase production there. Therefore, they can only provide us with a sense of the overall effects under stringent assumptions.

Structural empirical studies that look at the links between trade openness and labour market outcomes in general equilibrium overcome this limitation and provide overall welfare analysis. These models can also account for relevant input-output relationships between industries and across borders, using data on global input-output tables. However, the results of a GE approach depend on the completeness of the model and the set of parameters used for the estimations. For example, in the context of labour market outcomes, important aspects to account for in a GE model are how people's decisions to relocate depend on the benefits and costs of relocation, how workers react to changes in earnings (labour supply), and how the process of matching workers and employers operates.

Figure D.3: Trade openness and unemployment (1995 to 2008)



Source: World Development Indicators.

Note: Change from 1995 to 2008 expressed in percentage points where trade openness is measured as the sum of exports and imports of goods and services as a share of gross domestic product. Outliers are excluded.

and this triggers more workers to enter the labour market. The study shows that when the reaction of labour supply to changes in real wages is taken into account, trade has unanimously positive effects on employment and real wages across different sectors. The key mechanism is that when trade raises either nominal wages or decreases prices, individuals have a stronger incentive to work. The increased incentive then implies an increase in labour supply and higher employment (Adao et al., 2017).

In such simulation-based evidence, the specific estimated figure of the effect of trade on wages and employment will always be sensitive to the specifications of the model used for the estimation. However, including trade's indirect effects, such as the response of the labour supply to increased real wages or increases in disposable income, in the analysis of the effects of trade on labour markets is important when one wants to assess country-level effects.

In recent years, there has been a series of studies that have looked at the impact of China's trade expansion on local labour markets within the United States, as well as Brazil, France, Germany, Norway and Spain (see e.g. Autor et al., 2016; Malgouyres, 2016; Dauth et al., 2014). These studies identify how employment in regions more exposed to import competition has developed compared to other regions that are less exposed to import competition. Some of these studies use their results on relative regional effects to deduce absolute nationwide effects. Contrary to the simulation and cross-country evidence, they report reductions in national employment caused by increased Chinese imports. For instance, in the case of the United States, one study suggests that up to 2.4 million jobs were lost from 1999 to 2011, of which 1 million were in the manufacturing sector (Acemoglu et al., 2016).

However, it is important to note that a set of strong assumptions is necessary to deduce national-level effects from relative regional effects. For instance, as outlined by Muendler (2017), such estimates require that employment in the least exposed local labour market does not react to trade. Typically, these studies compare regions within a country and relate their performance to their exposure to import competition (difference-in-difference analysis). That is, regions in California with a focus on computer and electronics manufacturing are more exposed to Chinese import competition than regions in Wisconsin specialized in food and beverages. Based on the results that employment in less exposed regions developed favourably compared to employment in more exposed regions, these studies infer that overall employment must have declined as a result of trade with China. This inference implies that the negative relative effect found by these studies – i.e. less exposed relative to more exposed regions – translates into a negative absolute effect of the same magnitude. For this to hold, the underlying assumption must be that employment in less exposed regions does in fact not react at all. Coming back to the example, this means that employment in Wisconsin did not change as a result of higher Chinese imports while employment in California reacted a lot.[4]

The intuition is that we cannot deduce from a change in the difference of employment between two local labour markets after an increase in imports whether employment benefitted from this increase or not. Muendler (2017) explains this with an illustrative example:

> "Setting aside the mathematics, a common image to describe the consequences of trade […] is that of boats being lifted or lowered. Does the China shock lift or lower the boats in the United States? It is impossible to tell from DD [difference-in-difference] estimation. The DD estimator shows conclusively whether the difference in altitude between two typical boats grew or shrank […] By its methodological design, however, the DD estimator does not allow us to infer whether all boats were lifted (just some less than others), or all boats were lowered (just some more than others), or some boats were lifted (little) and others lowered (much). In short, the DD estimator can precisely answer the question how regional disparities between communities in the United States changed. But the DD estimator is, by construction, incapable of showing how the U.S. economy as a whole (the average U.S. boat) was affected (unless we know from conclusive independent analysis of some local community that was immune)".

Even if one were to believe that these studies have correctly identified an immune local labour market, the result that the impact of trade on the overall level of employment may have been positive, or only slightly negative, is also confirmed by alternative local labour market studies of the same type. A key distinguishing factor in this context is once again that imports affect labour market outcomes through more channels than direct substitution (i.e. the partial versus general equilibrium problem, see Box D.3). For instance, a preliminary study by Wang et al. (2017) finds that when the exposure measure additionally captures the expansion of downstream non-manufacturing firms that have benefitted from cheaper inputs

sourced from China, more exposure implies regional employment gains.

Another study, by Magyari (2017), moves the unit of analysis from regions to firms. It finds that firms moved jobs across their different plants as a response to the surge in imports from China, in order to specialize in their most competitive products. This actually led to an increase in the total number of jobs within the firms but since these plants are often in different regions this is consistent with the results of both the local labour market and the national studies.

To conclude, the research that establishes a link between trade and national employment and real wages suggests that trade benefits these two labour market outcomes, but not necessarily equally within countries. Therefore, the next section discusses how the overall labour market gains are shared at a more disaggregated level.

(b) How trade's overall effects on employment and wages map out within a country

The second key question for an assessment of the labour market effects of trade is how the overall effects map into outcomes at finer levels of disaggregation within countries. Trade shifts resources from less productive sectors to more productive ones and from less productive firms to more productive ones (see Box D.4 for an overview of the different effects of trade). Since firms and particular sectors are concentrated in certain regions, these shifts usually translate into regional disparities.

Similarly, since many workers are not fully mobile across firms or regions, trade – much like technological change – can affect individuals differently depending on their characteristics. As discussed in Section D.2(a), the empirical evidence on the impact of trade on labour markets that assesses relative effects cannot be used to infer level effects. This caveat applies to the literature that we review in this subsection. Recalling the example of the boats from above, this subsection looks at how the distance between the boats develops due to trade, but not at whether the boats are lifted or not. In particular, this subsection will look at disparities across sectors, firms, regions and individuals within an economy.

Starting with sectoral disparity, several studies have shown that after a trade shock, employment in import-competing industries suffers relative to employment in export-oriented sectors.[5] Focusing on import competition, early evidence has shown that through its impact on trade flows, the appreciation of the dollar between 1980 and 1985 affected wages and employment negatively in a sample of tradeable industries in the United States when compared to less affected industries (Revenga, 1992).

Similar evidence on relatively detrimental impacts in import-competing industries exists for tariff reductions in various developing economies including Argentina, Mexico and Morocco (Castro et al., 2007; Revenga, 1997; Currie and Harrison, 1997). In addition, a recent study by Pierce and Schott (2016a) confirms similar effects on employment in manufacturing in the United States arising from the elimination of tariff uncertainty rather than tariff reduction. Pierce and Schott argue that while the WTO accession of China had no implications for actual tariffs, which had been low since the United States granted China most-favoured-nation (MFN) status in 1980, it removed uncertainty because the MFN status had to be renewed periodically before the accession. They then show that employment was detrimentally affected in industries in which the difference between non-MFN and MFN tariffs was largest relative to employment in industries in which the difference was small. In addition, the work by Acemoglu et al. (2016) shows that upstream industries that supply the directly competing industries were also hit since input demand was affected.

Along the same lines, studies that also account for export opportunities provided by opening up to trade find a positive effect of trade on employment through this channel when compared to employment in import-competing sectors. A study on Germany shows that, following the rise of China and Eastern Europe, export-oriented industries created new job opportunities (Dauth et al., 2014). Along the same lines, increased US market access following the United States-Viet Nam regional trade agreement signed in 2001 allowed workers in Viet Nam to move from agriculture to more productive and better-paid jobs in manufacturing firms newly able to export to the United States (McCaig and Pavcnik, 2017).

There is also evidence of growing disparities across firms. Gains from trade materialize not only through the reallocation of resources across sectors, but also through the reallocation of resources from the least to the most productive firms within a sector. Just like sectoral reallocation, this can increase disparities in labour market outcomes of firms within the same sector. Amiti and Davis (2012) find that, in Indonesia, for instance, a reduction in industry-level input and output tariffs decreased wages in firms oriented only towards the domestic economy but increased wages in firms that import and export.

Box D.4: How does trade affect workers? Insights from economic theory

Distributional effects

Trade theory usually studies how trade affects the demand for different types of workers (skilled versus unskilled) under full employment. That is, it does not take into account the level of employment and focuses on how resources reallocate within an economy. What are its theoretical predictions?

The classical analysis of winners and losers of trade opening is based on the traditional Heckscher-Ohlin (HO) model. This model predicts that when an economy opens up to trade, it will export the good or service, the production of which intensively uses a factor in which that economy is relatively abundant. In this set-up, developing countries that are typically well endowed with low-skill labour will tend to specialize and export low-skill intensive goods, say textiles. Low-skill intensive industries will expand and the demand for low-skill workers in developing country will increase. In developed countries, on the contrary, the production of high-skill-intensive goods or services will increase and so the demand for high skill workers. As a consequence, wages for low-skill workers will increase in developing countries and decrease in developed countries independently of the sector (exporting or importing) or the firm in which they are employed.

The HO model assumes that workers move freely from one sector to another one. This is realistic in the long run, but not in the short run. Firms require time to invest in the production of a new product and workers often require time and effort invested in training before they can transition from one job to another one. The Ricardo-Viner (RV) model provides a framework to analyse the effects of mobility frictions. In this model, workers in import-competing sectors, who cannot move easily to the expanding sector (i.e. they are sector-specific factors) may lose out from trade reforms. Workers in the export-growing sector instead gain, independently of whether they are high-skilled or low-skilled.

The "new-new" trade theory challenges the prediction that winners and losers from trade reforms depend in the short-run on the sector of employment and in the long run on their factor endowment. Rather, it predicts that high-productivity firms will expand and low-productivity firms will shrink. Individuals working in high-productivity firms will gain and those working in low-productivity firms may lose either temporarily or permanently (Bernard et al., 2007). In these models, when a country opens up to trade, the highest-skilled workers end up working in the exporting firms, because they self-select or because more productive firms screen more intensively. Hence trade opening leads to higher wages for skilled workers in all countries (Yeaple, 2005; Sampson, 2014; Helpman et al., 2010; Antràs et al., 2006).

There are also other elements that affect workers' gains from trade. These are technological change (Aghion et al., 2005), the type of trade opening (Amiti and Davis, 2012), and whether or not a firm offshores parts of its production (see Feenstra and Hanson, 1995).

Long-run unemployment

Turning to the impact of trade on long-run unemployment, research has emphasised several mechanisms through which trade can affect the overall level of employment rather than the redistribution of jobs across workers. One mechanism is through sector-specific frictions in the labour market (for example, because requirements as to job-specific skills differ or because sectors face different minimum wages). Sectors facing higher frictions tend to have longer unemployment spells. By shifting resources across sectors, trade can increase or decrease long-run rates of unemployment, depending on whether a country's comparative advantage lies in sectors characterized by high or low frictions (Davidson et al., 1999; Helpman and Itskhoki, 2010; Moore and Ranjan, 2005).

Frictions can also be firm-specific. Firms can have differing abilities to monitor workers' efforts or they may adopt different mechanisms to hire workers. In this set-up, trade may have an impact on unemployment because if affects different firms differently (Davis and Harrigan (2011) and Felbermayr et al. (2011). Egger and Kreickemeier (2009) present a similar argument based on fair wages).

Although trade can theoretically affect overall employment, it is worth pointing out that empirically, according to a recent study by Carrère et al. (2015), the impact of trade on overall unemployment is relatively minor. Labour market institutions and technical change play a more relevant role in explaining employment than trade (Berger and Frey, 2016; Blanchard, 2006).

As labour markets adjust to trade and resources move from import-competing to exporting firms and across sectors, a country may experience growing regional disparity. This is because the industrial structure in a country is often regionally concentrated. That is, regions tend to depend on a certain sector or even firm rather than being diversified across import-competing and export-oriented sectors or firms, and trade shocks can thereby lead to detrimental impacts in regions in which, for example, the production structure depends on import-competing sectors/firms, compared to regions in which export-oriented sectors/firms may be concentrated. This mechanism is identical to that discussed in Section C, in which the increased use of industrial robots in a number of US industries led to a rise in cross-regional disparities (Acemoglu and Restrepo, 2017).

The result that trade has widened regional disparities in terms of wages and employment is quite general. It is a finding of both partial and general equilibrium studies and holds for regional trade agreements (RTAs) and unilateral trade opening, as well as for studies that focus on import competition from China.[6] Similar results have also been found in developing economies like Brazil, India, and Viet Nam (Dix-Carneiro and Kovak, 2017; Topalova, 2010; McCaig, 2011), as well as in developed economies like Germany or the United States (Dauth et al., 2014; Caliendo et al., 2015; Autor et al., 2013).

It is important to note that trade affects both tradeable and non-tradeable sectors in the same local labour markets. While only certain tradeable sectors are directly affected by increased import competition or increased market access, non-tradeable sectors, like retail, health or hospitality, in the same region are also typically affected because of indirect effects. Autor et al. (2013) find, for instance, that wages in non-tradeable sectors of areas most exposed to Chinese imports decreased while, conversely, preliminary evidence by Wang et al. (2017) suggests that these sectors expanded employment. Dauth et al. (2014) also report wage gains in the services sector of exported-oriented regions in Germany, while Menezes-Filho and Muendler (2011) show that, in Brazil, the services sector and the less trade-exposed informal sector absorbed initially displaced workers after Brazil's trade liberalization.

The combination of these effects on firms, sectors and regions trickles down further to individuals working in differently affected sectors and firms, or living in different areas. As discussed in Section B, this is because moving across sectors, firms or regions is costly for workers, and particularly so for workers with certain skills or in certain occupations. Therefore, the impact of trade on individual labour market outcomes will depend on a combination of five factors: the individual's employer, occupation, skills, sector of employment, and the region in which he/she lives.

Evidence on the effects of NAFTA on US labour market suggests, for instance, that despite average nominal wages and overall employment remaining largely unaffected, certain workers who lived in more exposed areas or worked in more exposed sectors incurred earnings losses relative to less exposed peers (Hakobyan and McLaren, 2016). For instance, the combined role of location and industry exposure implied that a blue-collar footwear worker without a high school degree in a town specializing in footwear production was hit across several dimensions (import-competing region and sector). Specifically, Hakobyan and McLaren report that in the most vulnerable regions and industries, high-school dropouts experienced a decrease in wage growth over the decade of respectively 4 and 17 percentage points compared to similar workers that were less exposed.[7]

Similarly, evidence for the US labour market shows that relative earning losses appear to be larger for low-wage workers, especially in manufacturing, while high-wage workers experience only minimal earning losses, as they are able to move across employers and outside manufacturing more easily (Autor et al., 2014; Krishna and Senses, 2014). On the other hand, evidence for exporting firms and sectors indicates that rising exports increase relative employment stability, in particular in smaller establishments (Kurz and Senses, 2016; Dauth et al., 2014).

However, the evidence for Germany shows that the expansion of export-oriented sectors did not benefit workers displaced from import competition. Instead, gains in these industries accrued primarily to workers from the same sector, new labour market entrants, or previously unemployed workers (Dauth et al., 2016). This is confirmed by Danish data (Keller and Utar, 2016), which suggests that many displaced mid-wage manufacturing workers moved into low-wage services jobs.

Furthermore, evidence suggests that occupation matters in addition to industry. Ebenstein et al. (2014), looking at total US trade, find that a 10 per cent increase in occupational-level import competition and offshoring to low-income countries brought about a relative decline in real wages, especially for occupations intensive in routine tasks. The study equally finds that an increase in export growth and offshoring to high-income countries

implies a relative increase in wages. Ebenstein et al. argue that the earning losses of workers faced with import competition are mainly those of workers who moved outside manufacturing, in line with the previous evidence that sector-specific training is crucial for the trade adjustment of individuals who have had to change jobs as a result of import competition.

Finally, evidence from Finland and Denmark (Hakkala and Huttunen, 2016; Utar, 2016; Hummels et al., 2014) confirms that both offshoring and import competition are likely to bring about lower employment probabilities and wages for workers in exposed firms when compared to workers in exporting firms. This effect is borne predominantly by low and medium-skilled production workers, who tend to move into the services sector rather than export-oriented manufacturing. Exporting on the other hand increased the wages across all skill types.

In conclusion, empirical evidence shows that without intervention by governments and other institutions, labour market gains from trade are not distributed evenly. Import-competing sectors, regions, firms or workers tend to fare worse in relative terms than their export-oriented counterparts. At the worker level, this is particularly problematic for less educated workers in manufacturing, who face the largest obstacles to labour mobility and therefore bear a larger part of the relative adjustment costs. This finding mirrors the results from Section C on technology. Note, however, that as discussed in Section D.2(a), these relative losses do not mean that these individuals are worse off in absolute terms.

(c) Which factors determine how easily countries adjust to trade?

A smooth and quick adjustment to trade shocks can reduce the trickle-down effect on workers discussed in section D.2(b). If workers can move fairly freely across firms, occupations, sectors or regions, the trade-induced disparity across these dimensions does not translate into heightened disparity for individuals. Typically, the ease of adjustment is affected by various external factors. Section B has highlighted the prominent role of macroeconomic conditions and obstacles to labour mobility. The section has shown that adjustment to economic shocks tends to be slower during recessions and that various frictions that affect the movement of capital and labour, such as information asymmetries, job market regulations or moving costs, prevent workers from capitalizing on the gains from trade. While these two factors can affect the adjustment to any type of shock, whether they are due to trade, technological change, or commodity prices, certain factors are particularly important in a trade context.

This subsection discusses three factors for which the trade context is important, namely trade balances, the pattern of trade opening, and the degree of regional diversification. While the evidence on responses to trade shocks so far been fairly homogeneous across economies, certain differences do exist, such as the differing responses of Germany and the United States to rising Chinese import competition. These differences can shed some light on the three factors that either smoothen or aggravate how national labour market gains from trade are shared within countries, thus allowing a better understanding of what is within the scope of policy when it comes to reducing these disparities.

First, trade balances matter for the ease of adjustment. A central difference between Germany and a set of other advanced economies when compared to the United States is the aggregate savings and investment behaviour, which has led to a large and persistent trade deficit in the United States. While the causes of this are usually not to be found in trade policy but rather in other areas such as taxation or monetary policy, the deficit can change the role of trade shocks for relative outcomes because it leads to an expansion of the non-tradeable sector *vis-à-vis* the tradeable sector (Krugman, 2016). The absorptive capacity of the tradeable sector for displaced workers becomes in this case limited and, as a consequence, these workers move into the non-tradeable sector, which implies a loss of sector-specific human capital,[8] or out of the labour force.

Another important factor is the industrial structure and pattern of liberalization. It matters how important the comparative advantage sectors of partner economies are for the economy that incurs the trade shock. For instance, the total manufacturing share in the United States of the textile sector in 1995 was around twice as high as the corresponding share in Germany, which had lost parts of this sector to other European countries during the European integration process. Since in 1995 China's biggest comparative advantage was in textiles, the differential impact on Germany and the United States can be partly be explained by this.

Several studies suggest that the initial industrial level of tariff protection is a major determinant of how trade shocks play out within countries. Naturally, in many cases employment in industries that enjoy high levels of protection prior to a trade opening faces higher adjustment costs than employment in less protected industries that have already adjusted to increased

competition (e.g. Hakobyan and McLaren, 2016; Hanson and Harrison, 1999). Jakubik and Kummritz (2017) show that it was not until 2015 that the US labour market largely adjusted to increased Chinese import competition.

Finally, how easily workers in import-competing sectors can adjust to the effects of rising imports depends on how diversified their local labour markets are. This is caused by the interplay of sector-specific skills and the cost of moving. When export-oriented industries within the same sector are in the same local labour market as the import-competing industries, workers can switch relatively easily because there are no moving costs and they can retain their sector-specific know-how. Evidence on the importance of diversification was presented recently in a study by Yi et al. (2017), who find that earning disparities in less diversified regions of Germany were three times as high as in highly diversified regions.

This section highlights that factors other than trade policy are also responsible for the distributional implications of changes in trade flows. In addition, individually addressing the three factors described above does not guarantee smooth adjustment since the condition of other factors might still prevent it. For example, recent work by Baldárrago and Salinas (2017) on Peru suggests that high labour mobility alone is insufficient for costless labour market adjustment after trade opening.

4. Trade and the structure of employment

Country-wide employment levels are largely affected by macroeconomic factors (see Section B). However, trade induces changes in countries' employment structure at the level of tasks, occupations, firms or sectors due to its reallocation effects. In other words, some jobs may disappear while other jobs are created. The previous subsection shows that such new jobs may differ from the old ones in the skillsets they require, their industry or their location, which may hamper the adjustment. This subsection discusses how these reallocation effects have affected the composition of the labour force in terms of skilled and unskilled workers, manufacturing and services jobs, and how they have affected job opportunities for women.

(a) Trade has increased the demand for skills

International trade and offshoring, like technology, can change the employment structure across skill levels by changing the demand for skills. As explained in Box D.4, the traditional factor-endowment theory of comparative advantage predicts that trade would increase the relative demand for skills in an advanced economy that is relatively skill-abundant, while in a low-income economy, where skills tend to be relatively scarce, trade could lead to an increased relative demand for low-skilled labour.

Recent theories nevertheless point out several channels through which trade can lead to an increasing demand for skills not only in developed, but also in developing countries.

As offshoring costs fall, a developed economy can relocate more production stages to a developing economy. This leads the former to specialize in a narrower set of stages that are relatively skill-intensive, while the latter attracts a wider set of stages. In the developing country, the new stages would be relatively more skill-intensive than the stages it used to host. As a consequence, the relative demand for skilled labour may increase in both economies.

Furthermore, an increase in the relative demand for high-skill workers can come from a trade-induced change in the firm composition. When trade liberalization opens new trading opportunities, the most productive firms try to seize them and expand their production. At the same time, international trade stiffens competition in the domestic market, leading the least efficient firms to reduce their sales or close down. High-productivity expanding firms tend to be more skill-intensive than low-productivity downsizing firms, and therefore this change in firm composition may translate into an increase in the relative demand for high-skill workers irrespective of the industry specialization.[9]

Finally, as mentioned in Box D.4, to the extent that trade brings about innovation and technology diffusion, it may also indirectly boost the demand for high-skill labour globally.

In the short term, the supply of workers with a given skillset tends to be fixed and an increased demand for skills translates into increases in the skill premium, i.e. the ratio of wages commanded by high-skill and low-skill workers. This higher skill premium acts as a signal for workers to increase their skill levels and/or acquire the appropriate type of skills. When skill supply responds to the market changes, the increased demand results in a higher share of high-skilled workers without long term repercussions for the skill premium. It can therefore be an important mechanism in upskilling the labour force and consequently in advancing economic development.

While the following paragraphs show that there is abundant evidence of upskilling following trade opening, there is also evidence that the skill premium tends to be higher for several years which suggests that the adjustment of skill supply can be sluggish (Goldberg and Pavcnik, 2007; Goldberg, 2015; Helpman, 2016). This is supported by empirical evidence which shows that while high-skill workers can adjust to changes in skill demand promptly, upskilling or re-skilling of low-skill workers is costly and takes time (Keller and Utar, 2016; Autor et al., 2014; Artuç and McLaren, 2015). Skills development policies therefore play an important role in shaping the impact of increased demand for skills on labour market outcomes, as discussed in Section E.[10]

Empirical evidence supports the view that international trade increases the relative employment of skilled workers both in developed and developing countries. The early literature focused on the period of the 1970s and 1980s in the United States. In this period, the share of non-production workers[11] in the manufacturing labour value added increased, suggesting that the demand for skills shifted towards high-skill workers. This is because the proportion of high-skill workers tends to be larger in activities that are not directly related to the production process, such as marketing or logistics, than in routine production activities. The early empirical analysis nevertheless showed that while international trade contributed to the observed trends, investment in computers and research and development (R&D) was the most important driver (Berman et al., 1994).

Other studies focusing on the impact of increased offshoring from the United States to Mexico also found that offshoring contributed to the increasing relative demand for non-production manufacturing workers, but that its impact was small relative to that of technology upgrading. The respective contributions were estimated to be around 15 per cent for trade and around 30 per cent for technology (Feenstra and Hanson, 1999).

More recently, empirical evidence from the United States and Belgium shows that imports of intermediate inputs from China mildly increased the relative employment of non-production workers compared to production workers (Wright, 2014). The estimates by Wright suggest that the effect accounted for around 6 per cent of the average decline in US production worker employment during the period 2001 to 2007. Moreover, Wright estimates that this decline was outweighed by a positive impact on the non-production employment, leading to a small but positive increase in aggregate employment.

Firm-level evidence from France supports findings that offshoring is associated with a lower relative demand for production workers and especially for the less skilled ones. Between 1986 and 1992, French manufacturing firms which increased their imports of final goods, and which were therefore likely to engage in offshoring of the assembly stage, changed their labour force composition towards non-production activities such as marketing or distribution (Biscourp and Kramarz, 2007). Evidence from the same study also shows that all types of offshoring, whether foreign sourcing of final goods or intermediate inputs, are associated with an increase in the share of skilled workers such as engineers or technicians among the remaining production workers. Interestingly, the employment changes in this study were due to offshoring to other OECD countries, suggesting that skills upgrading within firms from high-income countries is not necessarily linked to offshoring to low-wage countries. Rather, it appears to be associated with increases in sourcing from foreign markets in general.[12]

Newly available data on occupational characteristics allow researchers to characterize better the recent changes in the nature of work and the tasks required in each occupation. The types of tasks performed by a worker at the workplace also determine whether a job is suitable to be offshored and whether it is susceptible to import competition from low-wage countries. Occupations which require repetitive, easily codifiable tasks are not only easy to automate, as mentioned in Section C, but also to relocate. Non-routine occupations that require abstract thinking and face-to-face communication are much less tradeable.

This literature also emphasizes that the low- versus high-skill dichotomy is not sufficient to capture fully the labour market evolution in the past decade. The jobs that require the lowest level of skills are predominantly non-routine services jobs, such as cleaning or security services, and thus are not directly affected by offshoring or automation (at least so far). Consequently, trade and technology tend to increase the demand for high-skilled workers compared to mid- or low-skilled ones as well as to decrease the demand for mid-skill workers performing routine tasks compared to both high- and low-skill categories. This phenomenon, referred to as job polarization, has been documented for many developed countries since the late 1990s and recently also for some developing countries such as Brazil, Mexico and Turkey (OECD, 2017; Reijnders and de Vries, 2017).

Firm- and worker-level evidence shows that offshoring and import competition have a small positive impact on the demand for non-routine occupations and

thus on job polarization. Becker et al. (2013) show that offshoring by German multinational enterprises is associated with an increase in non-routine and interactive tasks performed in the onshore plants, and a higher share of high-skill workers. Still, Becker et al. estimate that offshoring accounts for only 10 to 15 per cent of these changes. Another recent study investigates the impact of import competition from low-wage countries on workers in Denmark (Keller and Utar, 2016). The study shows that import competition has led to a decline in routine, mid-skill manufacturing occupations, and has therefore contributed to an overall shift in employment towards both high- and low-skill occupations. Evidence from the United States and Western Europe suggests that services offshoring also increases the relative demand for high-skill workers in non-routine occupations, but that the effect is economically small (Crinò, 2010; Crinò, 2012).

Skills play an important role in shaping the impact of import competition on individual workers. The study by Keller and Utar (2016) finds that workers' ability to move up or down depends on several factors. First, workers in occupations that require cognitive skills either stay in mid-wage jobs or move upwards, and therefore are unaffected or benefit from import competition. Second, vocational training with a manufacturing focus makes mid-wage workers less vulnerable to wage declines if they stay in their job but it does not shield them from being obliged to move into low-wage jobs. Finally, third-level education and vocational training with an information technology focus prevents workers from having to move to low-wage jobs and strongly increases their chances of moving to high-wage jobs if they face import competition from a low-wage country.

Economists have pointed to different channels through which trade affects the demand for skills. One factor is simply that trade is a skills-intensive activity. There is evidence that increased trade may push up the relative demand for skills because exporting firms employ more skilled labour than non-exporters (Bernard and Jensen, 1995; Bustos, 2011a; Brambilla et al., 2011). Using a dataset which provides detailed information on the skill structure within French manufacturing firms, Maurin et al. (2002) find that firms employ relatively more skilled workers in marketing and development when they sell their products outside of France. At the same time, the skill intensity does not depend on whether they export to developed or to developing countries, which suggests that it is not the type of products that determines the skill intensity. It appears that the very act of exporting requires a skilled labour force. In the same spirit, Matsuyama (2007) emphasizes that exporting requires services like distribution, transportation, and advertising, which are intensive in certain skills.

Another way in which trade increases the demand for skills is by triggering skill-biased technical change. Trade opening provides more incentives and opportunities to increase productivity and product quality, which generally necessitates more investment in R&D and technology upgrading (Bustos, 2011a; Bloom et al., 2016). This in turn leads to an increased relative demand for skilled workers.

Empirical evidence shows that import competition leads to skill upgrading through its impact on product and process innovation. Using firm-level data for twelve European countries over the period 1996 to 2007, Bloom et al. (2016) estimate that increased trade with China accounted for about 15 per cent of the technology upgrading in Europe between 2000 and 2007. The explanation is that import competition triggers so called defensive innovation whereby low-productivity firms escape increased market competition by focusing on higher-quality and/or more high-tech segments of their product markets. This involves more investment in R&D and higher requirements of the skills of their workforce. The study indeed shows that technology upgrading has had a significant impact on the relative employment of skilled workers.

Supporting this evidence, an analysis of Belgian firms in the same period, 1996 to 2007, shows that import competition from China led to skill upgrading in low-tech industries (Mion and Zhu, 2013). The findings suggest that the response to imports from China accounted for 27 per cent of the increase in the share of non-production workers, and for almost half of the increase in the share of highly educated workers in the low-tech industries. Similarly, Attanasio et al. (2004) show that the substantial tariff reduction which took place in Colombia during the 1980s and 1990s induced skill-biased technical change. Attanasio et al. document how industries that experienced larger tariff cuts increased the share of more skilled workers into their workforce and argue that this change points towards skill-biased technical change due to increased competitive pressure brought about by a decrease in tariffs.

Bustos (2011a) provides a complementary mechanism in which exporters have more incentive to upgrade their technology when trade costs decrease. This is because their sales in foreign markets become more profitable, which in turn gives them an incentive to invest in more advanced technologies to increase their productivity. Since advanced

technologies often substitute for low-skilled workers and require servicing and operation by relatively high-skilled workers, the relative demand for skills by exporters increases. Examining how the elimination of import tariffs between the signatory members of the MERCOSUR (i.e. Southern Common Market) agreement affected Argentinean firms between 1992 and 1996, Bustos (2011b) finds that after trade opening, exporters upgraded their technology faster than non-exporting firms.[13] The technology upgrading was in turn accompanied by skills upgrading as exporters increased the share of high-skill workers in their workforce.

Furthermore, exporters from developing economies have an incentive to upgrade the quality of their product when they get better access to rich markets. This argument, proposed by Verhoogen (2008), is based on the assumption that firms can produce output of different qualities, depending on whether they sell in the export market (higher quality good) or in the domestic market (lower quality good). As trade costs decrease, more firms are able to enter the export market, and existing exporters can sell more to foreign producers. Because they only sell high quality to the foreign consumers, the average quality that they produce rises. The production of a high-quality product in turn requires more skilled workers than the low-quality one. Trade opening leads the high productivity firms to increase their sales in the export market (with the high-quality good) and to raise their relative demand for skilled workers. Supporting this argument, Brambilla et al. (2012) find that Argentinean firms exporting to high-income countries hire more skilled workers than exporters to middle-income countries or than purely domestic firms.

Finally, imported technological change may be an important driver of demand for skills in developing countries that rely on imports for most of their capital equipment (Burstein et al., 2013). The adoption of new technologies and building of incremental new-to-firm innovations and know-how around them, rather than deep innovation, are the main drivers of technical change in developing countries.[14] When imports of capital equipment become cheaper due to lower trade costs, new technologies embedded in such equipment become more accessible and thus more profitable to adopt.

The complementarity between advanced technology and skilled workers leads to an increase in the demand for skills. Lee and Wie (2015) find that the adoption in Indonesia of foreign technologies through imports and foreign direct investment was associated with an increased share of non-production workers in the labour value added of manufacturing firms. Similar evidence is available for Mexico and shows that Mexican firms that import machinery and equipment are more likely to employ more skilled workers (Hanson and Harrison, 1999).

On the other hand, evidence from Chile does not suggest that imported material and foreign technical assistance had any significant impact on the labour share of non-production workers by Chilean firms in the 1980s (Pavcnik, 2003). However, this finding may be due to the fact that not all imported materials are technology-intensive, which can blur the results. Using data from 21 developing countries over the period 1983 to 2000, Raveh and Reshef (2016) show that it is indeed the adoption of new technologies through imported capital goods[15] that is associated with a higher demand for skilled workers in developing countries.[16]

(b) Trade also benefits unskilled workers and the poor

Most of the studies on the effects of trade and trade policy on labour market outcomes do not consider the poverty implications directly.[17] However, those which examine the effect of trade on the skill premium and more generally on the relative demand for skilled workers provide some insight into the poverty implications, given that the poor are often low-skilled. When interpreting these results, it is important to bear in mind that an increase in the skill premium does not need to be associated with an increase in poverty. In many cases, the increase in the skill premium reflects a situation where both high-skill and low-skill wages increase, with the latter increasing at a faster pace.

For example, using Chilean plant-level data for the period 1995-2007, Pellandra (2013) finds that exporting had no effect on plant average low-skill wages, but it did have a significant positive effect on high-skill average wages. She also finds that exporting led to an increase in employment of low-skilled workers. In a study on Mexico, Verhoogen (2008) finds that an increase in the export share of sales was associated with a larger difference between white-collar and blue-collar wages, and both white-collar and blue-collar wages were found to increase in absolute terms. Focusing on Indonesia, Amiti and Cameron (2012) estimate that a decrease in tariffs on imported inputs in Indonesia decreased the skill premium in firms that import their intermediate inputs. They suggest that trade liberalization induced firms to substitute in-house input production for cheaper imported inputs. Since final goods production in Indonesia is relatively less skill-intensive than inputs

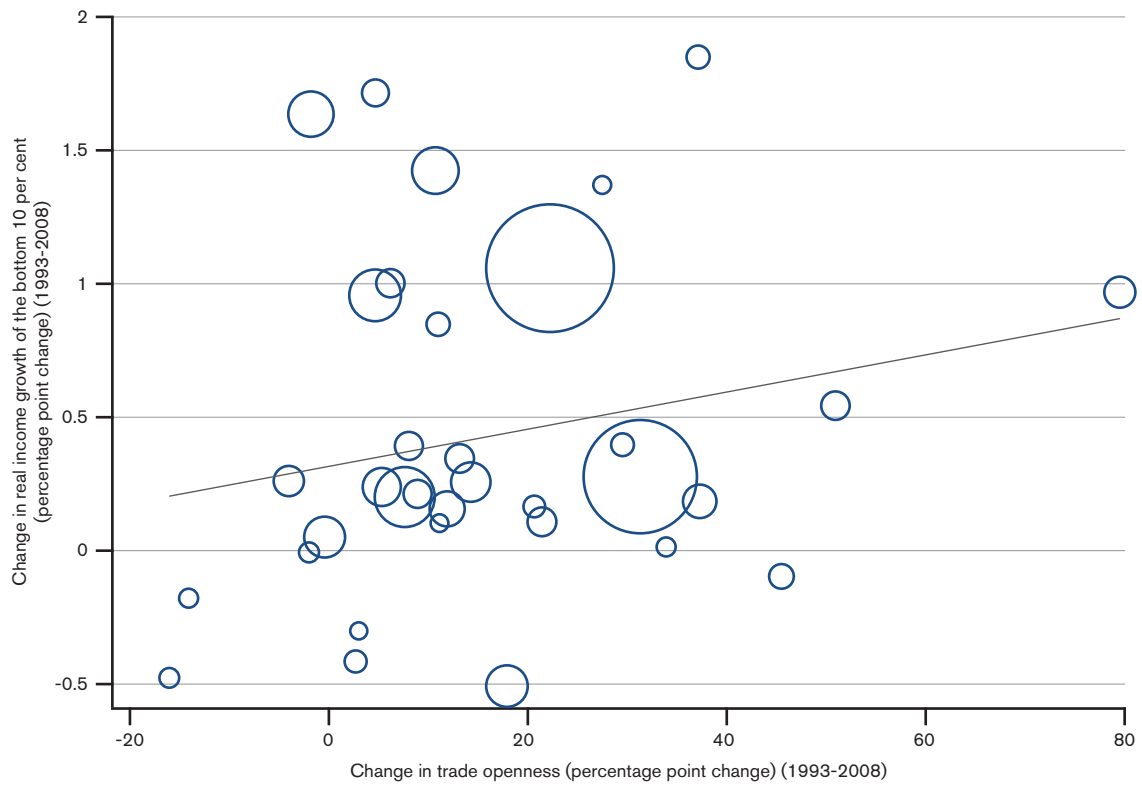
production, this led to a decrease in the relative demand for skilled labour.

While more research into the impact of trade on low-skilled workers is needed, a simple correlation between the change in real income in the bottom 10 per cent of the population over the period 1993 to 2008 and the change in trade openness in the same period show a clear positive relationship (see Figure D.4).

The specific consequences of trade opening on poverty depend, among other factors, on what the poor consume, what they produce and on patterns of trade opening, as well as on the impact of trade on the formal and informal sectors. Evidence on the effects of trade opening on the poor via a study of consumption shows that, on average, for 40 countries, the gains from opening up to trade are 63 per cent for the bottom 10 per cent of the income distribution and 28 per cent for the top 90 per cent. Trade opening favours relatively more poor consumers, because they spend relatively more on sectors that are more traded, while high-income individuals consume relatively more services, which are less traded (Fajgelbaum and Khandelwal, 2016).

Recent economic research stresses the importance of looking at the effects of trade on the poor through both the earning and the consumption channel. When these two channels are active, trade opening reduces the consumption price index, thus increasing real wages. This income effect, however, also shifts the composition of the consumption basket in favour of goods consumed at a higher level of income. Since production of these goods tends to be more skill-intensive, the income effect reduces the relative demand for low-skilled workers and thus pushes nominal wages down for the poor. Ultimately, the overall effect is a matter of empirical evidence. Existing empirical studies that look at the impact of trade opening through both the earning and the

Figure D.4: Change in trade openness and real income growth of the bottom 10 per cent of the income distribution (1993 to 2008)



Source: Lakner-Milanovic (2016), World Panel Income Distribution and World Bank, World Development Indicators.

Note: Figure D.4 shows the relationship between the real income growth of the bottom 10 per cent and the change in trade openness (in percentage points) in large countries with populations above 40 million. Trade openness is defined as exports plus imports over GDP. The size of a circle indicates the size of a country's population.

consumption channel do find positive effects on the poor resulting from trade opening in Argentina (Porto, 2006), India (Porto, 2006; Nicita, 2009; Marchand, 2012) and Mercosur (Nicita, 2009).

Furthermore, there is evidence that increases in job and wages opportunities in sectors where an economy can export competitively can benefit the poor. Focusing on the 2001 United States-Viet Nam Bilateral Trade Agreement, McCaig (2011) shows that between 2002 and 2004, provinces that had a higher pre-reform concentration of industries which ultimately experienced the largest tariff cuts in access to the US market also experienced greater decreases in poverty. Later research (McCaig and Pavcnik, 2014) shows that the agreement brought about a reallocation of workers from the informal to the formal sector. However, there is evidence that relative poverty declined less in areas with a high concentration of industries that lost tariff protection (Topalova (2010) for India and Kovak (2013) for Brazil).

Low geographical mobility for people at the bottom of the income distribution and inflexible labour laws appear to play a key role in reducing the benefits for the poor. The challenge is to accompany trade policy with policies that allow the poor to take advantage of the opportunities that are created by trade. For example, a reduction in tariffs will reduce the price paid at the border for the good by the importer. However, the transmission of this border price change to the price paid by local producers and consumers may be significantly affected by internal transport costs, thus limiting the benefits of trade opening on poor living in remote rural areas.

Similarly, trade opening provides workers with the opportunity to move from low-paid jobs in import-competing sectors to higher-paid jobs in exporting firms. However, labour rigidity (such as low mobility of workers) may lead to temporary unemployment, with potentially severe consequences for the poor.

(c) Trade has contributed to the shift of employment towards services in advanced economies

As trade brings about change in industrial structure, it also leads to shifts between broad sectors. Developed economies typically have a comparative advantage in tradeable services such as business services, R&D, design or financial services.[18] Increased trade may therefore lead these countries to specialize in the tradeable services sector. At the same time, economic progress in these countries in the past decades has been characterized by an increasing importance of the services sector as a source of employment and labour income (see Figure D.5). Trade is expected to contribute, among other factors, to this shift towards a services-based economy because disappearing jobs are predominantly in the manufacturing sector (see, for example, Box D.5), while new jobs are increasingly created in services (Spence and Hlatshwayo, 2012).

Empirical evidence from the United States and several European countries points towards the role of trade in faster transitions to services-based economies (Autor et al., 2013; Keller and Utar, 2016; Malgouyres, 2016; Balsvik et al., 2015). An exception is a recent study of Germany that suggests that German trade with China and Eastern Europe has slowed the decline of manufacturing employment (Dauth et al., 2014).

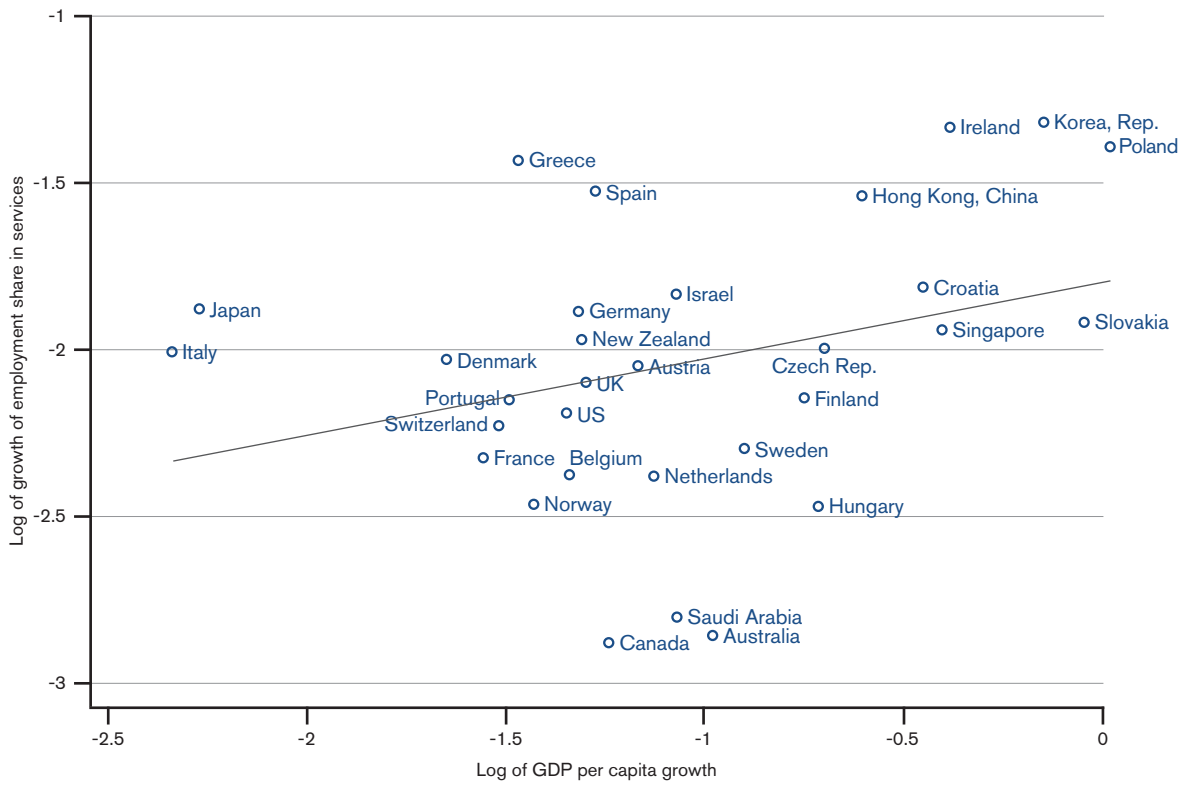
This suggests that one element that determines the impact of trade on sectoral composition can be the trade balance. When a country is running a trade deficit it consumes more foreign tradeable goods than it produces for consumption abroad. This leads employment to shift out of the tradeable sector towards the non-tradeable sector and thus also towards non-tradeable services. If, on the other hand, the country has a trade surplus, it concentrates its employment more in the tradeable sector than would be the case if its trade was balanced. The experience of the United States illustrates the former case, while Germany illustrates the latter.

In developing countries, economic progress is characterized by the shrinking of subsistence farming and transitions to the industry and services sectors (Figure D.6). Even China, which has become a manufacturing powerhouse, has experienced a faster increase in services than in manufacturing employment. International trade is therefore expected, in combination with other factors, to accelerate the shift of employment out of the primary, often informal, sector in these countries.

(d) Impact on women's employment and wages

Increasing women's participation in employment is crucial for achieving more gender equality, as well as being instrumental in achieving other development goals, such as reducing child mortality. Duflo (2012), for example, offers significant evidence that empowering women and enabling them to gain access to independent sources of income lead to better health outcomes for children.[19] Women's participation in the labour market has increased significantly in developing countries; according to the World Bank (2012) in Bangladesh, for example, the labour participation of young women (aged 20–24)

Figure D.5: GDP growth and growth of the services' share of employment (1995 to 2011)



Source: ILO (2014a): supporting datasets and World Bank, World Development Indicators.

Note: Figure D.5 shows the relationship between the growth of employment share in services (in logarithm) and the GDP per capita growth (in logarithm) in high-income countries with populations above 4 million. The income classification is based on the World Bank Country and Lending Groups 2011.

increased almost two and a half times over the period 1995 to 2000. The growth of job opportunities for women in this period has been principally linked to the expansion of export sectors such as the textiles industry and services such as tourism and data processing (Mehra and Gammage, 1999).

Several studies support the view that trade has played a key role in opening employment up to women and find a positive correlation between export orientation and female participation in manufacturing employment (Özler, 2007; Seguino, 2000). Furthermore, across developing countries, exporting firms generally employ a significantly higher share of women than non-exporters. For example, in export-processing zones studied by Boyenge (2007), women constituted an average 70 per cent of the labour force in 2005 to 2006, ranging from a low of 10 per cent in Bahrain to 90 per cent in Jamaica and Nicaragua.

Despite the fact that the gender gap in labour force participation and the wage gap have narrowed since 1990, women's participation rate remains well below that of men, and women are still paid less than men for the same work and skills. On average in the OECD, the gender gap of the full-time equivalent employment ratio is 32 per cent and women are paid 16 per cent less than men (OECD, 2011b).

This sub-section explores the ways in which trade affects women's employment and highlights some of the obstacles that women face in capturing a higher share of the opportunities that trade offers.

(i) How does trade affect women's participation in the labour market and their wages?

Trade and trade policies have different impacts on men and women in a given economy because of the existence of gender, social and cultural structures.

Women have, on average, lower access to education, finance and information and, in some countries, limited ownership of land. Moreover, women face

Box D.5: The role of trade in the recent decline in US manufacturing employment

Recent research on the impact of rising Chinese import competition on US labour markets has sparked a heated debate around the role of trade in manufacturing jobs. "Back-of-the-envelope" calculations in popular media outlets, blogs and policy briefs have provided policymakers with a wide range of estimates. De Long (2017), for example, estimates that trade agreements contributed less than 5 per cent or even as little as 1 per cent to the manufacturing jobs lost in the United States after 2000. De Long's estimate is supported by various other estimates which are slightly larger but usually do not exceed 15 to 20 per cent (Krugman, 2016; Hicks and Devaraj, 2015). At the other extreme, Scott (2015) goes as far as to claim that the growing manufacturing trade deficit of the United States can explain almost all of the manufacturing jobs lost in the period between 2000 and 2007.

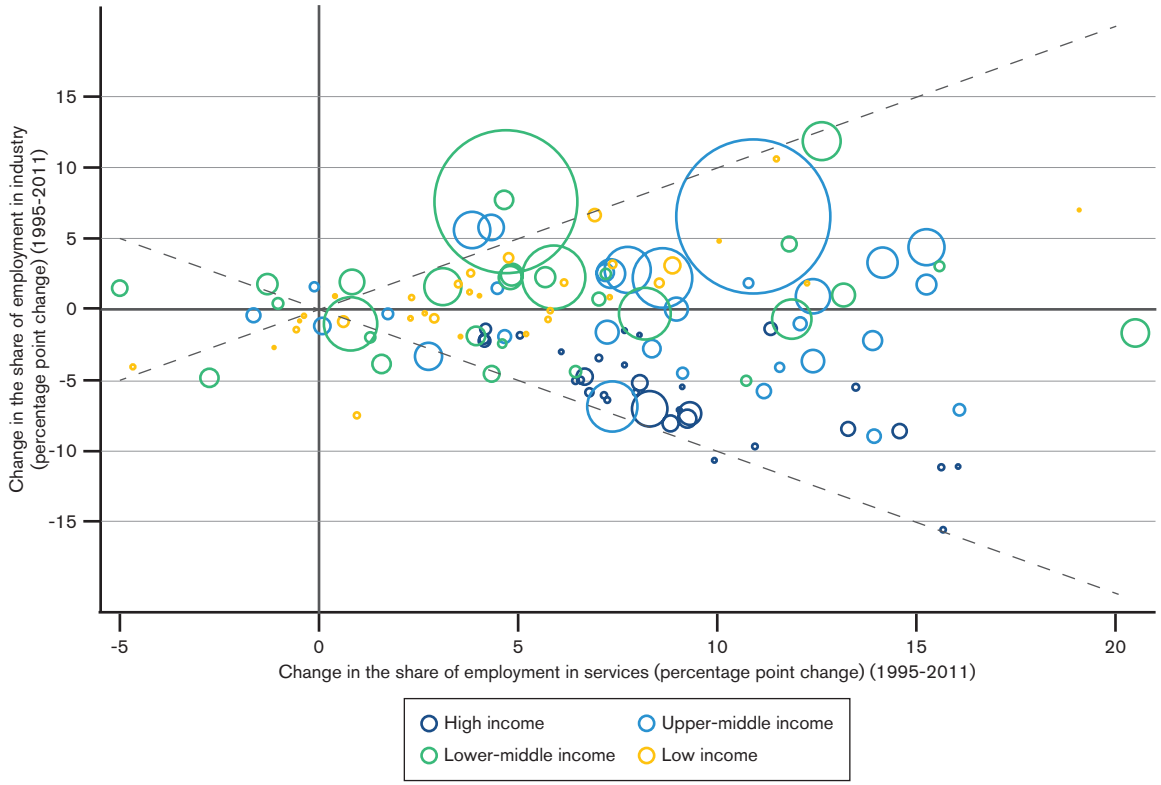
While back-of-the-envelope calculations can give a useful first idea of an effect, they are likely to miss important indirect effects of growing trade deficits or trade agreements. In addition, they usually do not adequately take into account weaknesses of underlying data or reverse causality. For instance, a trade deficit is an outcome itself usually caused by factors that might equally affect employment. Moreover, trade deficit analyses are usually based on gross trade data instead of on the appropriate value-added trade data. To illustrate this, we can use the trade between China and the United States as an example. Many Chinese gross exports to the United States contain US value-added. In the case of the iPhone, which is assembled in China and sent to the United States, the total value of the product is counted as Chinese despite the fact that much of its value is created in California. Value-added trade data subtract the US contribution from Chinese gross exports and are therefore more apt for job market outcome inference, since US value added in Chinese exports does not reduce numbers of US jobs. In 2011, for example, the US trade deficit with China was 50 per cent larger in gross terms than in value-added terms, according to OECD-WTO statistics (TiVA 2016 database).

Economic research that has more rigorously dealt with some of these issues can shed additional light on this question and potentially help to extract a more reliable number even if it does not address all of the aforementioned problems. Seminal work in this area by Acemoglu et al. (2016) and Autor et al. (2013) examines the increase in Chinese import competition by comparing more and less exposed local labour markets in the United States. It finds that it can explain around 20 per cent or 25 per cent of the manufacturing decline. Studies that take into account a larger set of indirect effects of trade more generally (i.e. not just trade with China) either confirm this or put the number lower, due to the fact that trade may even have stabilized manufacturing, as discussed in Section D.2 (Adao et al., 2017). This suggests that, at the very most, trade can explain one-fifth or one-quarter of the recent decline of US manufacturing employment, with the true number likely to be lower.

A view of the long-term trend can help to illustrate the virtues of this more careful estimate. Figure C.2 (Section C) depicts the decline of the share of US manufacturing employment and shows that the rise of China starting around 1990 does not seem to have changed this development much. China's WTO accession in 2001 seems to overlap with a slightly sharper drop but such declines seem to have occurred regularly over time if one looks at the early 1980s or mid-1970s. This regularity suggests that other factors could have played a role, such as the oil shock in the 1970s, the dollar appreciation in the 1980s, the dot-com and housing booms in the 2000s and the high domestic aggregate demand (Hlatshwayo and Spence, 2014),[20] all of which contributed to a relative increase of the non-tradeable sector.

All of this re-emphasizes the discussion in Section B, which has highlighted that many factors other than trade have been boosting the non-tradeable sector in the United States over time. For instance, changing demand patterns caused by demographic change and increased incomes favour services over manufacturing. Section C discusses at length the fact that technological change has increased productivity in manufacturing faster than in services and business cycles may be behind short-term deviations of the general trend like the one in the early 2000s. Moreover, Bernard and Fort (2017) suggest that part of the manufacturing decline is due to a statistical misconception, because certain US firms are counted as wholesalers despite the fact that they are increasingly involved in the production of goods, with Apple Inc. serving as a prime example. By re-classifying these firms as manufacturers, up to two million jobs can be shown to have switched from services to manufacturing in 2007.

Figure D.6: Change in the share of employment in industry and services (1995 to 2011)



Source: ILO (2014a): supporting datasets.

Note: Figure D.6 shows the change in the share of employment in industry (in percentage points) and the change in the share of employment in services (in percentage points) in countries with populations above 4 million. The size of a circle indicates the size of country's population. The income classification is based on the World Bank Country and Lending Groups 2011. Industry includes manufacturing, construction, mining and quarrying, and electricity, gas and water supply. Most data points are concentrated in between the dashed 45-degree lines, which indicate that the change in industry employment was smaller than the change in services employment.

more time constraints than men due to the uneven distribution of work in the household. Therefore, in many economies, women are still employed in low-skill intensive sectors, such as the textiles industry. They are more likely to be employed part-time than men, and, if they own a business, it is more likely to be a small business. These characteristics affect the supply of labour by women and women's participation in the labour market (WTO-WBG, 2015).

There are several ways in which opening up an economy to trade can affect women's participation in the labour market and their remuneration.

First, the traditional trade theory of comparative advantage predicts that opening up to trade increases job opportunities for women and reduces gender wage gaps in developing countries. Given that female workers predominate in less-skilled jobs in developing economies, the traditional Heckscher-Ohlin model predicts employment gains for women in export sectors of developing countries, as countries abundant in low-skill workers specialize in low-skill intensive sectors. Women's participation in the labour force is likely to increase because women represent an important share of the unskilled labour force.

Trade driven by comparative advantage is probably the driving force behind the increase in women's participation in developing countries in the early period of GVCs in the 1980s and the beginning of the 1990s. Trade expansion and the increasing specialization of some developing economies in the textiles industry led to an increased demand for low-skill workers, opening up job opportunities for women. In the Republic of Korea, the share of women employed in manufacturing grew from 6 per cent in 1970 to around 30 per cent in the 1980s and early 1990s. The importance of manufacturing as an employer of female labour in the Republic of Korea

has since declined (to 14 per cent in 2007), but the sector still employs 10 times more women today than in the 1960s (Berik, 2011).

However, to the extent that comparative advantage drives women's empowerment, individual country experiences may differ. Female workers may lose jobs elsewhere in export industries that have experienced an erosion of competitiveness.[21]

Second, economic theory has suggested that trade reduces the incentive to discriminate through its competition effect. Gender discrimination is costly and inefficient. Intensified competition resulting from more open trade reduces the ability of firms to practise wage discrimination against disadvantaged groups (Becker, 1957). There is evidence compatible with this argument. For example, Black and Brainerd (2004) find that the gender wage gap in US manufacturing narrowed rapidly between 1976 to 1993 in initially more concentrated industries that experienced larger increases in competition with trade reform. Other studies support this interpretation (e.g. CEA (2015) for the period 1989 to 2009 in the United States and Klein et al. (2010) for Germany between 1993 and 2007). In a recent study on Norway, Bøler et al. (2015) find that exporting firms have a larger share of female employees and a lower gender wage gap.

However, other studies point to other potential explanations for this trend. One is a composition effect, i.e. a reduction of the wage gap due not to a genuine closure of the gap for the same skill and occupation, but rather due to low-skill female workers exiting the labour force.[22] Other studies point to other confounding factors. For example, in their study on Norway, Bøler et al. (2015) show that women with a third-level education earn higher wages at exporting firms than at non-exporters, but that they are underpaid given their level of skill in comparison to men.

One counter-argument raised to Becker's theory that trade reduces the incentive to discriminate through its competition effect is that longer working hours and the increased need for flexibility required in more competitive environments put women at a disadvantage in exporting firms. Bøler et al. (2015) show for Norway that increasing the length of parental leave available to fathers, thus narrowing the employer's perceived time flexibility gap between genders, has led to a fall in the initially higher wage gap observed in exporting firms relative to non-exporters. This exemplifies how policies can be put in place to maximize the positive effects of trade and manage potentially negative effects on the gender gap.

A third way in which trade can help increase women's participation in trade and share more evenly the benefits of trade is through electronic commerce (e-commerce) and participation in GVCs. Information and communication technologies and e-commerce facilitate access to global markets, including for women, by reducing the transaction costs associated with time and mobility constraints. To the extent that time and mobility constraints are more binding for women, particularly those who have children, e-commerce has the potential to affect the trade gender gap.

E-commerce and GVC participation can also affect the gender gap because they favour small and medium-sized enterprises (WTO, 2016). Female entrepreneurs in developing economies typically run small businesses (ITC, 2016). Therefore, they suffer disproportionally from trade-related fixed costs. E-commerce and GVC participation can help small and medium-sized enterprises to overcome some of the barriers to accessing foreign markets by allowing them access to foreign consumers and distribution networks and enabling them to exploit certain economies of scale they could not otherwise access.

Fourth, trade can affect gender inequality by providing a bigger incentive for schooling. One of the aforementioned features of trade is that it is a skills-intensive activity and thereby increases demand for skills (see Section D.3(a)). By creating higher-skilled job opportunities, trade increases the incentive to acquire education. This can foster women's educational attainment in developing countries. For example, there is evidence that in Indian villages where outsourcing increased employment among women, girls were more likely to attend school than girls in other villages. The expectation that they would get a job in the future worked as an incentive for their current education. In contrast, the probability that boys would attend school was unaffected by trade linkages (World Bank, 2012; WTO-WBG, 2015).

The importance of domestic policies that are complementary to trade liberalization is also apparent; for example, if trade increases the demand for skills, it cannot, for example, increase the likelihood of women receiving education in environments where they do not have access to education.

Trade also provides an incentive to upgrade technologies (see section D.3(a)), and trade-induced technological change can provide opportunities for the empowerment of women. New technologies involve computerized production processes and lower the need for physically demanding skills, which can benefit women. Yet evidence of the effects

of technology upgrading on women's wages and participation in employment is mixed and appears to depend on whether technology affects routine-type occupations (which, according to Autor et al. (2015), affect women negatively) or increased robotization (for which Acemoglu and Restrepo (2017) do not find any significant impact on women) or purchases of computerized machinery and equipment (for which Juhn et al. (2013; 2014) find a positive effect for women).

Overall, there appears to be convincing evidence that trade has so far helped increase women's participation in the labour force and that these new job opportunities are a factor in women's empowerment. However, the evidence of the impact of trade on wage discrimination is less compelling, as some studies point to an increase in wage discrimination brought about by more competition generated by trade.

(ii) What are the specific obstacles that women face?

Women face significant obstacles to trade, resulting in lost opportunities to benefit from trade. The previous subsections have suggested that limited access to education can limit women's access to new employment opportunities offered by trade. Limited access to finance and legislations that may provide incentives to discriminate against women are other factors that limit the ability of women to benefit from increased market access (see Section D.2(c)).

Trade facilitation measures negotiated at the WTO may have a big effect on the gender gap. Women face particular time constraints due to the uneven distribution of work in the household. Therefore, time delays and non-transparent rules and regulations can be particularly burdensome for them, and the transparency fostered by the WTO's trade facilitation can help them to overcome these obstacles. In addition, trade facilitation measures particularly favour small-scale enterprises of the type run by women in certain developing economies (Fontagné et al., 2016).

Given the sectoral structure of their employment, women may also face higher tariff barriers to export. Existing evidence on India shows that women tend to work in sectors that face higher barriers to export in the destination country.

Table D.1 provides an example of tariffs faced in the export markets by women and men in India for different income categories. Table D.1 shows that for the same income category, women in general face higher tariffs than men if they have to export the product they produce, i.e. women tend to work in sectors that face higher tariffs. Although more research is needed to analyse the extent to which this tariff structure is common across countries, existing research on the impact of increased market access on wage and employment (see Section D.2) suggests that addressing these issues may help women to capture a higher share of the gains from trade.

Table D.1: Weekly wage and tariff faced on exports by men and women by decile, India

Wage decile	Weekly wage (Rupees)		Tariff faced (%)	
	Men	Women	Men	Women
1	208	206	20.4	21.7
2	386	382	22.2	22.6
3	529	522	19.9	21.5
4	666	663	19.9	20.2
5	767	744	18.1	21.7
6	934	920	15.8	18.2
7	1,113	1,091	14.7	19.7
8	1,419	1,401	12.0	15.1
9	2,190	2,254	7.8	8.6
10	8,268	8,508	4.6	3.6
Overall	1,675	720	14.4	20.4

Source: Mendoza, Nayyar and Piermartini (2017)

5. Conclusions

Trade increases welfare because each economy's consumers thereby gain access to relatively scarce products that are relatively abundant in another economy. Trade also spurs growth because it pushes countries to specialize. Economic resources are reallocated toward their most efficient utilization. While providing benefits, this reallocation of resources also engenders adjustment costs.

This adjustment can be costly and prolonged due to the presence of labour mobility frictions (such as the costs for workers to switch occupations, industries or regions but also job security legislation), capital mobility frictions or poor macroeconomic conditions.

Furthermore, domestic constraints, such as poor institutions or underdeveloped infrastructure and credit markets, can prevent the expansion of exports. These obstacles make it more difficult for displaced workers to find jobs in the export sector and are likely to have negative repercussions for wages and employment, thereby exacerbating the distributional effects of trade. When market adjustment is impeded, the negative effects of import competition on certain individuals and communities can be large and long-lasting, and workers may experience long periods of unemployment.

There are five key messages to retain from the review of the evidence provided in this section.

First, evidence consistently shows that the welfare gains from trade are considerably larger than the costs. Effects on aggregate employment are minor and tend to be positive. The net effect on welfare depends on the magnitude of adjustment costs and trade gains. But existing evidence evaluates costs to be just a fraction of the gains.

Second, the debate over the labour market effects of import competition needs to be qualified. While some manufacturing jobs may be lost in some local labour markets, other jobs may be created in other zones or in the services sector. When researchers take these effects into account their findings suggest a positive overall effect of trade on employment. Similar results are found when input-output linkages are taken into account or when the response of the labour supply to increased real wages is accounted for. Clearly, those who lose jobs because of import competition are not necessarily the same workers who get new jobs in exporting firms, because they are likely to have different skillsets or limited labour mobility. These adjustment costs need to be taken into account, but without losing sight of the overall picture.

Third, there is evidence that export opportunities are associated with employment growth. In developing countries, improved access to foreign markets has contributed to the movement of workers away from agriculture and towards services and manufacturing, as well as away from household businesses toward firms in the enterprise sector, and away from state-owned firms toward private domestic and foreign-owned firms. Although more should be done to understand how labour markets in least-developed countries (LDCs) are affected by trade opening, there is evidence that the involvement of LDCs in GVCs has been a vehicle for developing employment opportunities.

Fourth, trade offers opportunities for better-paid jobs. A significant share of jobs is related to trade, either through exports or imports, and both exporters and importers pay higher wages. This is because trading is a skills-intensive activity. International trade requires the services of skilled workers, who can ensure compliance with international standards, manage international marketing and distribution, and meet the demanding standards of customers from high-income countries; and trade leads to the selection of more productive firms and provides firms with an incentive to upgrade their technology. There is evidence that better access to foreign markets benefits exporting firms and thus their workers. This in turn positively affects regions where these firms are located, as well as occupations that are intensively used by these firms.

As regards the evidence on the impact of trade on wage dispersion, there is evidence that by increasing the demand for skills, trade contributes to wage differences between high- and low-skilled workers. This change in relative wages can motivate more workers to acquire the required skills, increasing the skill supply and thus making the increase in wage differences only temporary. Access to relevant education and active labour market policies that include the upskilling and reskilling of workers have an important role to play in ensuring a fast adjustment. It is also worth noting that most of the existing analysis fails to account for the fact that most of the gains from trade opening come through a reduction in prices. Workers are also consumers. Trade impacts their wellbeing not only through changes in the wage received, but also through changes in the price of the goods that they consume. Given that most of the gains from trade opening through the consumption channel accrue to lower-income groups, failing to account for the income-group specific price changes overestimates the impact on wage disparity.

Fifth, trade has played a significant role in creating jobs for women in many countries. This has proved

essential to achieve some of the United Nations' sustainable development goals, such as the reduction of child mortality and universal education. But trade has also increased competitive pressure in the job market and this has sometimes been reflected in increased wage gaps between the genders, due to the disadvantages women face in many societies.

In conclusion, trade opening need not produce net losers, if individuals are compensated. The next section will look at what policies can be adopted to ensure that the opportunities that trade provide are distributed more widely.

Endnotes

1 The share of jobs supported by exports in total employment is strongly related to the ratio of exports to GDP but it also depends on the labour intensity of exporting industries. Therefore, an economy with a relatively low exports-to-GDP ratio and labour-intensive exports can have the same share of export-supported jobs in total employment as an economy with a relatively high exports-to-GDP ratio that is specialized in capital-intensive industries.

2 See Schank et al. (2007) for a survey of the existing literature; also see Dai and Xu (2017) for China, Munch and Skaksen (2008) and Hummels et al. (2014) for Denmark, Bernard and Wagner (1997), Arnold and Hussinger (2005) and Schank et al. (2010) for Germany, Hahn (2005) for the Republic of Korea, Fariñas and Martín-Marcos (2007) for Spain, Hansson and Lundin (2004) for Sweden, and Greenaway and Yu (2004) for the United Kingdom.

3 This is compared to firms in the same industry, with the same number of employees and the same share of white-collar workers.

4 Note that the actual results would in fact equally be consistent with an increase of 2.4 million jobs in the United States. For instance, it is possible that employment in regions that are not in direct competition with Chinese imports, like Wisconsin, benefits from increased Chinese imports because they reduce average prices and thus raise disposable income, which translates into higher demand. While this channel is equally present in more exposed areas, it might be counteracted there by the closure of firms due to import competition, leading to a zero net effect on the local number of jobs. The interpolation from relative regional effects to absolute nationwide effects depends completely on the underlying assumption of how the least exposed labour market has reacted.

5 A relatively detrimental effect does not tell us anything about level effects. The evidence discussed here does not indicate whether both import-competing and exporting sectors expanded (but the exporting sector more), contracted (but the exporting sector less), or whether one expanded (exporting) and one contracted (importing). Moreover, a relatively detrimental employment impact in import competing sectors does not mean that imports hurt the economy or even overall employment. For instance, imports are solely responsible for the price-decreasing effect of trade which benefits everyone and, in particular, poorer individuals. It also allows input-importing firms to expand and thus might increase overall employment.

6 It is important to re-emphasize here the findings of our discussion in Section D.2(a), i.e. that while most of the local labour market studies cannot inform us on nationwide effects, they are well-equipped to provide evidence on the cross-regional disparities that we discuss here.

7 Note that the most exposed industries are usually industries that enjoyed the highest rates of protection before liberalization, which suggests that sectors that are protected for too long fail to develop adjustment mechanisms. This phenomenon is discussed in more detail in Section D.3(c).

8 This is because skills acquired in the tradeable sector may not match with the skills required in the non-tradeable sector.

9 A similar mechanism is proposed as an explanation for the decreasing labour share related to trade openness. High-productivity firms tend to be not only more skill-intensive but also more capital-intensive. Expansion of these firms at the expense of low-productivity firms then can lead to increased capital intensity at the industry level and consequently into a decrease in the labour share of income (Autor et al., 2017).

10 See ILO and WTO (2017) for a detailed exposition of the interaction between trade, skills demand and skills supply.

11 Non-production (or white-collar) manufacturing workers are those employed in activities that are not directly related to manufacturing production.

12 For a more detailed exposition of the literature that estimates the impact of offshoring on workers, see Hummels et al. (2016).

13 The MERCOSUR Agreement was signed in 1991 by Argentina, Brazil, Paraguay, Uruguay and the Bolivarian Republic of Venezuela.

14 Caselli and Wilson (2004) report that OECD countries account for over 90 per cent of the worldwide total expenditures on research and development (R&D) which illustrates the point that less developed economies engage in deep innovation only marginally.

15 They focus on imports of R&D-intensive capital goods that are likely to embed advanced technologies.

16 The intuition behind this is that high-tech capital often substitutes less-skilled workers and that, at the same time, the operation and service of such capital requires relatively high-skilled workers.

17 For a recent review on trade and poverty, see the report by the World Bank Group and World Trade Organization (WBG-WTO, 2015). This report also discusses the obstacles faced by the poor when attempting to capture a larger share of the gains from trade.

18 Based on the revealed comparative advantage index calculated using the TiVA database.

19 One explanation for this correlation is, for example, that when women have the opportunity to work, they may also get higher education and better healthcare for their children.

20 If the economy is near full employment, an elevated demand crowds out tradeable sectors. This is because tradeable goods and services can be sourced from abroad, while non-tradeable goods and services cannot (Hlatshwayo and Spence, 2014).

21 Kucera and Milberg (2000) found that over the period from 1978 to 1995, women in OECD countries working in import-competing industries such as textiles, garments, footwear and leather goods, suffered disproportionate job losses.

22 In Mexico, over the period between 1990 and 1995, higher export orientation was associated with a narrowing of the gender wage gap, but results differ by period and export sector under consideration (World Bank, 2012). In the Republic of Korea, greater openness had little impact on or even widened the gender gap (World Bank, 2012). Kongar (2007) shows for the United States that the reduction in the gender wage gap was due to the departure of low-skilled female workers rather than to a decline in wage discrimination against female workers.

E Policy responses to labour market adjustment and distributional changes

If the economy is to benefit from technological change and trade, workers will often have to change jobs or occupations, a process which may cause dislocation for workers. The more smoothly this process takes place in the labour market, the lower the adjustment costs for displaced workers and the greater the net gains to society from technological change and trade. Governments and other institutions can make the labour market more responsive to economic change through a range of measures that are targeted primarily at, but not focused exclusively on, the labour market. Reducing the costs of adjustment for workers can also lower public resistance to technological change and prevent the rise of trade protectionism.

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Some key facts and findings

- A combination of adjustment, competitiveness and compensation policies is necessary in order to maximize the benefits to society of technological changes and trade openness.
- Adjustment policies are usually intended to promote economic efficiency, assist those adversely affected by economic change, and maintain political support for trade openness.
- Active labour market policies, employment protection and compensation schemes can help to alleviate labour market dislocation arising from economic change. The balance needed between these measures varies according to the political, social and economic circumstances of the country concerned.
- Compared to industrialized countries, a larger share of the workforce in developing countries is employed in the informal sector, in agricultural work and in state-owned enterprises. Adjustment programmes in developing countries need to take into account the particular challenges that arise from those sectors.
- Self-employment and the informal sector can provide an important buffer for workers who lose their jobs in formal employment.
- Policies focusing on improving infrastructure, credit markets and education opportunities can make an economy more resistant to economic shocks and more receptive to opportunities created by technological change and trade.
- In addition to mitigating the costs of adjusting to economic change, should governments adopt measures to address how the consequences of trade and technological change are unevenly distributed? There is little support for the view that trade-opening and globalization hinder the capacity of governments to adopt such measures.

The first part of this section discusses the main types of domestic policies that countries have implemented to make the labour market more flexible and to mitigate the costs of adjustment to economic shocks. This is followed by a discussion of competitiveness-related policies that allow workers and firms to take better advantage of the opportunities offered by technological change and trade. Given that these economic changes sometimes leave some workers worse off in the long run even when they find new employment, the section goes beyond adjustment and competitiveness-related measures to discuss the role of compensation policies.

1. Labour market adjustment policies

This subsection discusses labour market policies intended to assist workers affected by economic change and the rationale for these adjustment policies. It develops a framework for examining these policies and discusses some of the issues that have been raised in the trade or economic literature on countries' experiences with these programmes.

(a) Rationale for adjustment policies

We begin by exploring the reasons why governments may want to intervene in the economy, and in labour markets in particular, to respond to the impacts of technological change or trade.

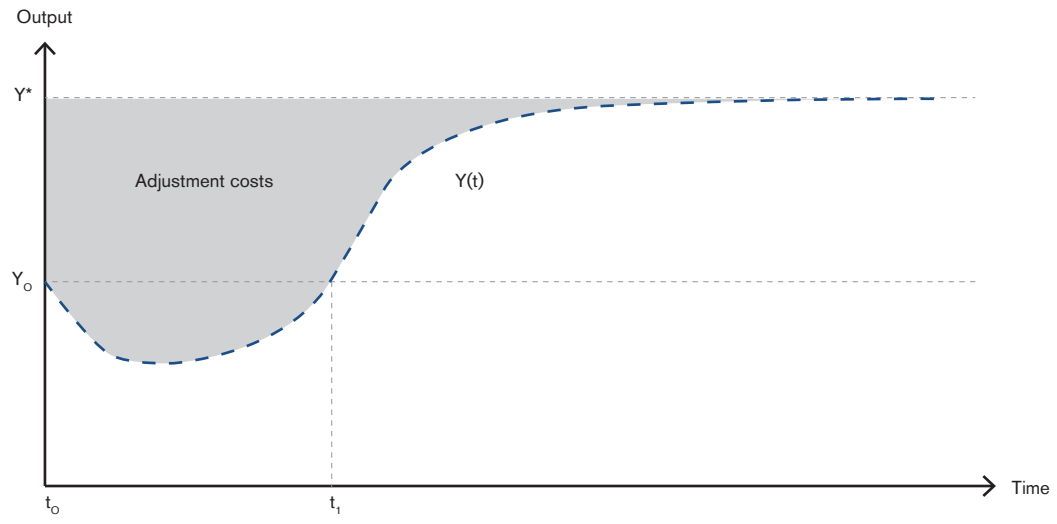
(i) Efficiency

Adjustment policy refers broadly to measures taken to lower the cost of reallocating resources, in particular labour, as a result of technological change or greater trade competition. As was discussed in Section B, there may be frictions (arising from skills mismatches, lack of geographical mobility, etc.) that impede the ability of the economy, and in particular that of the labour market, to effect a swift and smooth transition to a new equilibrium. Market failures in credit and insurance markets, a lack of information about jobs, and inadequate infrastructure can also hamper adjustment. The costs that arise from these problems of adjustment reduce the benefits that a society obtains from technological progress or more open trade. In effect, adjustment policies should aim to make the labour market and the economy in general function more efficiently in responding to economic changes (Magee, 2001).

Francois et al. (2011) provide a useful way of conceptualizing the adjustment costs to technology changes or trade for the economy as a whole. It is the value of output that is foregone in the transition from the initial pattern of production to the new long-run production pattern because of the time taken to reallocate factors from their initial to new occupations.

In Figure E.1, trade liberalization takes place at t_0 and would have resulted in output jumping immediately from Y_0 to the higher value Y^* in the absence of frictions in the labour market. In the presence of

Figure E.1: Adjustment costs path following an economic shock



Source: Francois et al. (2011)

frictions, output will instead follow a path like the dashed curve Y(t), where it first dips below the original output level Y_0 and remains below it for some time before eventually rising above Y_0 at time t_1 and converging to the new equilibrium Y^*. If the "no labour market frictions" scenario is used as the benchmark, adjustment costs would be equal to the present value of the foregone output represented by the area below the line Y^* but above the dashed curve Y(t).[1] This foregone output could also include any resources that are allocated for retraining workers and for job searches.

One limitation of this conceptual approach is that it may not give a full picture of how individual workers fare as a result of an economic shock. Even when the economy converges towards the new equilibrium, some workers may still find themselves with incomes that are lower than what they earned in their previous employment.

Market failures can hinder the reallocation of workers in the aftermath of disruptive technological change or greater import competition, and reduce the benefits that countries can reap from technological progress or trade (see also Section D.3(b), which discusses briefly the factors which make the adjustment process smoother). For example, credit market imperfections can constrain workers from borrowing to open a business, or pulling up stakes to seek opportunities elsewhere, or improving their skills. The faster pace of innovation and an economy's openness to trade may increase the level of employment uncertainty faced by a worker. In ideal circumstances, a risk-averse worker would be able to purchase insurance from the market. But the threat of moral hazard[2] and adverse selection[3] may make private insurers unwilling to provide such insurance, which would then require some form of public intervention. Under these circumstances, the most common form of such insurance is unemployment insurance.

Lack of information[4] on job opportunities can mean that workers remain unemployed even though there are job vacancies in the market. Inadequate infrastructure — of roads, means of transportation and housing — can make it costly for workers to move to be closer to employment opportunities. Under these conditions, government intervention to correct market failures will lower the cost of adjustment and lead to greater net benefits for society.

Box E.1 explains in some detail how the presence of one type of market imperfection — high search costs in labour markets (discussed in Section B) — can create external effects that result in a lower-than-socially-optimal level of job search.

While this discussion implies a strict economic efficiency rationale for adjustment policies, there are likely to be other reasons why governments intervene in the economy and in labour markets to respond to trade or technology changes.

Box E.1: Labour markets with search costs

One way to understand why adjustment programmes can improve economic efficiency is to embed the discussion in the context of a model of the labour market with search costs (Diamond, 1982; Mortensen, 1978; Pissarides, 1979). The basic idea is that workers and firms have to use up scarce resources before they can be matched up and for production to take place (Pissarides, 2000). This is because workers are heterogeneous and not perfectly substitutable, which means retraining will often be needed, and jobs will differ in requirements and in what they pay. Workers may be plentiful in one geographic area whereas jobs may be available elsewhere. Information about jobs and vacancies may also be hard to obtain. A labour market with search costs is marked by spillover effects that are created because firms and workers do not take into account the consequences of their search decisions.

Consider a worker (or a firm for that matter) who decides to increase her/his search activity. This decision will reduce the chances of other workers to find employment, the so-called "congestion" effect, but these negative external effects are not taken into account by the job-seeker (Diamond, 1982). On the other hand, if this more intensive search results in a successful match with an employer, it will remove that employer from the other side of the market, defined as the "thick market" effect, thereby saving society that firm's search costs (Pissarides, 1984). Again, the worker does not take these societal gains into account in her/his decision-making. In general, the market outcome does not necessarily achieve an optimal balancing of these two countervailing effects.

It is possible that more import competition or technological change can result in a situation where the "thick market" effect dominates, which means that neither firms nor workers are searching enough. In this case, governments have a role to play by subsidizing more searches to achieve the efficient level of matching between firms and job-seekers.

(ii) Equity

Society may judge it unfair that some citizens, who are often those less able to bear the cost of adjustment, have to shoulder the cost of more open trade or technological progress while other citizens appropriate the benefits. Adjustment policy offers a way to compensate those who lose out from the economic dislocation caused by trade or technological progress (Aho and Bayard, 1984).

Beyond the mere cost of adjustment, trade and technological progress may result in a permanent reduction in the incomes of some groups and outsized gains to others, worsening the distribution of income. Governments may take steps beyond adjustment policies to reverse some of these distributional effects. Section E.3 looks in more detail at the issue of compensation.

(iii) Political economy

There can be a political dimension to adjustment programmes, particularly in those instances of economic change over which policymakers have some or a great degree of control. For example, a number of theoretical papers have shown that adjustment assistance offered to trade-impacted import-competing workers can facilitate trade liberalization (Feenstra and Lewis, 1994; Fung and Staiger, 1996; Davidson et al., 2007). Fung and Staiger (1996) suggest that the use of adjustment assistance rather than the General Agreement on Tariffs and Trade (GATT) legal escape clauses provides assurance to one's trade partners that tariff reductions negotiated under the trade agreement would not be undone. According to Davidson et al. (2007), adjustment policies increase the likelihood that the median voter will support trade liberalization.[5]

Other political economy models of trade may also lend support to the relevance of adjustment programmes. Olson (1965) observed that the benefits from trade are dispersed among the many while the losses tended to be concentrated on a few. Further, the transaction costs of organizing support for or opposition to trade rises with the number of people who have to be involved. This means the cost-benefit calculus of political agitation favours the few who have a lot to lose but who are less costly to organize to influence political decision-makers. If adjustment programmes are able to target precisely those adversely affected by trade and compensate them adequately, they may succeed in tempering a backlash against trade. Magee (2001) provides some evidence that declines in tariff protection lead to increased certification of workers for adjustment assistance in the United States. However, the econometric estimates Magee obtains are very sensitive to the specification of the model, so in the end he concludes that the evidence of a political economy motivation for adjustment assistance is inconclusive.

It is unlikely that adjustment programmes will have only a single objective and far more likely that they will have multiple objectives, although the weight that policymakers place on any of them may be difficult to determine. Having multiple objectives means that there are bound to be trade-offs that policymakers will face. For example, providing unemployed workers with unemployment benefits (equity objective) may dampen their effort to search for alternative employment and thus slow down the process of reallocation of workers from the import-competing to the export sector (efficiency objective).

Furthermore, there are deadweight costs to raising tax revenues to fund adjustment programmes. This means that even if policymakers only care about efficiency, smoothing the process of adjustment by additional spending on training has to take into account the welfare cost of raising the revenues needed to finance those programmes.

(b) A framework for examining adjustment policies targeting the labour market

While the previous subsection examined the objective(s) of adjustment policies, this subsection looks more closely at the design of the instruments used to achieve those objectives. This subsection presumes that the design of those programmes matters and that it may be possible to determine what elements in isolation or in combination work best. Given the multiplicity of possible objectives, it may at least be possible to characterize the trade-offs that specific designs create. In order to do this, it is necessary to develop a framework for examining adjustment programmes (Brander and Spencer, 1994; Davidson and Matusz, 2006; Blanchard et al., 2013; Lawrence and Litan, 1986; Andersen et al., 2007).

(i) General or specific adjustment programmes

It is sometimes useful to distinguish between general adjustment and specific adjustment programmes. By a general adjustment programme, what is meant is designing labour market, education and social policies so that they help workers to adjust to economic change, no matter what its initial cause may have been. A specific adjustment programme is one meant to assist those workers displaced by a specific type of economic change, such as greater import

competition. Box E.2 gives examples of general and specific adjustment programmes.

(ii) Active or passive labour market policies

Another way to distinguish between adjustment programmes is to determine whether they involve active or passive labour market policies. Active labour market policies aim to increase the likelihood of unemployed workers finding new jobs. Typically, they involve measures such as training or job-search assistance, but they can also include employment incentives, supported employment, and direct job creation (Nie and Struby, 2011). Passive labour market policies do not directly help workers to find jobs, but they do help displaced workers by providing them with financial support. They typically consist of income replacements such as unemployment insurance or early retirement benefits for older workers who are deemed unlikely to find new employment. Passive labour market policies include unemployment insurance, employment protection, minimum wage and other forms of income support. They can complement active labour market policies by providing compensation to those who lose out from economic change.

Active labour market policies increase the efficiency of the labour market by improving its ability to match jobs and vacancies and enhancing the skills of unemployed individuals. Activation strategies provide incentives for workers to increase job search intensity through benefit sanctions or mandatory participation in training or subsidized employment (Boeri and Van Ours, 2008; OECD, 2015a). These strategies have been shown to increase re-employment rates, especially in the cases of those who are hard to place and the long-term unemployed (OECD, 2015a). Additionally, benefit sanctions can help to speed up reemployment (Van Der Klaauw and Van Ours, 2013).

Evidence from Canada (Riddell, 1995) and Sweden (Carling and Richardson, 2004; Forslund and Krueger, 2010) shows that on-the-job training is more effective than classroom training in raising the

Box E.2: European Social Fund and European Globalisation Adjustment Fund

A key component of the Lisbon Strategy, the European Social Fund (ESF) is the European Union's main *ex ante* (in the context of adjustment costs) instrument to promote employment, growth and social cohesion. The main objectives of the programme include promoting sustainable and quality employment and supporting labour mobility; promoting social inclusion and combatting poverty and any discrimination; investing in education, training, and vocational training for skills and life-long learning; and enhancing the institutional capacity of public authorities and stakeholders (Dickinson and Lloyd, 2010).

It tries to create inclusive labour markets by improving access to employment for jobseekers and the unemployed, focusing on the sustainable integration of young people and helping those who face greater challenges in integrating into the labour market and undertaking sustained work. The ESF programs are run by a wide range of "beneficiaries" (public administrations, workers' and employers' organizations, non-governmental organizations, charities, etc.) and the individuals who take part in the programme are known as participants.

The European Globalisation Adjustment Fund (EGF) is the European Union's main *ex post* instrument to assist workers who are affected by changing trade patterns. Its main objectives have been to keep workers in employment or help them regain employment after redundancy by improving their skills and employability using a heterogeneous set of interventions. A non-exhaustive list of the interventions includes providing information to dismissed workers, offering advice and guidance through individual case management, training, recruitment and employment incentives, and promoting entrepreneurship, financial and subsistence allowances.

The EGF is designed to provide workers with support for a limited time period in cases where there have been at least 500 redundancies over a period of four months (nine months in the case of small and medium-sized enterprises, or SMEs) in an enterprise (or its suppliers or downstream producers) in a member state and in small labour markets or under exceptional circumstances. Application to the programme must be made by member states, and the EGF can pay up to 60 per cent of the total cost of any active labour market policies that the member state proposes. The rest of the cost of the programme must be paid for by the state at the local or national level or through private funds. The implementation period for the programme starts from 24 months after the application. Studies evaluating the EGF are discussed in Section E.1(c).

probability of employment. Workers acquire far more skill-enhancing knowledge on the job than in the classroom (Jacobson, 1998). Job search assistance can help the matching process, although recent research suggests that those who for whom jobs are found may do so at the expense of other unemployed workers who do not receive assistance (Crepon et al., 2013).

Studies of the United States show that re-employment bonuses can improve job-finding rates and are more effective when they are targeted towards workers instead of employers (Woodbury and Spiegelman, 1987). Additionally, they are cost-effective when targeted at the potentially long-term unemployed (O'Leary et al., 2005). In the case of wage subsidies, payments made to workers are shown to be more effective than those paid to employers (Dickert-Conlin and Holtz-Eakin, 2000).

(iii) Ex post *and* ex ante *adjustment policies*

Another important distinction between adjustment programmes relates to the time dimension. Adjustment programmes may be *ex ante*, that is, they can be activated even in advance of the economic dislocation, or they can be *ex post*, which means the assistance will only be made available after the economic damage has occurred. Box E.2 compares the European Globalisation Adjustment Fund (EGF), an *ex post* programme, with the European Social Fund (ESF), an *ex ante* programme.

(iv) The wider context

Finally, there is research to suggest that it would be a mistake to examine adjustment programmes in isolation from the wider political, social, economic and perhaps international context of the country. This interaction between the adjustment programme and the wider context means that successful outcomes are not explained solely by the nature of the adjustment programme but also depend on the degree of trust and confidence that the various sectors of society have in one another (Blanchard et al., 2013). For instance, Andersen et al. (2007) discuss how the Nordic model for adjustment programmes relies on a feeling of trust and a sense of fairness among the citizens of a country. Box E.3 discusses the Danish flexicurity model.

To take the notion further, that the wider context matters in facilitating adjustment, one can look at the trend for the private sector to adopt socially responsible behaviour. Corporate social responsibility (CSR) encompasses economic, legal, ethical and discretionary expectations that society has of particular organizations at a given point in time

Box E.3: The Danish flexicurity model

The Danish flexicurity model involves three main pillars (Andersen et al., 2007): (i) a comprehensive welfare state with an emphasis on transfers to households and publicly provided social services financed by high taxes; (ii) a lot of public and/or private spending on investment in human capital, including child care and education as well as research and development (R&D); and (iii) a set of labour market institutions that include strong labour unions and employer associations, significant elements of wage coordination, relatively generous unemployment benefits and a prominent role for active labour market policies.

These three elements are expected to work together to create:

- a flexible labour market (the "flex" part of flexicurity) with employers able to hire and fire workers quickly depending on economic circumstances;
- unemployment security (the "security" part of flexicurity) in the form of a guarantee for a specified level of unemployment benefits to workers who lose their jobs; and
- a system of active labour market policies to help unemployed workers get guidance, education and ultimately a new job.

While the Danish model, and more broadly the Nordic model, is held up as a success story in dealing with the effects of trade opening, its effectiveness is often attributed to societal idiosyncrasies, i.e. a feeling of trust and sense of fairness prevalent in society (Andersen et al., 2007). The combination of flexibility and security together with collective risk-sharing by citizens and institutions might be a unique product of contemporary Nordic societal norms and values.

(Carroll, 1979). There are international standards and initiatives related to CSR, such as the SA8000 (1998) certification, issued by the International Organization for Standardization (Kitzmueller and Shimshack, 2012) and based on human and labour rights. Another prominent standard is the OECD's Guidelines for Multinational Enterprises. The SA8000 certification represents a new form of private governance of working conditions made jointly by companies, labour unions and non-governmental organizations (Hiscox et al., 2008). Currently, over 2 million employees in about 4,000 facilities are certified under the standard.

CSR-labour market relations are often analyzed in a theoretical framework of information asymmetry involving adverse selection and moral hazard (Kitzmueller and Shimshack, 2012). There may be different types of workers, those who work hard and those who shirk, between whom hiring firms may not readily be able to distinguish. Hence, firms have to expend resources to screen potential employees, while job applicants also need to use resources to signal their type to the firms. Greening and Turban (2000) show that CSR can act as a positive signal to attract a quality workforce. Additionally, a firm perceived as high in social responsibility may face relatively few labour problems, and public-private cooperation (as discussed earlier) has been shown to be very effective for the design and implementation of training programmes. Brekke and Nyborg (2004) argue that CSR can reduce moral hazard in the labour market and can act as a screening device for firms that want to attract motivated agents. These results are consistent with Stigler's (1962) classic insight that non-monetary conditions of employment can enable firms to pay lower wages and still attract good workers.

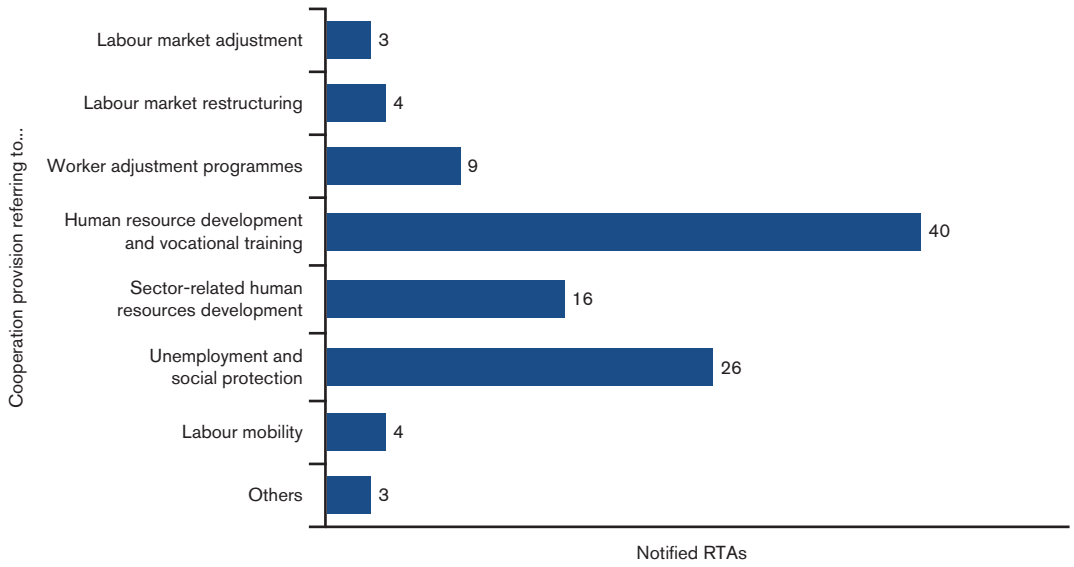
International context: labour-market adjustment provisions in regional trade agreements

There is also an international context to consider. Since the use of adjustment measures can have an impact on other countries through trade, trade agreements sometimes include provisions on adjustment measures.

Regional trade agreements (RTAs) are sometimes considered as a laboratory in which countries establish new provisions and address new trade-related issues and challenges. A review of the 280 RTAs currently in force and notified to the WTO as of June 2017 suggests that only a limited number of agreements incorporate explicit provisions referring to labour market adjustment, as shown in Figure E.2. Although the language differs between agreements, all of these provisions identify labour market adjustment as an area of cooperation. Most of these provisions are found in the RTA's chapter on labour.[6] Some relevant provisions are, in certain cases, also included in the RTA's chapter on cooperation or in a side agreement on labour cooperation.

The RTAs to which the European Union is a party with the Caribbean Forum (CARIFORUM), Georgia and the Republic of Moldova are the only notified agreements explicitly to mention "labour market adjustment". In particular, both agreements negotiated with Georgia and the Republic of Moldova identify labour

Figure E.2: Cooperation provisions related to labour market adjustment in RTAs



Source: WTO Secretariat based on WTO RTA database

market adjustment, human resources development and lifelong learning, and social protection as potential areas of cooperation in the context of the trade-related aspects of the International Labour Organization's (ILO) Decent Work Agenda.[7]

The RTA between the European Union and CARIFORUM also refers to labour market adjustment in two provisions. First, the parties agree to seek advice from the ILO on, among other things, the use of effective policy tools for addressing trade-related social challenges, such as labour market adjustment. Second, the parties agree to cooperate, including by facilitating support, in educational and awareness-raising programmes, including skills training and policies for labour market adjustment. In a Joint Declaration on Development Cooperation, the parties further recognize the important adjustment challenges that the implementation of the agreement will pose, in particular to smaller economies among the CARIFORUM states.

Instead of referring to labour market adjustment, the RTAs negotiated by the European Union with the former Yugoslav Republic of Macedonia, Montenegro and Serbia specify that social cooperation shall focus on upgrading job-finding and careers advice services, providing back-up measures and promoting local development to assist industrial and labour market restructuring. The RTA between the European Union and Algeria also explains that alleviating the adverse impact of the adjustment of economic and social structures is one of the priority measures for social cooperation. Similarly, the RTAs to which the European Union is a party with Jordan, Morocco and Tunisia state that economic cooperation shall focus primarily on sectors suffering from internal difficulties or affected by the overall process of liberalization of the developing party's economy, in particular trade liberalization.

Another approach adopted by the RTAs to which the United States is a party with the Kingdom of Bahrain, Chile, Colombia, the Republic of Korea, Morocco, Panama and Peru is to list worker adjustment programmes, along with unemployment assistance programmes and human resource development and life-long learning programmes as potential cooperative activities. The RTA between Chile and Colombia and the memoranda of understanding on labour cooperation negotiated by China with Peru and New Zealand incorporate a relatively similar provision. A related provision found in both US RTAs negotiated with North America (Canada and Mexico) and Chile stipulates that the institution established under the agreement shall or may prepare background reports setting out publicly available information supplied by the parties on various topics, including human resource development issues, such as training and adjustment programmes.

The identification of provisions related to labour market adjustments is, however, not always straightforward. In fact, several other agreements identify human resource development programmes as an area of cooperation, without explicitly mentioning the terms "labour market adjustment" or "worker adjustment programmes". This is the case of the US RTAs negotiated with Singapore, Central America and the Dominican Republic, and Panama. The two latter agreements also mention the development of programmes to promote new employment opportunities and workforce modernization, including employment services, as another potential area of cooperation.

A relatively similar provision mentioning labour market policies, including measures promoting employability, vocational training, skills development and the unemployment insurance system, is found in several agreements, including the RTA between Switzerland and China, and that between Singapore and Costa Rica, as well as in the memorandum of understanding on labour cooperation associated with the Trans-Pacific Strategic Economic Partnership. More recently, the RTA between the European Union and Ukraine defines a number of objectives for cooperation on employment, such as promoting labour market conditions combining flexibility with security, supporting active labour market measures and improving the efficiency of employment services to match the needs of the labour market.

While provisions on human resource development are found within an article in most RTAS, a few agreements, such as the RTA between Australia and Singapore and the RTAs to which Japan is a party with Malaysia, the Philippines, Thailand and Viet Nam, incorporate a cooperation chapter or section dedicated to education and human resource development with detailed provisions specifying the areas and forms of cooperation. Some of the agreements negotiated by Japan also establish a subcommittee or working programme on education and human resource development in charge of various specific tasks, including exchanging views and information and making recommendations.

In other agreements, some of the cooperation provisions promoting human resource development are specific to certain sectors. For instance, the RTAs to which Japan is a party with Mongolia and Singapore, and the RTA between the European Union and South Africa, identify the development of human resources with advanced knowledge and skills in information and communication technologies as an

area of cooperation. Other similar provisions found mostly in agreements signed by Japan, the European Union and the Common Market for Eastern and Southern Africa (COMESA), focus cooperation on the development of human resources in agriculture, forestry and fisheries, energy, the manufacturing industry, textiles, transportation, financial services, health care and tourism. For instance, the RTA between the European Union and Jordan gives special attention to cooperation on vocational training for industrial restructuring. A few agreements, such as the RTAs negotiated by China with Chile and Costa Rica, include another cooperation provision referring to the development of human resources and management skills in small and medium-sized firms in order to increase the knowledge of their respective markets.

Other cooperation provisions potentially relevant to labour market adjustments are specific to one or a couple of agreements. For instance, the labour cooperation agreement negotiated by China and Chile in parallel to their RTA stipulates that the parties shall carry out mutually agreed cooperation, including on globalization and its impact on employment. Another provision found in the agreements on labour cooperation to which Canada is a party with Colombia and Peru refers explicitly to labour mobility.[8] In particular, the parties recognize the mutual benefits to be gained by enhancing labour mobility, and they commit to exploring avenues for reaching this objective by (i) exchanging labour market information to enhance worker and employer awareness of labour needs and labour force availability, (ii) facilitating public-private sector partnership initiatives regarding labour market intermediation, and (iii) facilitating initiatives allowing training institutions to develop tailored curricula.

Similarly, the RTA between the European Union and Central America commits the parties to promoting actions and programmes aimed at, for example, creating well-functioning labour markets, extending social protection coverage, exchanging best practices in the field of workers' mobility, and addressing issues relating to the informal economy.

(v) Regional development policies

Section D discusses how in some industrial countries, the labour impacts of trade tend to be concentrated in particular regions and can be quite acute. While enhancing labour mobility is often held up as a good solution to this problem, many workers are often not willing to move for a wide range of reasons. One solution to this could be well-designed regional development policies which would focus on reintegrating displaced workers into the labour force by creating more jobs on-site (see Suedekum, 2017). Such programmes could involve direct subsidies to firms as well as infrastructure investment. Suedekum (2017) has suggested there is evidence that some types of place-based policies deliver quite well, including the relocation of large public agencies to depressed areas, which in turn triggers local multiplier effects. Among other benefits, such policies can increase social solidarity and reduce disparities in important indicators of well-being between regions.

There are many existing regional development programmes but they generally have broader objectives beyond supporting job creation. In the case of the European Union's regional policy for example, other goals include "business competitiveness, economic growth and sustainable development" (European Commission, 2015). However, the labour market and training and education feature prominently as areas of intervention. Hence, it may be possible to redesign existing regional development programmes so they have a narrower focus on finding employment for displaced workers at their region of residence.

(c) How well have adjustment policies worked?

This section reviews the literature that has examined the labour market outcomes from adjustment policies and attempts to identify what makes for effective adjustment programmes. Although studies of programmes in developing countries are included in this section, most of the evidence is drawn from the experience of advanced economies.

Since adjustment programmes are meant principally, but not exclusively, to reduce the costs of reallocating resources in the aftermath of trade or technological change, they have been evaluated based on the re-employment rates of workers, how much wages have been recovered upon re-employment, the financial costs of running the programme, and whether the programmes meet social cost benefit criteria. However, since there may be equity and political economy rationales behind these programmes, the programmes' success may also be judged by how much they cushion workers from economic losses or blunt calls for restrictions on trade or technological progress.

General programmes tend to show marginally better results in terms of re-employment rates, wage change on re-employment, net financial costs and social benefits. The size and coverage of specific programmes are often very small. For instance, the Trade Adjustment Assistance (TAA) and EGF had budgets of US$ 800 million in 2015 and US$ 153 million in 2014 respectively.[9] Workers are often unaware of the

existence of these programmes (Cernat and Mustilli, 2016; European Commission, 2011a). However, there may be some advantages from a political economy perspective for specific programmes. Finally, it must be noted that the delineation between the specific and the general is often difficult, and that many of the general programmes analysed are highly "specific" along a range of other parameters, such as the sectors targeted, the intended intervention or the geographical region.

(i) General adjustment programmes

Studies of general adjustment programmes suggest that they increase employment prospects for workers, including young or unskilled workers. For instance, the Canadian Earnings Supplement Program was found to increase the number of people who found full-time jobs by 4.4 per cent (Bloom et al., 1999). The sector-specific Austrian Steel Foundation was found to have significantly improved employment prospects and wages for younger participants and low-wage workers (Winter-Ebmer, 2001).

Some general adjustment programmes place a lot of emphasis on training and there is evidence that they have been effective. Sweden's Trainee Replacement Scheme (1991-1997) subsidized employers by 50 per cent for sending employees into training. Workers participating in the programme improved their employment opportunities by 6 per cent compared to workers who did not participate (Sianesi, 2008). Self-employment training was found to be particularly helpful for certain categories of workers. The Growing America through Entrepreneurship (GATE) programme was shown to be effective for promoting the rapid reemployment of unemployed individuals interested in self-employment (Michaelides and Benus, 2012).

These programmes also tend to reduce the duration of unemployment. The Massachusetts Self-Employment Assistance Experiment increased the rate at which project participants started a business, reduced the length of their unemployment and increased their total time in employment, which includes self-employment (O'Leary et al., 2012; Benus, 1994). Mexico's training programme for unemployed workers (PROBECAT) was shown to reduce the mean duration of unemployment for both men and women (Revenga et al., 1994).

The involvement of labour unions and businesses in the adjustment programmes was found to be valuable in some cases. Japan's Employees in Structurally Depressed Industries Law involved getting the government, labour unions and private companies to work closely together to maintain levels of employment and undertake restructuring programmes. Rajan and Takeda (2006) suggest that the joint effort by Japanese managers and bureaucrats to retain older workers was important in the face of the rapid aging of the Japanese population and, consequently, a shrinking labour force.

Finally, one argument that could be made for general adjustment programmes over specific ones can be found in the analysis of the effects of trade shocks in Section D.2(c). It shows that the adverse effects can be felt in sectors or industries that were not directly exposed to trade shocks. Workers who were displaced in those sectors may not be eligible for trade adjustment assistance but would be helped if general adjustment programmes were in place.

(ii) Specific

Trade Adjustment Assistance (TAA) – United States

Since its inception in 1962, the TAA, has gone through many important changes (see for example Rosen (2006) and Alden (2017)). A study of the TAA's effectiveness under the Trade Act of 2002 by the US Department of Labour found: (i) the participants significantly increased their receipt of re-employment services, education and training services; (ii) the participants were engaged in some form of productive activity at about the same rate as the comparison group; (iii) there was heterogeneity in outcomes depending on the characteristics of the participants (younger workers who received training fared better than older workers and workers who did not receive training); and (iv) participants experienced a decline in total income during the four-year follow-up period (D'Amico and Schochet, 2012).

While judged to have provided crucial income replacement, the TAA was found inadequate in increasing employment or wages of participants (D'Amico and Schochet, 2012). This overall finding is reflected in studies that examined how the US TAA worked in the case of the North American Free Trade Agreement (NAFTA). A study by the OECD found that the TAA provided substantial income replacement to workers displaced by NAFTA. However, it failed to appreciably increase employment among trade-impacted NAFTA workers (O'Leary et al., 2012).

The study by D'Amico and Schochet (2012) found that the TAA's net economic benefit to society was negative, a loss of US$ 26,965 per person, but once the possibility of its promoting free trade was considered, the benefits outweighed the losses. This

is consistent with earlier work that finds that unless the political economy rationale is taken into account, there is little reason to prefer a trade-specific programme over a general programme that responds to all sources of displacement (Baicker and Rehavi, 2004). Another dimension that might need to be taken into account is that the TAA has been very important in enhancing social cohesion amongst communities negatively affected by trade and alleviating some of the negative effects of prolonged unemployment in manufacturing areas. This is particularly important since prolonged episodes of unemployment have been linked to poor health outcomes, higher mortality, lower achievements by children of affected workers, and other social ills (Pierce and Schott, 2016b; Davis and Von Watcher, 2011; Autor et al., 2015).

European Globalisation Adjustment Fund (EGF) – European Union

Due to its design, the European Globalisation Adjustment Fund provided benefits significantly later than the actual redundancy periods, so that by the time the benefits kicked in, many of the more mobile workers had already re-entered the labour market. Those who received assistance were therefore predominantly the harder-to-help workers — older workers, workers with fewer skills, and women with household-caring responsibilities. Therefore, given that it mainly targeted harder-to-help participants, the EGF's performance on re-employment and wage change metrics was better than it initially appeared (GHK, 2011).

The EGF was also found to be most effective when it complemented existing national programmes and provided a personalized package of assistance. Success also depended on local economic conditions and supply-side factors. Some of the drawbacks to the EGF identified by the review study included an excessively high original threshold for redundancies, an overly long approval process and non-coverage of temporary and agency workers (GHK, 2011).

Trade Adjustment Assistance (TAA) – Republic of Korea

The Korean TAA program was introduced in 2006 to help businesses and workers that were likely to be adversely affected by the Republic of Korea's negotiation of free trade agreements (FTAs) (Insoo et al., 2016). The programme attempts to improve the international competitiveness of affected firms by providing financing (e.g. loans) and consultancy services on business management and technology. However, in its first four years of operation, only a total of five firms became eligible to receive assistance, probably because of the strictness of the eligibility criteria (Cheong and Cho, 2011). To be eligible for assistance, a firm had to experience a fall of 25 per cent in sale or production due to an increase of imports from an FTA partner over a six-month period. In 2012, the eligibility criteria were lowered to a 10 per cent fall in sales or production.

(d) Some issues to consider based on experiences implementing adjustment programmes

While research into the effectiveness of adjustment programmes is rather limited, a number of substantive issues have been raised based on experiences of implementing these programmes in developed as well as developing and least-developed countries, which may be important to discuss.

(i) Developed country experience

General and specific programmes have their advantages and disadvantages. General adjustment programmes can deal with a wider range of economic shocks but trade-targeted programmes can be cheaper than those that cover all types of shocks (OECD, 2005; Kletzer, 2001). In any case, whether they are general or specific adjustment programmes, the economic literature surveyed above suggests that certain features of these programmes can help improve outcomes.

A significant part of today's anti-trade sentiment is fed by the perception that those who lose out due to economic change are not getting the assistance and support they need. This suggests that not only are more effective adjustment programmes required, but also much better financed ones. The recent joint International Monetary Fund (IMF)-World Bank and WTO report calls for well targeted and adequately financed trade adjustment assistance (IMF et al., 2017). In the European context, calls for more funding for such programmes have been made by the European Commission (2011b) and by Cernat and Mustilli (2016). Nie and Struby (2011) recommend more US investment in active labour market policies. Lawrence (2014) calls for a TAA programme with a more generous wage loss insurance programme. Hufbauer and Lu (2017) suggest sharply improved adjustment programmes to compensate those who lose both from deeper integration and from newer technology.

Another point identified in the literature is that programmes tailored to worker and country specifications appear to perform better. One evaluation of the EGF suggests that it works best

when it is synchronized with national policies and institutions (GHK, 2011). Studies on the Nordic and Japanese approaches to adjustment policy have highlighted the importance of factors such as the "feeling of trust and sense of fairness" within Nordic communities (2007) and the specific community dynamics in Japan (Rajan and Takeda, 2006). In addition, theoretical (Coşar, 2010) and empirical work (Schochet et al., 2012) suggests that consideration of differential worker characteristics is extremely important when designing adjustment schemes to increase efficiency and equity. This may partly be due to the way the programmes affect the incentives of workers to accumulate human capital through education.

A third point raised is the importance of striking a balance among employment protection, levels of compensation and active labour market policies. The specific balance to be struck varies according to the country and the circumstances. As noted above, if political economy reasons or compensating those who lose out from economic change are important considerations, passive labour market policies can be important tools of adjustment as well.

There is some divergence in views about the effectiveness of active labour market policies. A recent survey of studies of active labour market policies in developed countries concludes that, in general, they have not been particularly effective (Crépon and van den Berg, 2016). However, the review also acknowledges that certain active labour market instruments work better than others. For instance, the rate of return from job search assistance services is positive. The authors judge employment subsidies, i.e., subsidies given to employers to entice them to hire more workers, to be only moderately effective. Finally, there are few cost-benefit studies that demonstrate whether these programmes provide a net benefit to society.

On the positive side, if judged on the rate of re-employment of displaced workers, the change in their wages on re-employment, active labour market policies produce better results than passive labour market policies (GHK, 2011; Schochet et al., 2012; Baicker and Rehavi, 2004). Retraining subsidies are successful in reducing inequality (Mileva et al., 2013) and public-private partnerships offer a practical institutional arrangement to implement them. Perhaps not surprisingly, training subsidies are particularly helpful for unskilled and low-skilled workers (Mileva et al., 2013). Some studies find wage insurance programmes effective in increasing incentives for workers to find a new job (Kletzer, 2004).

(ii) Developing and least-developed country experience

A recent survey of evaluations done on developing countries claim that many of their active labour market policies are much less effective than hoped for, as it finds no significant impacts on either employment or earnings (McKenzie, 2017). One reason given is that urban labour markets in developing countries work reasonably well in many cases, with fewer market failures than is often assumed. There are also a number of features in developing economies that differ from those of developed economies. Resources to fund adjustment programmes are limited. There is a greater role for the state, whether in the use it makes of public employment or the presence of state-owned enterprises (SOEs) in the economy. Both the agricultural and informal sectors tend to constitute a large share of total employment. These could lead to important differences in adjustment costs and strategies, including a greater emphasis on agricultural, state-owned enterprises and the informal sector.

Informality

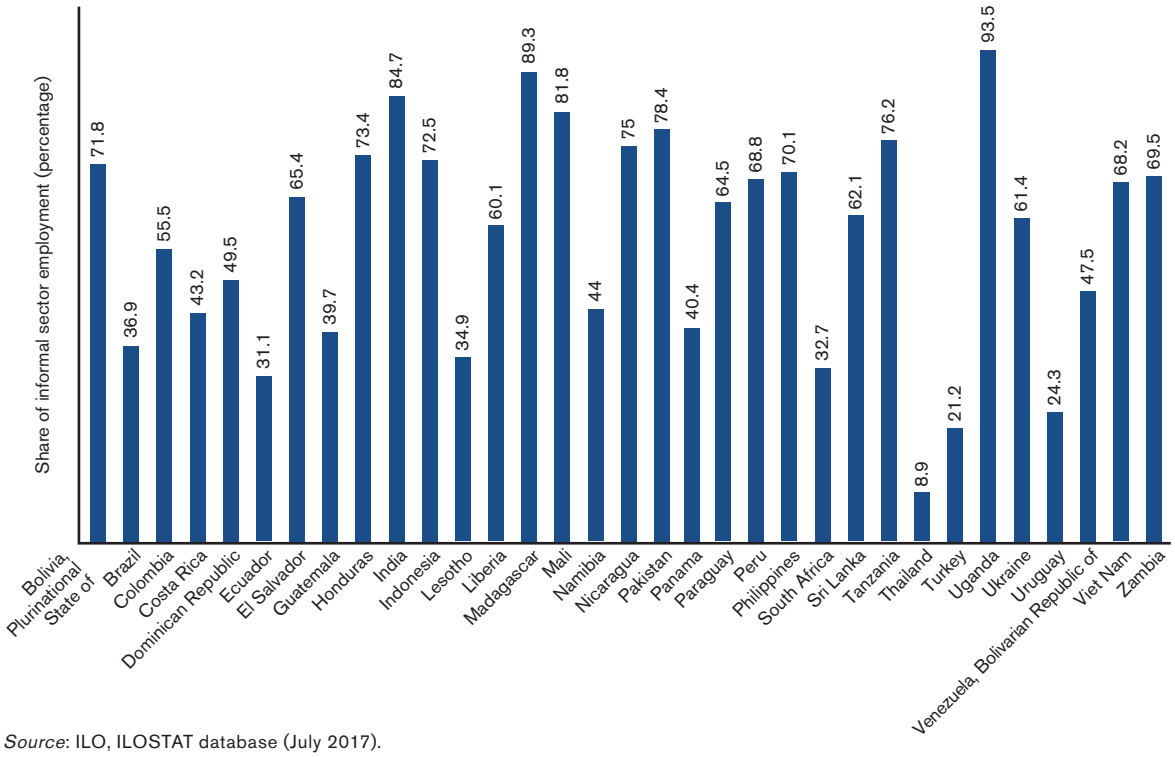
As discussed in Section B, labour markets may be segmented so that wages and conditions of employment can differ in different parts of the market. In many developing countries, this segmentation often manifests itself in a dual labour market — a formal and an informal one. Figure E.3 shows informal sector employment as a share of total employment in a select group of developing countries.[10] The informal sector can provide a crucial adjustment channel in developing countries. It is not necessarily an inferior employment option since it may be sought by those who prefer flexible hours (Goldberg and Pavcnik, 2003).

Public employment and state-owned enterprises (SOEs)

In many developing countries, the public sector (including SOEs) is often significantly larger than the private sector. Thus, policymakers have to be sensitive about the role it plays in the labour market and the consequence it has on adjustment after trade reform and/or liberalization. In the aftermath of trade reforms, countries with large public sectors often have to design compensation programmes for workers who are retrenched due to privatization or the restructuring of SOEs.

Haltiwanger and Singh (1999) have carried out a comprehensive study in a wide range of countries with

Figure E.3: Informal sector employment as share of total employment (2009 to 2015)



Source: ILO, ILOSTAT database (July 2017).

public sector retrenchment adjustment programmes. While the results show great heterogeneity, the authors are able to draw some lessons from them. Programmes that design compensation packages that take into account workers' skills and ages were the most successful. While a multi-dimensional approach is costly, it has a potentially large payoff in productivity gains and lower adjustment costs. Additionally, even though one must be cautious about over-emphasizing financial indicators, since they often do not cover many relevant private and social costs and benefits, such programmes can generate financial savings in the long run from retrenchment even though there is an immediate financial hit from pay-outs made to those workers that are let go (Haltiwanger and Singh, 1999).

Agriculture

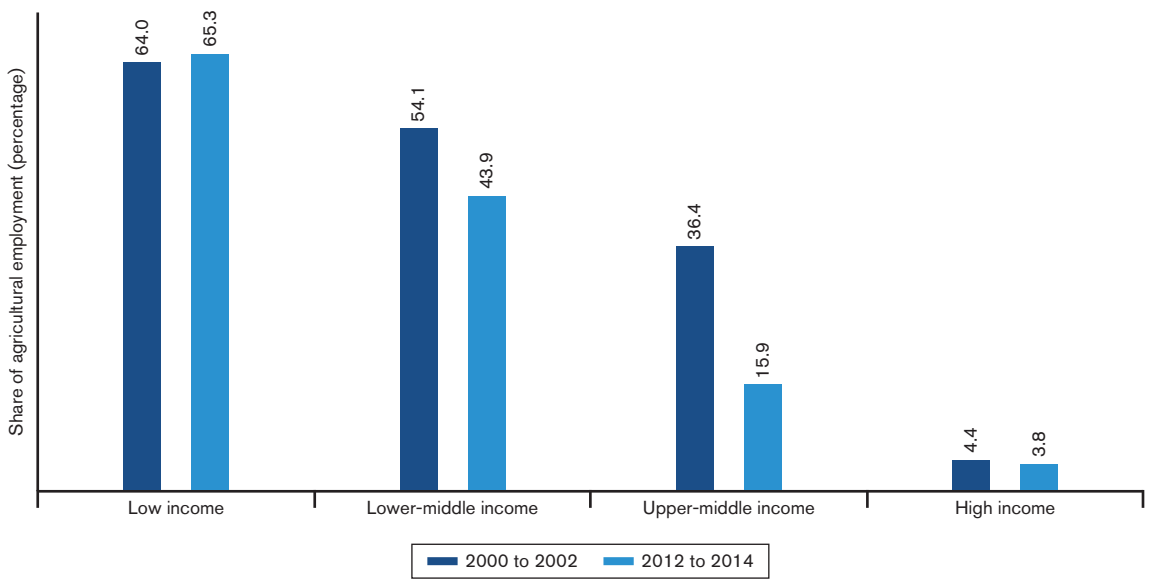
In many developing countries, the agricultural sector still employs a large share of the labour force. Figure E.4 shows agricultural employment as a percentage of total employment by level of income. Since trade reform can lead to serious adjustment costs for the agricultural sector, many developing countries have agriculture-focused adjustment programmes in order to help affected farmers.

An example of a successful agricultural adjustment programme is PROCAMPO in Mexico, which provided a cash transfer per hectare of cultivated land. An independent evaluation of the programme showed that it reduced poverty (Cord and Wodon, 2001). The authors offer a number of possible explanations for the performance of PROCAMPO. By lifting the liquidity constraint faced by farmers or by reducing the risk aversion of the beneficiaries, the programme may have increased household investments and facilitated the choice of riskier investments which have higher rates of return. Alternatively, the programme's income transfers may have stimulated the local economy, raising the demand for local goods and services.

Least-developed country experience

Information on adjustment programmes in least-developed countries is hard to come by, although there are some studies on active labour market policy interventions. The available evidence about the effectiveness of these programmes is mixed. Cho et al. (2013) show that a vocational training programme in Malawi led to enhanced (self-reported) skills of the type the training was supposed to impart, but it did not have any significant effect on labour market outcomes. On the other hand, Abebe et al. (2016)

Figure E.4: Evolution of agricultural employment as a share of total employment (2000 to 2014)



Source: World Development Indicators (July 2017) and authors' calculations.

show that reducing search frictions by lowering the spatial and informational barriers to job searches significantly helped young job-seekers in Ethiopia. Interventions in the form of transport subsidies and formal skill certification for young people largely excluded from the formal labour market helped young job-seekers obtain employment. Bassi and Nansamba (2017), using a field experiment focusing on matching and signalling in the labour market in Uganda, also show benefits from reducing information frictions.

2. Competitiveness-related policies

Measures not targeting the labour market directly can still be extremely helpful in reducing the impact of technology and trade shocks on the labour market as well as preparing the economy to take better advantage of the opportunities offered by technological change and openness. In this section, they will be categorized as "competitiveness-related policies" although the distinction between them and adjustment policies may sometimes be blurred. In fact, some studies can actually classify them together with adjustment policies (see for example Bacchetta and Jansen (2003) and IMF et al. (2017)). Although it is true that, as Krugman (1994) argues, firms and not countries compete, competitiveness can nevertheless be a concern in those sectors of the economy where producers face international competition (Alden, (2017). Policies that increase competitiveness can make the economy more responsive and facilitate labour reassignments from contracting to growing industries, particularly in the tradeables sector. Some of these competitiveness-related policies lead to an outward shift in the demand for labour while others help expand the supply of certain types of workers or skills that are in demand in the market. Examples of these policies include more investments to increase levels of education and skills, more infrastructure spending, improvements in the functioning of financial markets, and trade policies.

(a) Education policies

The rationale for investing in more education is based on the observation that the higher an individual's education level, the better appears her/his performance in the labour market. The basic explanation behind this is that additional education and experience enable workers to adjust more rapidly to changes in economic circumstances (Schultz, 1975). Better educated workers have a comparative advantage with respect to adjustment to and adoption and use of new technology. As a result, some have proposed providing education subsidies on the grounds they can thereby improve the ability of workers to adjust to changing labour markets (Blanchard and Willman, 2016).

Better educated workers also appear to suffer from lower incidences and durations of unemployment (Nickell, 1979; Mincer, 1991; Farber, 2004). Riddell and Song (2011) find that higher levels of education

significantly increase the re-employment rates of the unemployed in the United States. Their baseline result is that the probability of re-employment, conditional on being unemployed one year earlier, is about 40 percentage points higher for high school graduates than for those who did not complete high school, with each additional year of schooling leading to a 4.7 percentage point increase in the probability of re-employment.

As was shown in sections C and D, both technological change and trade tend to increase the skill premium. Exporting firms in particular tend to be more productive than non-exporters and are likely to need a lot of skilled workers. While an increase in the skill premium ought to provide the market signal to workers that they should upgrade their level of education and skills, the labour supply response also depends on how easy it is to access educational institutions, educators and trainers, the right mix of academic and vocational programmes, and relevant and up-to-date curricula, given the speed at which technology changes. The public sector can play a pivotal role here to improve or enhance these crucial elements of the educational system.

While the focus of the present discussion is on education policies, skills development or training programmes can be considered, if not part of, at least complementary to them. They have been discussed in Section D.1 in the context of adjustment policies but they could also fall under competitiveness-related programmes (ILO and WTO, 2017). While national governments have a prominent role to play in designing, funding and implementing skills development, there are also examples of local government programmes. There are also notable business-led training programmes that have been demonstrated to help low-skilled young workers acquire the skills to enable them to obtain full-time jobs, such as the "Year Up" training programme (see Box E.4).

(b) Infrastructure policies

The quality, cost and reliability of infrastructure have a far-reaching impact on competitiveness. Among the key sectors in this regard are transport, power and telecommunications, and even housing. These are crucial not only to production but for moving goods, services and peoples within and across national borders and also for acquiring information. The ability of workers and companies to respond to available vacancies and export opportunities and to compete with imports depends on the quality, cost and reliability of the services these sectors provide. Lack of or poor-quality infrastructure can lead to congestion and delays (which can be fatal for firms relying on just-in-time inventory management), intermittent or unreliable power supply, and slow internet connections — all of which add to firms' costs.

Increasing investment to expand the supply and quality of infrastructure is likely to pay dividends for countries. Declining transport costs are estimated to account for 8 per cent of average world trade growth in the post-World War II era (Baier and Bergstrand, 2001). It is estimated that each day of delay incurred by goods in transit is equivalent to an *ad valorem* tariff of 0.6 to 2.1 per cent (Hummels and Schaur, 2013). In the developing world in particular, economies could reduce the unit cost of production by as much as 20 per cent by reducing inventory holdings by half (Guasch and Kogan, 2001).

Making infrastructural services more efficient may also require regulatory reforms. These infrastructure sectors may give rise to one or a few dominant enterprises because these markets are characterized by increasing returns to scale or strong network effects. However, the lack of competition can also increase the cost of infrastructural services, thus making it difficult for domestic producers to be competitive. The regulatory changes to correct

Box E.4: Year Up training programme

Year Up is a private-sector funded training programme that serves more than 3,000 students in the United States every year and aims to get people without university degrees into good jobs. The participants are given six months of training in a classroom and counselling from mentors before the programme connects them with six-month internships in private companies. Year Up also pays students a stipend while they go through the programme. Year Up receives much of its funding from employers.

There is evidence that the programme is effective. An evaluation of Year Up compared participants who were accepted into the programme to a control group who were not. It was found that one year after their training, Year Up participants were earning 30 per cent more than members of the control group. Year Up participants were also more likely to be working full-time than members of the control group.

Source: Adapted from Semuels (2017)

this problem could include privatization of state-owned infrastructure enterprises, curbing anti-competitive practices, and encouraging more new entrants, including foreign enterprises, into these markets. Opening up the infrastructure market to new enterprises also encourages more private investment to augment public-sector investments.

(c) Financial market policies

Credit market imperfections can hamper the competitiveness of domestic firms by raising the cost of borrowing or making it difficult for enterprises to borrow in the first place to finance their expansion or their requirements for working capital. If there are credit constraints, these are likely to be more binding for productive firms than for unproductive firms which are not likely to be looking for financing in any case (Sepahsalari, 2016). As a consequence of the binding constraint, productive firms will find it more difficult to expand. On the other hand, unproductive firms which face a lower cost of keeping their workers because they have less competition for them from more productive firms are less willing to shrink or downsize. Consequently, credit market constraints generate a delay in the reallocation of capital and labour from less productive to more productive firms and make the overall economy less productive.

In addition, a lack of access to trade finance, particularly for SMEs, can severely affect the ability of firms to compete in the international market. Comparing the ability of SMEs and large firms to draw on trade financing, Di Caprio et al. (2016) find that in emerging economies over half of trade finance applications by SMEs are rejected, against just 10 per cent for multinational companies.

Badly functioning credit markets can also hamper the labour adjustment process. Displaced workers who opt for self-employment or workers who decide to advance themselves by going back to school can find it nearly impossible to finance their decision. Problems in the credit market are also likely to be closely associated with difficulties in arranging or refinancing mortgages, thus hampering the geographical mobility of workers.

(d) Trade policies

Trade measures can be used to increase the competitiveness of a country's producers as well as facilitate adjustment.

Negotiating greater market access in foreign markets reduces the trade barriers faced by a country's producers and allow them to sell more to foreign consumers. All things being equal, an expanding export sector is also better able to absorb workers displaced in import-challenged sectors.

If a country is integrated into global value chains (GVCs), reducing one's own import barriers particularly those affecting intermediate inputs, is another way to increase a country's competitiveness in global markets. Imports of intermediate goods are essential to exports in GVCs. Further, if these barriers are reduced in sectors where there is not much domestic production, this need not result in a sizeable displacement of domestic workers.

Trade facilitation reform, through implementation of the WTO Trade Facilitation Agreement (TFA), offers another way to increase a country's competitiveness. Estimates by the OECD indicate that full implementation of the TFA could reduce trade costs globally by between 12.5 and 17.5 per cent.[11] Previous work by the WTO has shown that such a reduction in trade costs could boost global exports by as much as one trillion dollars annually (WTO, 2015).

As noted above, trade measures can also be used to prepare for or facilitate adjustment in labour markets. For countries embarking on greater trade opening, tariffs can be reduced gradually rather than cut immediately, giving workers more time to prepare for the change in policy and to find alternative employment.

If a rise in productivity abroad makes foreign producers more competitive, a temporary increase in protection can buy domestic producers time to adjust. Countries often use trade-contingent measures (anti-dumping, safeguards or countervailing duties) to provide temporary relief to industries suffering from import competition. As Blonigen and Prusa (2015) observe, anti-dumping measures involve a relatively short administrative process and can thus respond fairly quickly to changing economic circumstances. They also find that the frequency of anti-dumping actions is positively correlated with sizeable and increased import competition, as well as poor economic performance by enterprises in the domestic industry. This pattern holds more broadly if one looks beyond anti-dumping to other trade remedies like safeguard and countervailing duty measures (Bown and McCulloch, 2005).

However, the drawback to using temporary trade restrictions is that the country using them foregoes the benefits that more imports can bring. Furthermore, the idea that temporary trade restrictions can help

the adjustment process has found little empirical support. Examining the case of US trade remedies, Bown and McCulloch (2005) discover that in many instances they become sources of market distortions. For instance, they can temporarily increase profitability in the protected industry and draw in new resources. However, since these industries face a long-term decline relative to foreign competition, temporary protection will simply prolong the process of adjustment and increase total adjustment costs.

3. Compensation for permanent income losses

As discussed in the previous sections, the adjustment process through which an economy realizes the efficiency gains of increased trade and technological change may result in permanent income losses incurred by particular individuals. Two questions that arise in connection with this are whether, in addition to the types of measures discussed in the previous sections aimed at mitigating adjustment costs, there is a rationale for governments to take redistributive measures to compensate for any such permanent adverse distributional consequences; and whether the process of globalization of economic activity through trade and capital mobility has affected the ability of governments to apply such compensatory measures.

(a) Possible rationales for compensatory measures

Specifically with respect to trade, one possible argument in favour of redistributive measures to compensate for permanent income losses involves the notion of compensation as it is used in the welfare economic analysis of trade. A basic principle in this context is that since a move toward trade liberalization will typically have distributional consequences, those who are adversely affected must be compensated in order for that move to be considered to result in a gain in overall social welfare. This compensation principle reflects the Pareto criterion, according to which a change enhances the overall welfare of a society if it makes at least someone better off and does not harm anyone.[12]

The question of how compensation measures should be designed in order for trade liberalization to be Pareto efficient has been analysed in the economic literature (Dixit and Norman, 1980; Dixit and Norman, 1986; Davidson and Matusz, 2006). It has been noted that compensation, whether in the form of lump sum transfers or non-lump sum transfers, poses informational requirements that are hard to resolve in practice (Stein, 2016; Kapstein, 2000). Some authors have identified problems that arise in terms of the credibility and political feasibility of such compensation measures (Boix, 2011), and scepticism has sometimes been expressed as to whether existing compensation schemes are adequate to compensate adversely affected individuals for the full extent of the income losses suffered (Scheve and Slaughter, 2007; Alden, 2017). Several recent studies of the optimal design of compensation measures highlight the efficiency benefits of active labour market policies, particularly measures involving the subsidization of employment and of worker retraining (Coşar, 2010; Asatryan et al., 2014; Lechthaler and Mileva, 2014).

Another possible justification often advanced in favour of redistributive measures to address adverse domestic distributional consequences of trade liberalization is based on considerations of equity. Thus, the argument has been made that when society as a whole benefits from a policy change, it is unfair that the costs of that change be borne disproportionately by a subset of its members (Trebilcock, 2014).[13] Magee (2001) provides empirical evidence showing that equity considerations have played a role in decisions regarding the administration of the US trade adjustment assistance programme. Whether this kind of equity argument can justify compensation specific to trade has sometimes been questioned on the grounds that there appears to be little empirical evidence that trade-displaced workers differ systematically from workers adversely affected by other, non-trade-related changes (Aho and Bayard, 1984; Kapstein, 2000; OECD, 2005a; 2005b).[14]

It is sometimes argued that such trade-specific measures to compensate trade-displaced workers can be justified on grounds of equity considerations because they have been harmed by a specific historical government policy of promoting expanded trade (Aho and Bayard, 1984). This raises the question of why compensation should be made available only in relation to policy changes in the area of trade and not in other areas.

(b) The debate on the impact of globalization on the demand and supply of compensation

A question that has attracted much debate, particularly in the literature on the relationship between economic globalization and the welfare state, is whether growing international economic openness increases the public demand for governments to adopt social protection and redistribution measures to address labour market risks, and whether it affects governments' ability to adopt such measures.

The research in this area has produced mixed results. Positions differ as to whether increased openness to the international economy (1) has resulted in an expansion of the welfare state, (2) has led to a retrenchment of the welfare state; (3) has resulted in a convergence of welfare state development across different countries; or (4) has not had any significant effect on welfare state development (Brady et al., 2005; Gemmel et al., 2008; Hays, 2009). To some extent, the inconsistencies can be attributed to differences in methodology, data used and the periods and economies covered. For example, an important methodological difference is that some studies focus narrowly on the impact of *trade* (often operationalized as imports plus exports) on the welfare state, whereas other studies analyze the impact of various dimensions of *globalization*, with trade being considered as one of several indices of economic globalization.[15]

The view that international economic openness causes an expansion of the welfare state is commonly referred to as the compensation hypothesis. According to this view, governments increase social spending to meet voters' demands for social protection against the risks and uncertainty in labour markets caused by increased exposure to the international economy. The idea that there exists a compensatory relationship between growing international economic openness and the growth of domestic social protection is often viewed as a reflection of the compromise of "embedded liberalism" (Ruggie, 1982; Hays, 2009; Burgoon, 2013). The concept of "embedded liberalism" denotes "the idea that there is a more or less universal expectation held by citizens in the developed democracies that their governments will limit the costs and distribute the benefits of open markets through some kind of government spending, and that public support for liberalism depends on the willingness and ability of governments to do this successfully" (Hays et al., 2005). As noted by Hays et al. (2005), the specific form of the embedded liberalism compromise "is both geographically and historically contingent".

Initially, studies purporting to support the compensation hypothesis typically focused on the macro level and attempted to establish a relationship between a measure of an economy's openness and vulnerability to external risk, on the one hand, and a measure of aggregate government spending or social spending, or the composition of government expenditures, on the other.

Thus, based on data covering a large number of developed and developing countries, Rodrik (1998) finds a robust, positive association between an economy's openness, as measured by its share of trade in gross domestic product (GDP), and the scope of its government, as measured by its share of government expenditures in GDP. He explains this result by hypothesizing that more open economies are more exposed to risks emanating from turbulence in world markets and that larger government spending in such economies performs an insulation function in that the government sector is the "safe" sector relative to other activities and especially compared to tradeables. To substantiate this hypothesis, Rodrik provides evidence showing that the relationship between openness and government spending is stronger in economies exposed to greater external risk, as measured by the volatility of an economy's terms of trade and the concentration of its exports.

Several other studies also find support for the compensation hypothesis through an analysis of the relationship between economic openness and the size of government spending, although in those studies the relationship is often qualified by factors such as the nature of the political regime, the quality and effectiveness of domestic institutions, the type of welfare state regime[16] and the type of electoral system.

For example, Adserà and Boix (2002) conclude that the positivity of the relationship between trade openness and government spending in countries depends, among other factors, upon whether a country has an inclusive political regime. Mares (2005) finds that the impact of external openness on the nature of social protection is conditioned by the effectiveness of state institutions, to the extent that, where states are weak, an increase in the level of external risk will not necessarily result in an expansion of social insurance coverage. Hays (2009) argues that a meaningful test of the compensation hypothesis should focus on imports, as opposed to imports plus exports, and finds that there is a positive relationship between imports and government spending. However, this relationship is conditioned by the change in employment structure from agriculture and manufacturing to services and by the overall level of employment in an economy. Accordingly, whether politicians need to respond to surges in imports by increased spending to maintain support for free trade depends upon whether there is a large number of workers employed in tradeable sectors of the economy and on whether the overall economic performance is poor. This implies that in post-industrial, high-employment economies, the effects of imports on spending are smaller in magnitude.

Leibrecht et al. (2011) study the effect of globalization, measured by an index that combines trade and

foreign direct investment with several other variables, on social protection expenditures as shares of GDP in Western and Eastern European countries and find that the compensation thesis is supported only in the case of certain countries in Western Europe with a conservative welfare regime. Menendez (2016) concludes from an analysis of aggregate data on the generosity of active labour market measures in a number of European countries over the period 1980-2010 that the interplay between economic geography and electoral institutions fundamentally influences whether or not increased trade leads to compensation. Specifically, she submits that increasing trade will most likely produce greater compensation when adversely affected workers are concentrated geographically and politicians have electoral incentives to target specific constituencies, as tends to be the case in electoral systems with lower district magnitude, i.e. where electoral districts are small and geographically based. On the other hand, trade dampens compensation in political economies where adversely affected workers are dispersed, and decreases it where electoral districts are larger and losers are concentrated.

Several recent studies have focused on the micro foundations of the compensation argument and purport to provide support for the compensation hypothesis by demonstrating how individuals' perceptions of economic insecurity caused by trade lead to demands for increased social protection (Walter, 2010; 2017) and how compensation has a positive impact on voter's support for open trade (Hays et al., 2005; Hays, 2009; Ehrlich and Hearn, 2014). Rickard (2014) finds support for the compensation hypothesis through a study of US legislators' votes on trade adjustment assistance funding.

The compensation hypothesis has been challenged on various theoretical and empirical grounds. For example, Iversen and Cusack (2000) reject the idea that government spending can be explained as a form of insurance against risks associated with external economic openness. They argue that there is no support for the view that price volatility in international markets is greater than in domestic markets, nor is there evidence that trade concentrates risk. In their view, the growth of government spending and variance in the growth of government spending between different countries can largely be explained by demands for state compensation in modern industrialized societies caused by labour market risks generated by the transition of the employment structure from agriculture and industry to services. Similarly, Kittel and Winner (2002) conclude from their empirical analysis that globalization does not play a decisive role in explaining cross-country differences in government expenditures and that most parts of the dynamics in government expenditures are explained by the domestic environment.

Other studies that have questioned the compensation hypothesis on the basis of a lack of causal relationship between economic globalization and public spending include Dreher et al. (2008), Busemayer (2009) and Meinhard and Potrafke (2012). Moreover, while the compensation thesis assumes that individuals' support for or opposition to increased trade is determined by the distributional effects of trade, there is recent research that highlights the role of non-material cultural factors in determining individuals' trade preferences. Margalit (2012) argues that individuals assess the impact of international economic integration partly in light of the social and cultural changes that they associate with growing economic openness and that measures aimed at compensation and redistribution may therefore be of limited effectiveness.

The view that increased internationalization will result in a retrenchment of welfare states is commonly referred to as the efficiency hypothesis (Scharpf, 2000). It posits that as a result of capital mobility and tax competition, the ability of states to finance social welfare expenditures has been eroded. However, while advanced economies have witnessed important changes in the last two decades in the nature of welfare policies, notably as a result of the shift from social consumption to social investment policies,[17] most recent research rejects the idea that globalization has uniformly resulted in a retrenchment of the welfare state and in convergence along a liberal model (Swank, 2005; 2010; Boix, 2011; Hemereijck, 2013; Beramendi et al., 2015).

Many authors who find that their empirical analysis does not support the compensation hypothesis also explicitly reject the efficiency hypothesis (Dreher et al., 2008; Kittel and Winner, 2002; Meinhard and Potrafke, 2012). Swank (2002) argues that globalization will lead to welfare state retrenchment depending upon a country's political institutions, electoral system and welfare state model. Brady et al. (2005) analyse the relationship between different indicators of globalization and various measures of the welfare state for 17 advanced economies from 1975 to 2001 and conclude that "globalization does not have one overall effect on the welfare state, and what effects it has are most certainly relatively small" and that "[g]iven that it has such small effects, globalization does not necessarily force a welfare state to expand, retrench, or converge."[18]

Overall, it would seem that any effects of economic globalization through trade and capital mobility on welfare state development in advanced economies are outweighed by the importance of domestic factors. This suggests that the extent to which governments act to compensate and redistribute to mitigate any adverse distributional consequences of trade is determined in the first place by countries' internal conditions. There is an extensive literature aiming to explain the trends in, and differences between, the redistribution policies of different welfare state types in advanced economies (Bradley et al., 2003; Kenworthy and Pontusson, 2005; Iversen and Soskice, 2006; 2009; 2015; Huber and Stephens, 2014; Rueda, 2015). This literature indicates that the extent of redistribution has increased in recent decades in all welfare state regimes, albeit to significantly varying degrees, but has not compensated for the increase in market income inequality. As a result, inequality in disposable income has risen.

For example, Huber and Stephens (2014) examine trends in household income inequality and redistribution since 1985, based on Luxembourg Income Study data for 18 post-industrial countries. They find that inequality has increased in all welfare state regime types and that, while the rise in pre-tax and transfer inequality has been accompanied by increasing efforts at redistribution in all welfare state regimes, these efforts have not neutralized the trends towards greater inequality. The inequality in pre-tax and transfer income is largely a function of labour market variables, including overall levels of employment, industrial employment, wage dispersion and union density, the percentage of children living in single-parent households, and education spending. Variations between countries with respect to pre-tax and transfer income inequality are strongly related to welfare state regime type. Regarding redistribution, Huber and Stephens find that unemployment, the percentage of children living in single-parent households, and the generosity of unemployment compensation increase redistribution, and that the total level of employment decreases redistribution.[19] Huber and Stephens also find that the extent of redistribution varies by type of governing party. Regarding the increase of redistribution through time, the authors note that this has been driven by changing needs rather than by a change in redistributive policy profile. The authors find significant differences between economies both in respect of the factors explaining the rise in income inequality and in their efforts at redistribution and investment in human capital (Huber and Stephens, 2014).

Much of the research discussed above on the question of the relationship between international economic openness and welfare state development has focused on developed economies. While findings from several recent studies on this relationship in the case of developing countries would seem to provide more support for the efficiency hypothesis than in the case of developed economies, other research reports findings are consistent with the compensation hypothesis.

Kaufman and Segura-Ubiergo (2001) find, based on an analysis of changes in social transfers and of health and education expenditures in 14 Latin American countries from 1973 to 1997, that trade openness has a negative effect on key components of social security spending and thus that the weight of evidence favours the efficiency over the compensation hypothesis (Kaufman and Segura-Ubiergo, 2001).[20] Haggard and Kaufman (2004) conclude from a review of social spending in Latin America, East Asia and the former socialist countries over the period 1980 to 2000 that there is no support for the contention that trade openness leads to increases in the overall size of the public economy. Wibbels and Ahlquist (2011) argue that in developing countries social insurance arose in a context of protectionist, import-substitution policies.

At the same time, there are also studies that report a positive relationship between openness and social spending in developing countries. Thus, for example, in a study of social spending in 19 Latin American countries based on data for the period 1980 to 1999, Avelino et al. (2005) find that trade openness has "a strong positive and significant association with spending on social security and education" (Avelino et al., 2005). These apparently inconsistent results from empirical analysis may be attributable to the role of factors such as type of welfare regime and political regime, which mediate the effect of openness. Thus, Swank (2010) suggests that the effect trade openness has on social protection in a developing country depends upon the country's political regime. Moreover, an important theme emerging from the literature on the effect of globalization on the ability of governments of developing countries to provide compensation for adverse distributional effects of international trade is that such effects are often addressed through forms of compensation other than social welfare transfers, such as public employment and public work programmes (Mitra and Ranjan, 2011; Rodrik, 2011; Nooruddin and Rudra, 2014; Lim and Burgoon, 2016).

4. Conclusions

Technological progress and more open trade make enormous contributions to economic well-being, but they can also confront firms, and especially workers,

with important adjustment challenges. Governments have a broad array of possible measures to help displaced workers, while at the same time making sure that the overall economy captures as many of the benefits from technology and trade as possible. In this section, these policies have been categorized as adjustment, competitiveness and redistribution policies.

Given the complex nature of policy objectives – a mixture of efficiency, equity and political economy motives – and the wider social and political situations within economies, there is unlikely to be a one-size-fits-all "optimal" package of adjustment measures. At the same time, a number of notable issues have been raised based on the experiences countries have had in responding to economic change. In the case of industrialized countries, these issues include better funding of adjustment programmes, developing programmes that strike a balance between employment protection, levels of compensation and active labour market policies. In the case of developing countries, a number of structural features of those economies — larger share of agriculture, state-owned enterprises and the informal sector in employment and more limited resources available to finance adjustment programmes — also have to be taken into account.

Policies that increase competitiveness — such as more investments in education and physical infrastructure, improving the functioning of financial markets, and trade policies — can make an economy more responsive and facilitate labour reassignments from contracting to growing industries, particularly in the export sector. These measures enhance the capacity of an economy to benefit from technological progress and trade.

Various considerations suggest that, in addition to policies that facilitate adjustment and enhance competitiveness, policymakers also consider measures designed to compensate for possible adverse effects of income loss due to trade or technological changes. Ensuring that such measures are effective is especially important at a time of mounting public concerns in many countries regarding the distribution of the benefits of these changes.

Endnotes

1 Francois et al. (2011) also provide an alternative definition of adjustment cost which is equal to the present value of the foregone output represented by the shaded area below the original output level Y_0.

2 Moral hazard in insurance markets refers to the increased risk-taking by the insured party as a result of knowing that another party, i.e. the insurance company, now bears the cost of the insured party's risky behaviour. Thus a worker who obtains unemployment insurance may theoretically become less diligent when working, in the knowledge that if she or he is fired, she or he would be able to obtain unemployment benefits.

3 Adverse selection in an insurance market occurs when buyers of insurance consist primarily of those individuals who face the highest risk. Insurance companies often find it difficult to avoid the problem of adverse selection because of information asymmetry. The buyer of insurance knows more about her or his own intrinsic risk than does the insurance company.

4 To the extent that information on job opportunities is characterized by non-rivalry in consumption and high costs of exclusion, it is a public good. This makes it very likely that the market is not supplying this "good" in sufficient quantity, i.e. there is a market failure.

5 The median voter theorem is a model of the political process which predicts that if voters rank policies along just one dimension and they all have single-peaked preferences, the policy that will be chosen by a majority vote is that which the median voter would most prefer (Black, 1948; Downs, 1957). Preferences are single-peaked if the choices under consideration can be represented as points on a line, and there is a unique maximum at some point on the line, with preferences sloping away from this maximum on either side.

6 See ILO (2013b; 2016a) for a review of labour provisions in trade and investment agreements.

7 The RTA of the European Union, Colombia and Peru includes a similar cooperation provision but without the references to labour market adjustment, human resources development and lifelong learning.

8 Several RTAs also include provisions related to international labour mobility in the context of the temporary movement of natural persons or free movement of workers. These provisions, however, go beyond the notion of labour market adjustment. For instance, the East African Community Common Market establishes a number of provisions related to the access to employment opportunities, including the collection and dissemination of information on job vacancies. In addition, one of the tasks of the EAC Secretariat is to undertake, in collaboration with the partner states, manpower surveys to determine available skills and gaps in the labour market within the EAC.

9 The original figure for the EGF was in euros. To convert this into US dollars, the conversion rate used was €1: US$ 1.33. This statistic displays the annual exchange rate (average or standardized measure) of the euro to the US dollar according to the data from the European Central Bank, which cover the period from the introduction of the euro in 1999 up until 2016. The average (standardized)

measure is based on the calculation of many observations throughout the period in question. It is therefore different to an annual measure at a point in time, which reflects specific values as of end of the year.

10 In the figure, we use the ILO's definition of the informal sector as "where employment relationship is, in law or in practice, not subject to labour legislation, income taxation, social protection or entitlement to certain employment benefits" (ILO, 2013a).

11 See http://www.oecd.org/trade/tradedev/WTO-TF-Implementation-Policy-Brief_EN_2015_06.pdf

12 A slightly different principle states that a change enhances the overall welfare of a society if the aggregate gains are large enough to enable those who gain from the change to compensate those who are adversely affected and still be better off themselves. According to this principle, trade produces overall gains, in the sense that those who gain can in principle compensate those who are adversely affected, while still remaining better off than before (see, e.g., Krugman et al., (2014). This reliance on hypothetical compensation is known as Hicks-Kaldor efficiency. The application of this principle to international trade has been questioned by a number of scholars, e.g. (Kapstein, 1998; Kapstein, 2000; Driskill, 2012; James, 2012; and Antràs et al., 2016).

13 According to John Rawls' "difference principle", "social and economic inequalities, for example inequalities of wealth and authority, are just only if they result in compensating benefits for everyone, and in particular for the least advantaged members of society" (Rawls, 1999). This principle has not frequently been invoked as possible grounds to justify compensatory measures in the context of trade. It may call for compensation to those adversely affected by trade liberalization but only if they are among the most disadvantaged members of the community (Trebilcock, 2014).

14 Some authors argue that in cases in which, prior to a move towards trade liberalization, workers enjoyed a rent as a result of artificially high prices caused by trade barriers, there may not be an equity-based argument for compensation of any losses incurred by such workers as a result of trade liberalization (Kapstein, 2000; OECD, 2005b).

15 An index of globalization that is very frequently used in research on the relationship between globalization and the welfare state is the KOF Swiss Economic Institute index of globalization. This index covers variables relating to three dimensions of globalization: economic, social and political. The economic globalization indices cover (i) actual flows: trade, foreign and portfolio investment, and income payments to foreign nationals and (ii) restrictions: hidden import barriers, the mean tariff rate, taxes on international trade and capital account restrictions. The KOF index of economic globalization does not include immigration.

16 Studies that examine the role of the type of welfare state regime as a factor mediating the effects of exposure to the international economy commonly use the classification of welfare state regimes originally suggested by Esping-Andersen (1990) or a variation thereon. In *The Three Worlds of Welfare Capitalism*, Esping-Andersen distinguishes between thee clusters of welfare state regimes: a "liberal" model, a "conservative", "corporatist" model, and a "social-democratic" model.

17 As defined in Beramendi et al. (2015), "social consumption" refers to expenditures aimed at immediate income restoration, such as unemployment and disability benefits, whereas "social investment" refers to social expenditures aimed at increasing people's capacity for future earnings, including education, child care and labour market activation.

18 See also Brady et al. (2007).

19 Huber and Stephens (2014) find that measures of globalization are not significantly related to either pre- and post-tax and transfer inequality.

20 See also Rudra (2002) and Segura-Ubiergo (2007).

F. Conclusions

Economic progress involves economic disruption, and there has always been an inherent and unavoidable trade-off between the benefits of growth, on the one hand, and the cost of adjustment, on the other. Today is no exception. The expansion of the global economy – spurred by technological advances and market opening – is enhancing the welfare and improving the living conditions of billions of people around the world. But it is also resulting in economic change, displacement and disruption – creating enormous pressure for individuals and societies to adjust and adapt if they are to keep up with, and share in the benefits of, economic progress.

The 2017 *World Trade Report* has looked at the impact of technology and trade on labour markets in developed and developing countries. It concludes that while technological advance and trade-opening continue to yield enormous benefits for economies overall, they can also adversely affect specific groups and regions – a problem which a number of countries are currently struggling to address. The report also argues that a key source of this problem is the mismatch, or "friction", between the new skills demanded by an increasingly information-driven global economy and the older skill set of many workers – a situation exacerbated by the current pace, scale and scope of economic change.

The report suggests that while technology, more than trade, is driving these changes, the two are interrelated – and that the question of whether job losses are the result of trade or technology risks missing the point that people need more creative and effective help to adjust to economic change, irrespective of its specific causes. The report notes that some economies seem to be adjusting better than others to the challenges, as well as to the opportunities, offered by trade and technology, suggesting that domestic policies and institutions play a key role in helping economies to prepare for economic change by facilitating labour adjustment and sharing benefits more widely.

Success seems to depend on finding an appropriate balance between labour market flexibility, on the one hand, and employment security, on the other. Adjustment programmes, especially active policies aimed at retraining workers, helping them to find new job openings, and assisting them with relocation, can provide people with the necessary support and security, as well as with encouragement and incentives to transition into new opportunities. More comprehensive, wide-ranging investments in education, from the primary to the post-secondary levels, are also critical to prepare individuals to cope with economic change and to take advantage of a more skills- and technology-rich economy.

In addition, redistributive policies aimed at compensating those who have suffered long-term losses from economic change may be necessary to sustain political support for further technological advance and economic openness. We forget at our cost what the architects of the post-war system learned after the economic disaster of the 1930s – namely, that people support economic opening and change only when it benefits them.

Finally, adjusting to economic change is a global challenge that requires a global response. Even if many of today's labour market problems are traceable to domestic policy shortcomings, a failure to find answers can have global ramifications that affect all countries, as history has shown. By providing a forum where governments meet, talk, and negotiate, the WTO – in cooperation with other relevant international organizations – offers an indispensable platform where governments can discuss how best to maximize the benefits of economic change and how best to minimize or mitigate any adverse consequences.

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Technical notes

Composition of regions and other economic groupings Regions				
North America				
Bermuda	Canada*	Mexico*	United States of America*	
Other territories in the region not elsewhere specified				
South and Central America and the Caribbean				
Antigua and Barbuda*	Chile*	El Salvador*	Panama*	Trinidad and Tobago*
Argentina*	Colombia*	Grenada*	Paraguay*	Uruguay*
Aruba (the Netherlands with respect to)	Costa Rica*	Guatemala*	Peru*	Venezuela, Bolivarian Republic of*
Bahamas**	Cuba*	Guyana*	Saint Kitts and Nevis*	
Barbados*	Curaçao	Haiti*	Saint Lucia*	
Belize*	Dominica*	Honduras*	Saint Vincent and the Grenadines*	
Bolivia, Plurinational State of*	Dominican Republic*	Jamaica*	Sint Maarten	
Brazil*	Ecuador*	Nicaragua*	Suriname*	
Other territories in the region not elsewhere specified				
Europe				
Albania*	Czech Republic*	Iceland*	Montenegro*	Slovenia*
Andorra**	Denmark*	Ireland*	Netherlands*	Spain*
Austria*	Estonia*	Italy*	Norway*	Sweden*
Belgium*	Finland*	Latvia*	Poland*	Switzerland*
Bosnia and Herzegovina**	France*	Liechtenstein*	Portugal*	The former Yugoslav Republic of Macedonia*
Bulgaria*	Germany*	Lithuania*	Romania*	Turkey*
Croatia*	Greece*	Luxembourg*	Serbia**	United Kingdom*
Cyprus*	Hungary*	Malta*	Slovak Republic*	
Other territories in the region not elsewhere specified				
Commonwealth of Independent States (CIS), including associate and former member States				
Armenia*	Georgia*	Moldova, Republic of*	Turkmenistan	
Azerbaijan**	Kazakhstan*	Russian Federation*	Ukraine*	
Belarus**	Kyrgyz Republic*	Tajikistan*	Uzbekistan**	
Other territories in the region not elsewhere specified				
Africa				
Algeria**	Congo*	Guinea*	Morocco*	South Africa*
Angola*	Côte d'Ivoire*	Guinea-Bissau*	Mozambique*	South Sudan
Benin*	Democratic Republic of the Congo*	Kenya*	Namibia*	Sudan**
Botswana*	Djibouti*	Lesotho*	Niger*	Swaziland*
Burkina Faso*	Egypt*	Liberia*	Nigeria*	Tanzania*
Burundi*	Equatorial Guinea**	Libya**	Rwanda*	Togo*
Cabo Verde*	Eritrea	Madagascar*	São Tomé and Príncipe**	Tunisia*
Cameroon*	Ethiopia**	Malawi*	Senegal*	Uganda*
Central African Republic*	Gabon*	Mali*	Seychelles*	Zambia*
Chad*	The Gambia*	Mauritania*	Sierra Leone*	Zimbabwe*
Comoros**	Ghana*	Mauritius*	Somalia**	
Other territories in the region not elsewhere specified				

Middle East				
Bahrain, Kingdom of*	Israel*	Lebanese Republic**	Saudi Arabia, Kingdom of*	Yemen*
Iran**	Jordan*	Oman*	Syrian Arab Republic**	
Iraq**	Kuwait, the State of*	Qatar*	United Arab Emirates*	
Other territories in the region not elsewhere specified				
Asia				
Afghanistan*	Hong Kong, China*	Malaysia*	Papua New Guinea*	Timor Leste**
Australia*	India*	Maldives*	Philippines*	Tonga*
Bangladesh*	Indonesia*	Mongolia*	Samoa*	Tuvalu
Bhutan**	Japan*	Myanmar*	Singapore*	Vanuatu*
Brunei Darussalam*	Kiribati	Nepal*	Solomon Islands*	Viet Nam*
Cambodia*	Korea, Republic of*	New Zealand*	Sri Lanka*	
China*	Lao People's Democratic Republic*	Pakistan*	Chinese Taipei*	
Fiji*	Macao, China*	Palau	Thailand*	
Other territories in the region not elsewhere specified				
Regional integration agreements				
Andean Community (CAN)				
Bolivia, Plurinational State of	Colombia	Ecuador	Peru	
ASEAN (Association of South East Asian Nations) / AFTA (ASEAN Free Trade Area)				
Brunei Darussalam	Indonesia	Malaysia	Philippines	Thailand
Cambodia	Lao People's Democratic Republic	Myanmar	Singapore	Viet Nam
CACM (Central American Common Market)				
Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua
CARICOM (Caribbean Community and Common Market)				
Antigua and Barbuda	Belize	Guyana	Montserrat	Saint Vincent and the Grenadines
Bahamas	Dominica	Haiti	Saint Kitts and Nevis	Suriname
Barbados	Grenada	Jamaica	Saint Lucia	Trinidad and Tobago
CEMAC (Economic and Monetary Community of Central Africa)				
Cameroon	Chad	Congo	Equatorial Guinea	Gabon
Central African Republic				
COMESA (Common Market for Eastern and Southern Africa)				
Burundi	Egypt	Libya	Rwanda	Swaziland
Comoros	Eritrea	Madagascar	Seychelles	Uganda
Democratic Republic of the Congo	Ethiopia	Malawi	South Sudan	Zambia
Djibouti	Kenya	Mauritius	Sudan	Zimbabwe
ECCAS (Economic Community of Central African States)				
Angola	Central African Republic	Democratic Republic of the Congo	Gabon	São Tomé and Príncipe
Burundi	Chad	Equatorial Guinea	Rwanda	
Cameroon	Congo			
ECOWAS (Economic Community of West African States)				
Benin	Côte d'Ivoire	Guinea	Mali	Senegal
Burkina Faso	The Gambia	Guinea-Bissau	Niger	Sierra Leone
Cabo Verde	Ghana	Liberia	Nigeria	Togo
EFTA (European Free Trade Association)				
Iceland	Liechtenstein	Norway	Switzerland	

European Union (28)				
Austria	Denmark	Hungary	Malta	Slovenia
Belgium	Estonia	Ireland	Netherlands	Spain
Bulgaria	Finland	Italy	Poland	Sweden
Croatia	France	Latvia	Portugal	United Kingdom
Cyprus	Germany	Lithuania	Romania	
Czech Republic	Greece	Luxembourg	Slovak Republic	
GCC (Gulf Cooperation Council)				
Bahrain, Kingdom of	Oman	Qatar	Saudi Arabia, Kingdom of	United Arab Emirates
Kuwait, the State of				
MERCOSUR (Southern Common Market)				
Argentina	Brazil	Paraguay	Uruguay	Venezuela, Bolivarian Republic of
NAFTA (North American Free Trade Agreement)				
Canada	Mexico	United States		
SADC (Southern African Development Community)				
Angola	Lesotho	Mauritius	Seychelles	Tanzania
Botswana	Madagascar	Mozambique	South Africa	Zambia
Democratic Republic of the Congo	Malawi	Namibia	Swaziland	Zimbabwe
SAFTA (South Asia Free Trade Agreement)				
Afghanistan	Bhutan	Maldives	Pakistan	Sri Lanka
Bangladesh	India	Nepal		
WAEMU (West African Economic and Monetary Union)				
Benin	Côte d'Ivoire	Mali	Senegal	Togo
Burkina Faso	Guinea-Bissau	Niger		
Other groups				
ACP (African, Caribbean and Pacific countries)				
Angola	Côte d'Ivoire	Guyana	Nauru	Somalia
Antigua and Barbuda	Cuba	Haiti	Niger	South Africa
Bahamas	Democratic Republic of the Congo	Jamaica	Nigeria	Sudan
Barbados	Djibouti	Kenya	Niue	Suriname
Belize	Dominica	Kiribati	Palau	Swaziland
Benin	Dominican Republic	Lesotho	Papua New Guinea	Tanzania
Botswana	Equatorial Guinea	Liberia	Rwanda	Timor-Leste
Burkina Faso	Eritrea	Madagascar	Saint Kitts and Nevis	Togo
Burundi	Ethiopia	Malawi	Saint Lucia	Tonga
Cabo Verde	Fiji	Mali	Saint Vincent and the Grenadines	Trinidad and Tobago
Cameroon	Gabon	Marshall Islands	Samoa	Tuvalu
Central African Republic	The Gambia	Mauritania	São Tomé and Príncipe	Uganda
Chad	Ghana	Mauritius	Senegal	Vanuatu
Comoros	Grenada	Micronesia	Seychelles	Zambia
Congo	Guinea	Mozambique	Sierra Leone	Zimbabwe
Cook Islands	Guinea-Bissau	Namibia	Solomon Islands	
Africa				
North Africa				
Algeria	Egypt	Libya	Morocco	Tunisia

Sub-Saharan Africa				
Western Africa				
Benin	The Gambia	Guinea-Bissau	Mauritania	Senegal
Burkina Faso	Ghana	Liberia	Niger	Sierra Leone
Cabo Verde	Guinea	Mali	Nigeria	Togo
Côte d'Ivoire				
Central Africa				
Burundi	Central African Republic	Congo	Equatorial Guinea	Rwanda
Cameroon	Chad	Democratic Republic of the Congo	Gabon	São Tomé and Príncipe
Eastern Africa				
Comoros	Ethiopia	Mauritius	South Sudan	Tanzania
Djibouti	Kenya	Seychelles	Sudan	Uganda
Eritrea	Madagascar	Somalia		
Southern Africa				
Angola	Lesotho	Mozambique	South Africa	Zambia
Botswana	Malawi	Namibia	Swaziland	Zimbabwe
Territories in Africa not elsewhere specified				
Asia				
East Asia (including Oceania)				
Australia	Indonesia	Malaysia	Samoa	Tuvalu
Brunei Darussalam	Japan	Mongolia	Singapore	Vanuatu
Cambodia	Kiribati	Myanmar	Solomon Islands	Viet Nam
China	Korea, Republic of	New Zealand	Chinese Taipei	
Fiji	Lao People's Democratic Republic	Papua New Guinea	Thailand	
Hong Kong, China	Macao, China	Philippines	Tonga	
West Asia				
Afghanistan	Bhutan	Maldives	Pakistan	Sri Lanka
Bangladesh	India	Nepal		
APEC (Asia-Pacific Economic Cooperation)				
Australia	Hong Kong, China	Mexico	Russian Federation	Thailand
Brunei Darussalam	Indonesia	New Zealand	Singapore	United States
Canada	Japan	Papua New Guinea	Chinese Taipei	Viet Nam
Chile	Korea, Republic of	Peru		
China	Malaysia	Philippines		
BRIC				
Brazil	Russian Federation	India	China	
Developed economies				
North America (except Mexico)	European Union (28)	EFTA (Iceland, Liechtenstein, Norway, Switzerland)	Australia, Japan and New Zealand	
Developing economies				
Africa	South and Central America and the Caribbean, Mexico	Europe except the European Union (28) and EFTA; Middle East	Asia except Australia, Japan and New Zealand	

LDCs (least-developed countries)				
Afghanistan	Comoros	Kiribati	Nepal	Tanzania
Angola	Democratic Republic of the Congo	Lao People's Democratic Republic	Niger	Timor-Leste
Bangladesh	Djibouti	Lesotho	Rwanda	Togo
Benin	Equatorial Guinea	Liberia	São Tomé and Príncipe	Tuvalu
Bhutan	Eritrea	Madagascar	Senegal	Uganda
Burkina Faso	Ethiopia	Malawi	Sierra Leone	Vanuatu
Burundi	The Gambia	Mali	Solomon Islands	Yemen
Cambodia	Guinea	Mauritania	Somalia	Zambia
Central African Republic	Guinea-Bissau	Mozambique	South Sudan	
Chad	Haiti	Myanmar	Sudan	
Six East Asian traders				
Hong Kong, China	Malaysia	Singapore	Chinese Taipei	Thailand
Korea, Republic of				
Pacific Alliance				
Chile	Colombia	Mexico	Peru	

*WTO members
**Observer governments

WTO members are frequently referred to as "countries", although some members are not countries in the usual sense of the word but are officially "customs territories". The definition of geographical and other groupings in this report does not imply an expression of opinion by the Secretariat concerning the status of any country or territory, the delimitation of its frontiers, nor the rights and obligations of any WTO member in respect of WTO agreements. The colours, boundaries, denominations and classifications in the maps of the publication do not imply, on the part of the WTO, any judgement on the legal or other status of any territory, or any endorsement or acceptance of any boundary.

Throughout this report, South and Central America and the Caribbean is referred to as South and Central America. Aruba; the Bolivarian Republic of Venezuela; Hong Kong Special Administrative Region of China; the Republic of Korea; and the Separate Customs Territory of Taiwan, Penghu, Kinmen and Matsu are referenced as: Aruba, the Netherlands with respect to; Bolivarian Rep. of Venezuela; Hong Kong, China; Korea, Republic of; and Chinese Taipei respectively.

The data supplied in the World Trade Report 2017 are valid as of 31 July 2017.

Abbreviations and symbols

ADB	Asian Development Bank
CARIFORUM	Caribbean Forum
CEA	Council of Economic Advisors
COMESA	Common Market for Eastern and Southern Africa
CSR	corporate social responsibility
DD	difference-in-difference
EAC	East African Community
EC	European Commission
EGF	European Globalisation Adjustment Fund
EPL	employment protection legislation
EGF	European Globalisation Adjustment Fund
ESF	European Social Fund
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FDI	foreign direct investment
G20	Group of Twenty
GATS	General Agreement on Trade in Services
GATT	General Agreement on Tariffs and Trade
GDP	gross domestic product
GE	general equilibrium
GPT	general purpose technology
GVC	global value chain
ICT	information and communication technology
IFR	International Federation of Robotics
ILO	International Labour Organization
IMF	International Monetary Fund
ISCO	International Standard Classification of Occupation
ISEA	Institute for Spatial Economic Analysis
IT	information technology
ITC	International Trade Center
LDCs	least-developed countries
MENA	Middle East and North Africa
MERCOSUR	Southern Common Market (Mercado Común del Sur)
NAFTA	North American Free Trade Agreement
OECD	Organisation for Economic Co-operation and Development
PE	partial equilibrium
PPF	production possibility frontier

PPP	purchasing power parity
R&D	research and development
RBTC	routine biased technical change
RTA	regional trade agreement
SBTC	skill-biased technical change
SME	small and medium-sized enterprise
SOE	state-owned enterprise
TAA	Trade Adjustment Assistance
TFA	WTO Trade Facilitation Agreement
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
US	United States
WBG	World Bank Group
WEF	World Economic Forum
WTO	World Trade Organization

The following symbols are used in this publication:

…	not available
0	figure is zero or became zero due to rounding
-	not applicable
US$	United States dollars
UK£	UK pound

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WTO members

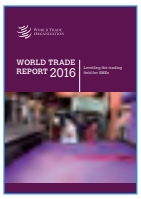
(As of 1 August 2017)

Afghanistan
Albania
Angola
Antigua and Barbuda
Argentina
Armenia
Australia
Austria
Bahrain, Kingdom of
Bangladesh
Barbados
Belgium
Belize
Benin
Bolivia, Plurinational State of
Botswana
Brazil
Brunei Darussalam
Bulgaria
Burkina Faso
Burundi
Cabo Verde
Cambodia
Cameroon
Canada
Central African Republic
Chad
Chile
China
Colombia
Congo
Costa Rica
Côte d'Ivoire
Croatia
Cuba
Cyprus
Czech Republic
Democratic Republic of the Congo
Denmark
Djibouti
Dominica
Dominican Republic
Ecuador
Egypt
El Salvador
Estonia
European Union
Fiji
Finland
France
Gabon
The Gambia
Georgia
Germany
Ghana
Greece
Grenada
Guatemala
Guinea
Guinea-Bissau
Guyana
Haiti
Honduras
Hong Kong, China
Hungary
Iceland
India
Indonesia
Ireland
Israel
Italy
Jamaica
Japan
Jordan
Kazakhstan
Kenya
Korea, Republic of
Kuwait, the State of
Kyrgyz Republic
Lao People's Democratic Republic
Latvia
Lesotho
Liberia
Liechtenstein
Lithuania
Luxembourg
Macao, China
Madagascar
Malawi
Malaysia
Maldives
Mali
Malta
Mauritania
Mauritius
Mexico
Moldova, Republic of
Mongolia
Montenegro
Morocco
Mozambique
Myanmar
Namibia
Nepal
Netherlands
New Zealand
Nicaragua
Niger
Nigeria
Norway
Oman
Pakistan
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Poland
Portugal
Qatar
Romania
Russian Federation
Rwanda
Saint Kitts and Nevis
Saint Lucia
Saint Vincent and the Grenadines
Samoa
Saudi Arabia, Kingdom of
Senegal
Seychelles
Sierra Leone
Singapore
Slovak Republic
Slovenia
Solomon Islands
South Africa
Spain
Sri Lanka
Suriname
Swaziland
Sweden
Switzerland
Chinese Taipei
Tajikistan
Tanzania
Thailand
The former Yugoslav Republic of Macedonia
Togo
Tonga
Trinidad and Tobago
Tunisia
Turkey
Uganda
Ukraine
United Arab Emirates
United Kingdom
United States of America
Uruguay
Vanuatu
Venezuela, Bolivarian Republic of
Viet Nam
Yemen
Zambia
Zimbabwe

Previous World Trade Reports

Levelling the trading field for SMEs

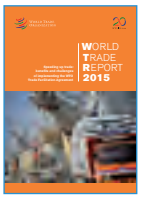
2016



The *World Trade Report 2016* examines the participation of small and medium-sized enterprises (SMEs) in international trade. It looks at how the international trade landscape is changing for SMEs and what the multilateral trading system does and can do to encourage SME participation in global markets.

Speeding up trade: benefits and challenges of the WTO Trade Facilitation Agreement

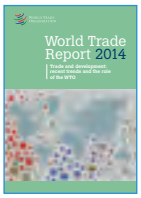
2015



The WTO Trade Facilitation Agreement (TFA), agreed by WTO members at the Ministerial Conference in December 2013, is the first multilateral trade agreement concluded since the establishment of the WTO in 1995. The 2015 *World Trade Report* is the first detailed study of the potential impacts of the TFA, based on a full analysis of the final agreement text.

Trade and development: recent trends and the role of the WTO

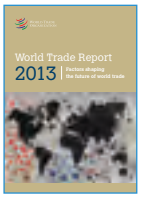
2014



The *World Trade Report 2014* looks at four major trends that have changed the relationship between trade and development since the start of the millennium: the economic rise of developing economies, the growing integration of global production through supply chains, the higher prices for agricultural goods and natural resources, and the increasing interdependence of the world economy.

Factors shaping the future of world trade

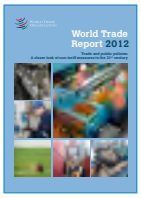
2013



The *World Trade Report 2013* looks at what has shaped global trade in the past and reviews how demographic change, investment, technological progress, developments in the transport and energy/natural resource sectors, as well as trade-related policies and institutions, will affect international trade.

Trade and public policies: A closer look at non-tariff measures in the 21st century

2012



Regulatory measures for trade in goods and services raise challenges for international cooperation in the 21st century. The *World Trade Report 2012* examines why governments use non-tariff measures and services measures and the extent to which these measures may distort international trade.

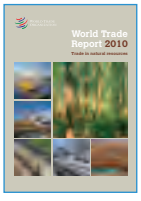
The WTO and preferential trade agreements: From co-existence to coherence

2011

The ever-growing number of preferential trade agreements (PTAs) is a prominent feature of international trade. The Report describes the historical development of PTAs and the current landscape of agreements. It examines why PTAs are established, their economic effects, the contents of the agreements themselves, and the interaction between PTAs and the multilateral trading system.

Trade in natural resources

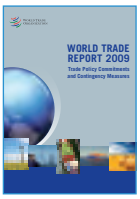
2010



The *World Trade Report 2010* focuses on trade in natural resources, such as fuels, forestry, mining and fisheries. The Report examines the characteristics of trade in natural resources, the policy choices available to governments and the role of international cooperation, particularly of the WTO, in the proper management of trade in this sector.

Trade Policy Commitments and Contingency Measures

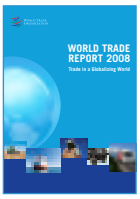
2009



The 2009 Report examines the range and role of contingency measures available in trade agreements. One of the Report's main objectives is to analyse whether WTO provisions provide a balance between supplying governments with the necessary flexibility to face difficult economic situations and adequately defining these in a way that limits their use for protectionist purposes.

Trade in a Globalizing World

2008



The 2008 Report provides a reminder of what we know about the gains from international trade and highlights the challenges arising from higher levels of integration. It addresses the question of what constitutes globalization, what drives it, what benefits it brings, what challenges it poses and what role trade plays in this world of ever-growing inter-dependency.

Sixty Years of the Multilateral Trading System: Achievements and Challenges

2007

On 1 January 2008 the multilateral trading system celebrated its 60th anniversary. The World Trade Report 2007 celebrates this landmark anniversary with an in-depth look at the General Agreement on Tariffs and Trade (GATT) and its successor the World Trade Organization — their origins, achievements, the challenges they have faced and what the future holds.

Exploring the Links between Subsidies, Trade and the WTO

2006

The *World Trade Report 2006* focuses on how subsidies are defined, what economic theory can tell us about subsidies, why governments use subsidies, the most prominent sectors in which subsidies are applied and the role of the WTO Agreement in regulating subsidies in international trade. The Report also provides brief analytical commentaries on certain topical trade issues.

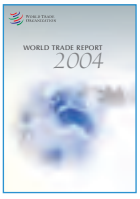
Trade, Standards and the WTO

2005

The *World Trade Report 2005* seeks to shed light on the various functions and consequences of standards, focusing on the economics of standards in international trade, the institutional setting for standard-setting and conformity assessment, and the role of WTO agreements in reconciling the legitimate policy uses of standards with an open, non-discriminatory trading system.

Coherence

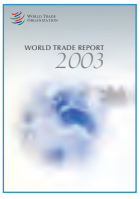
2004



The *World Trade Report 2004* focuses on the notion of coherence in the analysis of interdependent policies: the interaction between trade and macroeconomic policy, the role of infrastructure in trade and economic development, domestic market structures, governance and institutions, and the role of international cooperation in promoting policy coherence.

Trade and Development

2003



The *World Trade Report 2003* focuses on development. It explains the origin of this issue and offers a framework within which to address the question of the relationship between trade and development, thereby contributing to more informed discussion.

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World Trade Report 2017

While the world continues to change at an increasingly rapid pace, questions about the effects on jobs and wages of technological advances and trade – two of the most powerful drivers of global economic progress – have gained prominence in the debate about the impact of globalization. What are the effects of technology and trade on labour markets? Are all benefitting or are some being left behind by globalization and advances in technology? What are governments already doing and what else could they do to ensure that trade and technology are as inclusive as possible?

The *World Trade Report 2017* examines how technology and trade affect employment and wages. It looks in particular into the part played by technology and trade in the shift of employment from manufacturing to services, in the decreasing proportion of middle-skilled jobs, in the growing value placed on skills within the jobs market and in the increasing participation of women in the workforce. It analyses the challenges for workers and firms in adjusting to changes in labour markets and how governments can facilitate such adjustment to ensure that trade and technology are inclusive.

The Report finds that labour markets have evolved in many different ways across countries, suggesting that country-specific factors play a pivotal role. It also finds that although technological advances and trade have yielded important benefits for economies overall, certain types of workers and/or regions may sometimes be adversely affected. It also finds that, although interrelated, technology more than trade appears to be responsible for the decreasing share of manufacturing jobs and for the declining number of middle-skill jobs relative to low- and high-skill jobs. The Report concludes that helping workers adjust to changes in the labour market and ensuring that benefits are spread more widely can increase the positive impact of open trade and technological progress.

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Cover image: A robotic production line in a factory in Barcelona, Spain.
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