EU Monitor
Digital economy and structural change

Digital structural change and the welfare state in the 21ˢᵗ century

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While digitalisation does promise significant additional prosperity, it also threatens to lead to higher inequality. Many observers fear that it might have a significant negative impact on the demand for labour. This, in turn, might push numerous people into poverty, who would then require state welfare.

A major automation wave or increasingly capital-intensive production would reduce the overall wage share and raise corporate and capital income. If technology does indeed create mass unemployment, we might be in for serious economic, social and political disruptions.

Digitalisation brings both opportunities and risks for the welfare state. If policymakers remain in control and succeed in raising adequate taxes on digitalisation profits, the digital structural change might make government finances more sustainable. In particular, the additional revenues might help to fund the ageing-related fiscal burdens, which are already looming in many countries.

If, however, labour is broadly replaced by capital and technological progress leads to mass unemployment, the government will need to re-think the financial basis of the welfare state. This unfavourable scenario might result in great budget gaps, as, assuming that effective corporate tax rates stay low, additional corporate tax revenues will not be sufficient to offset the drop in revenues from wage taxes and social security contributions and fund higher welfare spending at the same time.

According to our scenario analysis, the EU countries would, on average, have to deal with a huge annual fiscal deficit of c. 7% of GDP if automation reduced employment to half its current level. In Germany, the largest EU country, the fiscal gap might even amount to almost 10% of GDP. And even if employment declined less, say by 25%, the average deficit in the EU countries would still come to a very high 3% of GDP. Even if the average wage level of the remaining employees rose on the grounds of increased productivity, the welfare states would nevertheless be in for major financing problems. Assuming that average wages rose by 30% and employment was halved, the deficit would still amount to a very high 6% of GDP.

It is uncertain how digitalisation will affect the demand for labour and the public finances. As long as there are no clear, definite signs that machines and robots are replacing human labour, it is probably better not to make dramatic changes to current tax and social security systems. Nevertheless, governments should try and prepare their countries for the future, for example by paying more attention to education policy and adapting the international tax system to the realities of the 21ˢᵗ century, for example in the field of corporate taxation.
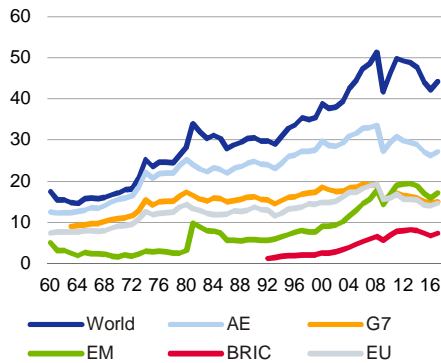
Globalisation and technical progress have led across the globe ...

Trade openness (sum of exports and imports), % of GDP (based on current US dollars)

AE: Advanced economies

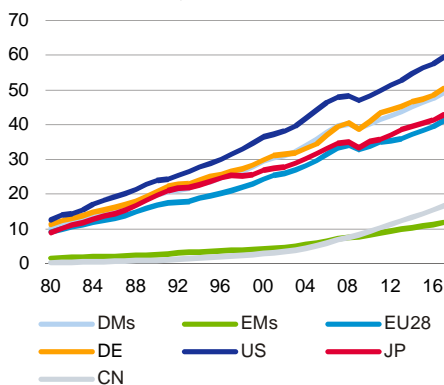Sources: World Bank, IMF, Deutsche Bank Research

... to huge gains in prosperity ...

GDP per capita, '000 current int. dollars (CID) (based on purchasing power parity)

DMs: Developed markets. EMs: Emerging markets.

Sources: IMF, Deutsche Bank Research

... but also went along with rising income inequality

Share of top 1% income recipients in pre-tax national income, %

Sources: World Inequality Database, Deutsche Bank Research

1. Introduction: A blessing or a curse?

After globalisation, digitalisation is the latest development which promises significant future gains in prosperity. However, many observers are afraid that, similar to globalisation, it may divide society into winners and losers and thus become a danger to social peace and put the welfare state's ability to act to the test. Digital structural change offers enormous potential to raise productivity growth, which has recently been quite weak (Chart 8), and may thus pave the way for more prosperity. At the same time, it might intensify the trend towards an unequal distribution of income and wealth within individual countries, which has already come to light during the last few decades due to automation and globalisation (Chart 3). As a result, any prosperity gains might not be for the benefit of society as a whole any more ("inclusive growth"), but only for that of a small group ("exclusive growth"). In fact, top earners' share in national income (which is already high in many countries) might rise further, whereas the shares of medium and lower income earners might continue to decline (Charts 16, 17 and 18).

The curse: A 'polarised society' (aka the horror scenario)

Automation leads to structural mass unemployment, overtaxes the social security system and undermines the welfare state.

Fears that digital structural change might divide society into winners and losers are grounded mainly on technology-related rationalisation trends, which enable companies to produce goods or provide services more efficiently and, in turn, more cheaply as they use automated, "computerised" and/or "robotised" work processes. Human labour is increasingly replaced by capital input (for example robots). As lots of full-time jobs, which are subject to social security contributions, are lost, the financial basis of numerous western welfare states erodes.

Even work which has escaped automation so far because it requires complex thinking and problem-solving abilities might be done by machines in the future, as artificial intelligence (AI) is developing quickly and being deployed on a broad basis. In this case, labour-intensive, service-oriented sectors, such as childcare, nursing or old-age care, might become the only source of employment, as this is where human labour is not so easily replaced by machines. With people starting to move towards these sectors, where they can still find employment, a surplus of labour surplus might push wages downwards.

"Technology-related" mass unemployment would, in turn, weigh on wages for the remaining employees, who might be substituted by machines and equipment. In fact, large chunks of society might be pushed to the brink of poverty, as work done by humans is no longer required. Apart from a small number of highly qualified specialists, human labour would become superfluous, as all routine and even complex cognitive non-routine work would be done by machines and robots.

In this scenario, the majority of the population would have to rely on welfare benefits and need to be content with low and at best stagnating income in real terms (losers of digitalisation). While many people would not have much of a chance to use their education and training do well on the labour market and thus earn higher incomes, a shrinking number of capital owners and specialists, who are still needed and therefore highly remunerated, would become ever more
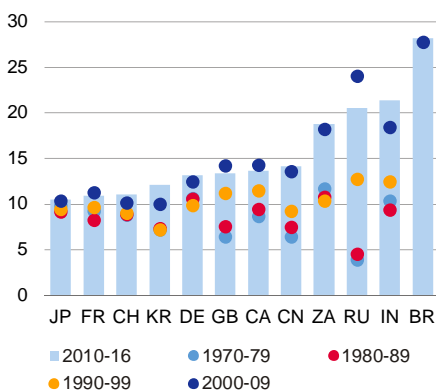
Real GDP per capita has risen significantly in the G7 economies since the early 1980s ... `4`
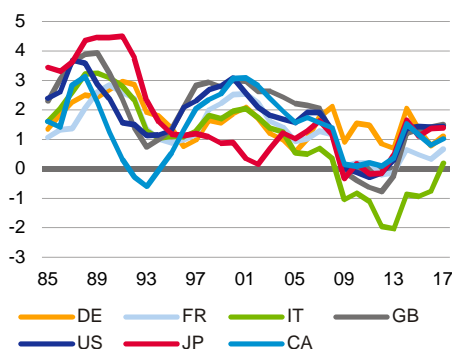
Real GDP per capita, index: 1980=100
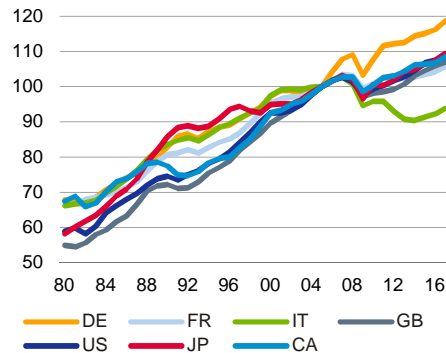
Sources: IMF, Deutsche Bank Research

... though increased only very slowly or even shrunk lately `5`
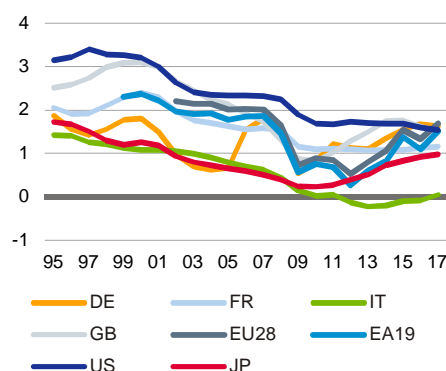
Real GDP per capita, % yoy
(5-year moving averages)

Sources: IMF, Deutsche Bank Research

Potential growth has partly slowed considerabley in developed markets ... `6`

Potential growth rate (real), %

Sources: OECD, AMECO, Deutsche Bank Research

prosperous (winners of digitalisation). Ultimately, the middle classes would vanish and society would be split (polarised).

Only a relatively small number of technology-interested people ("digitalisation avant-garde") would be able to work their way upwards in society. All others would find it highly difficult to become more (or less) prosperous, which means that a key feature of functioning (social) market economies would no longer apply. The consequences would indeed be devastating. In the end, increasing economic imbalances might lead to significant social and political disruptions, as the welfare states would probably be hard pressed to offset inequalities against the background of global and international coordination problems. Populism would benefit further ("swing riots 2.0") and make it even more difficult to form a government than today. This, in turn, would reduce any chance of finding a political solution for the problems.

The blessing: the "goldilocks" scenario (aka the optimal scenario)

Productivity boost creates inclusive growth, counteracts demographic burdens and strengthens the welfare state.

'Digitalisation optimists' point out that technological progress has led to a significant increase in income and prosperity in the past. According to Autor's calculations (2015), an average wage earner in the US had to work only for 17 weeks in 2015 to achieve the real average annual income of 1915. This development is not exclusively, but to a large extent due to technical progress. It is therefore quite possible that digitalisation may help the rapidly ageing societies in many countries (Charts 7, 9 and 28) to increase or at least maintain their income and prosperity in the future. In the best case, a digitalisation-related productivity boost might counteract the ageing-related burdens on growth, the labour markets and the social security systems. In this best possible "goldilocks" scenario, fewer employees and/or working hours will be necessary to generate the same or a higher output. However, as the workforce shrinks, qualified labour becomes scarcer and numerous employees would like to have more spare time, this development appears quite desirable. In many developed countries, lower potential growth rates will soon not be sufficient any more to deal with the demographic burdens on the welfare systems.

A digitalisation-related boost to sluggish productivity growth and a smaller pool of workers might create room for wage increases, in particular since the wage-dampening effect of globalisation might weaken or even reverse, as some important emerging markets (such as China) are ageing dramatically and the workforce shrinks.

Beyond cushioning the demographic funding difficulties, technical innovation and progress related to digitalisation might lead to a slower rise in healthcare and old-age care expenses than currently forecast (for example because advanced medical technology becomes available). Overall, the digital structural change might therefore have a significant favourable impact on countries' prosperity and strengthen or at least support the long-term sustainability of the public finances and the welfare state.

Topic and structure of this report

The key question is obviously: Which of these two scenarios will become reality? From today's vantage point, it is impossible to give a reliable answer. If the downside scenario materialised, the question is to what extent public finances will be hit by the "automation-related" decline in employment and
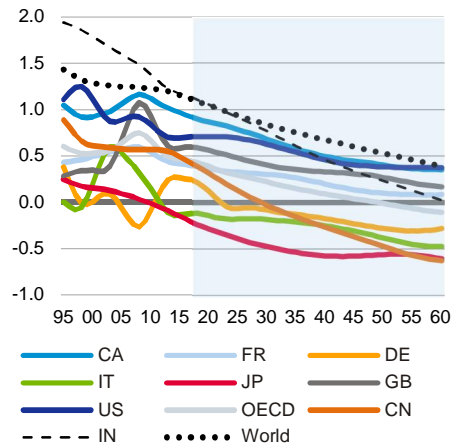
... driven by demographic developments in many countries ...
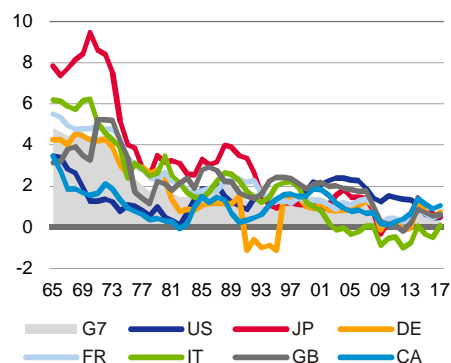
7

Population, %

Medium variant projections by the United Nations

Sources: United Nations, Deutsche Bank Research

... as well as by slow(ing) productivity growth

8

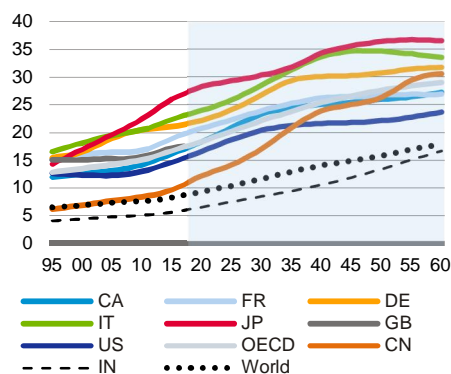Labour productivity index (OECD data), % yoy (5-year moving average)

Sources: OECD, Deutsche Bank Research

Many countries are ageing rapidly

9

Persons aged 65 years or above, % population

Medium variant projections by the United Nations

Sources: United Nations, Deutsche Bank Research

whether the decline in (wage) tax and social security revenues stemming from the decline in employment can be offset by higher corporate tax revenues. Which difficulties might hamper higher corporate taxation in this situation?

The report is structured as follows. We will explain the potential impact of digitalisation on the factor markets (labour, capital) and on revenue distribution in the second part below. The third part will deal with the opportunities and risks which digitalisation brings for the viability of the welfare state in the 21st century. The fourth part contains several downside scenarios with different assumptions, which illustrate how hard the EU countries might be hit from a significant "digitalisation-related" impact on the labour market and how large the fiscal effects may be. The final part will contain the conclusions.

2. The impact of digitalisation on the factor markets and on the distribution of income

Contrary to widespread fears, the potential effects of the digital structural change on future labour demand are not clear. In fact, they are quite uncertain and a topic of heated academic debate. There are two main narratives, one which expects technology-related mass unemployment and a lower standard of living for most people, and one which focuses on the positive effects on productivity and the labour market. Even though digitalisation should increase prosperity overall, it is nevertheless true that the related automation process might increase inequalities in terms of income and prosperity distribution and present major challenges for education and social policies.

The impact on employment: Controversial and uncertain

Some observers believe that technical progress ...

Economists Autor, Levy and Murnane (2003) believe that technical change will enable computers to replace humans not only in cognitive and manual jobs which are subject to explicit routines (substitution effect), but also in non-routine jobs, which involve problem solving or complex communication (complementary effect). This seems to suggest that digitalisation will make some activities redundant (and free up workers) and enable employees to deal with more complex non-routine jobs. However, activities are widely different (labour is not a homogeneous factor), which is why substitution and complementary effects will also be different depending on the group of workers we look at. Moreover, during past automation waves, the input factors labour and capital were imperfect substitutes, which means that (significant) parts of the work process could not (yet) be replaced by machines. However, it is increasingly doubtful whether this assumption will hold true in the era of 'big data', 'deep learning' and AI, which may make it possible to automate cognitive non-routine jobs.

... is the reason for a polarisation of the labour market

Economists Autor and Dorn (2013) suspect that technical progress has already erased numerous industrial routine jobs in the US and that declining prices for information technology have pushed down wages for routine activities. This has led to a structural change on the labour market. While industrial jobs were lost, low-wage services jobs were created. These jobs are less endangered by automation, as it is more difficult to replace humans by machines in the services sector. In addition, technical progress (such as the widespread use of computers) has raised the productivity, the employment ratio and the wages of
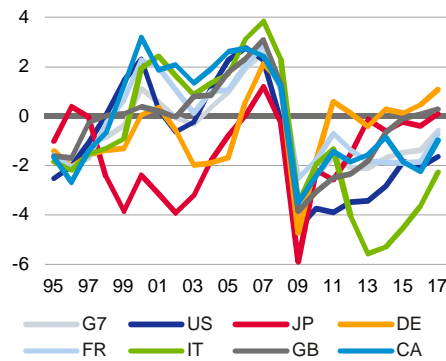
highly qualified workers with well-developed cognitive problem-solving capabilities.

Taking the US as an example, Jaimovich and Siu (2012) found that jobs which require a medium level of qualification and are characterised by routine work are shed during economic downturns and not replaced during recoveries ("jobless recoveries"). This suggests that the labour market is becoming polarised over time, with wages going into different directions. On the one hand, there are highly qualified top earners and on the other, low-qualified low-wage earners. While technical progress makes highly qualified workers more and more productive and valuable for companies (and pushes their wages up accordingly), low or moderately qualified people lose out, as their work can be done more cheaply by machines or computers.

And automation is not the only factor weighing on the employment opportunities and the wages of low and moderately qualified workers in the developed markets. The effect was probably compounded by the fact that jobs were shifted from high-wage into low-wage countries in the framework of globalisation. Taken together, automation and globalisation have led to better and cheaper products for consumers and higher wages for highly qualified workers, but also to lower wages for many employees which have only medium or low qualifications.
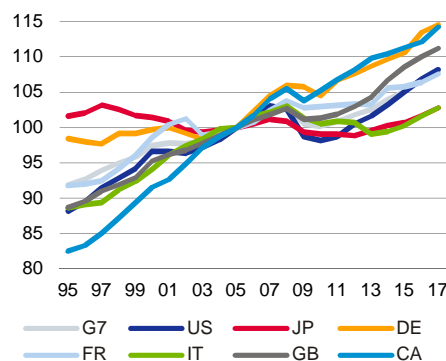
Many economists fear significant job losses from automation

Oxford researchers Frey and Osborne (2013) have asked the pertinent question of what the "work of the future" will look like. Taking the US as an example, they have analysed just how vulnerable current jobs are to further computerisation (i.e. automation by computer-supported or computerised equipment). They found that almost half of all US jobs (47%) were at risk. In November 2015, Andy Haldane, chief economist of the Bank of England, joined the camp of the skeptics. Speaking at a trades union congress in London, he mentioned the "third age of the machine", which might undermine the labour markets and increase income imbalances.[1] Bonin et al (2015) based their analysis on the Frey/Osborne approach and found that roughly 42% of all German jobs might be at risk from technological progress because they are in sectors with a high probability of automation. In return, Pfeiffer and Suphan (2015) have shown where the Frey/Osborne approach meets its limits (Frey and Osborne base their conclusions on the assumption that it is possible to distinguish between routine and non-routine jobs) and argued why this approach might overestimate potentially harmful effects on employment.

Recent studies see favourable overall effect on employment

The Institute for Employment Research (IAB) is more optimistic in its assessment. Zika et al. (2018) found in a study on the labour-market effects of digitalisation in Germany up to 2035 that digitalisation will trigger major structural changes on the labour market (in terms of sectors and types of jobs), but is unlikely to have a major impact on employment as a whole.

Possibly fewer jobs that are subject to social security contributions

Another important question for the labour market and the funding basis of the welfare states is how digitalisation will affect the type of work. Today, most jobs are provided by companies and subject to social security contributions. It is unclear whether this will be the case in the future. As a result of the digital

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Despite fully (or almost fully) utilised production capacities ...   10

Output gap, %

Source: OECD

... and with the jobs engine humming ...   11

Number of employed persons (aged 15 years or above), index: 2005=100
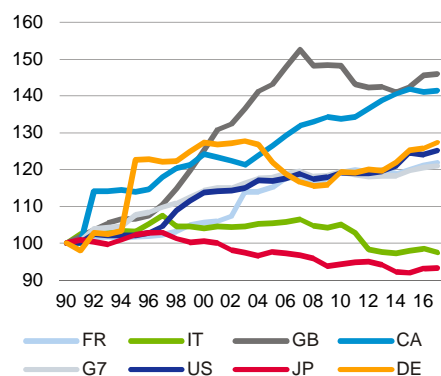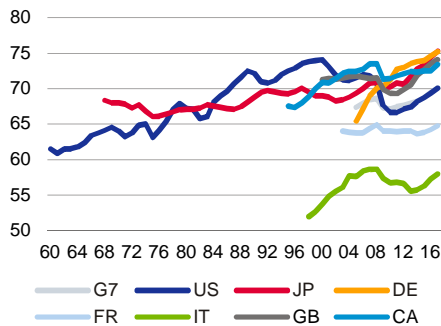

Sources: OECD, Deutsche Bank Research

... wage pressure remains subdued   12

Real compensation of employees per employee, index: 1990=100 (adjusted for inflation)

Sources: OECD, Deutsche Bank Research

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[1] See Haldane, Andy G. (2015).

The labour market situation is currently (still) good ...   `13`
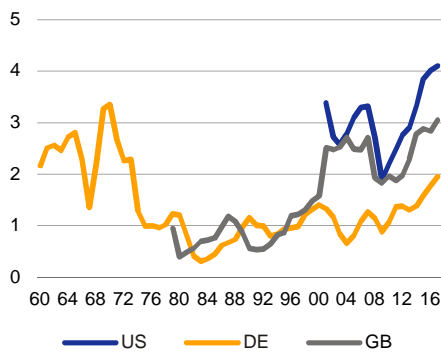
Employment rate*, %

* Employed persons aged between 15 and 64 years as a percenage of the working-age population (15–64 years).

Source: OECD

... and skills shortage remains the more pressing issue at the moment   `14`
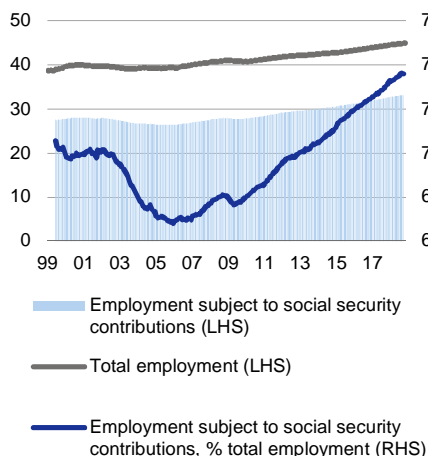
Job vacancies, % employees

Sources: OECD, Deutsche Bank Research

Germany: Employment subject to social security contributions has reached new highs   `15`

Million persons

- Employment subject to social security contributions (LHS)
- Total employment (LHS)
- Employment subject to social security contributions, % total employment (RHS)

Sources: WEFA, Deutsche Bundesbank, Deutsche Bank Research

structural change, work might be done less in the context of a major company. For example, self-employment might increase. This implies that, even if there is no technology-related mass unemployment, the number of jobs which are subject to social security contributions may decline. As a result, the social security systems, which are based on employment in most countries, may run into significant funding problems, unless the government takes measures to counteract this development.

Digitalisation and income imbalances

Beyond the potential effects on employment, the impact of digitalisation on the distribution of income is just as important for social policy. Against the background of automation and globalisation, inequalities in the distribution of income (market income, before taxes) have increased, in some cases significantly, in numerous developed countries over the last few decades, or at least that is what the available data suggest; see for example Piketty and Zucman (2017, 2018a, 2018b).

Based on the World Inequality Database[2] (WDI), which contains time series for the distribution of income and wealth in numerous industrial countries and emerging markets (in some cases with a very long history), top earners' incomes have risen considerably, and not only in absolute, but also in relative terms, i.e. compared to their share in national income before taxes (Charts 16 and 17).

Over the last few decades, income inequalities have increased within individual countries, ...

In the US, the share of the top percent of income earners (market income, before taxes) in national income has risen steadily and considerably over the last few decades, from just above 10% in 1976 to more than 20% in 2014 (latest available data from the WID). The trend is the same for the top 10% of US income earners, whose share in pre-tax national income has increased from an average of c. 35% in the 1970s to 47% in 2014. In contrast, the medium 40% of US income earners, who had a share of more than 45% in annual pre-tax national income in the 1970s and 1980s, dropped to just above 40%. And the share of the bottom 50% of income earners dropped from c. 20% in the 1970s to only 12.5% today (Charts 16, 17 and 18).

Most other developed countries have experienced a similar, if somewhat less extreme, trend. To some extent, France is the opposite of the US. Here, the share of the top 1% (10%) of income earners in pre-tax national income is less than 11% (33%) and the share of the medium 40% or bottom 50% in pre-tax national income is much higher, at 45% and 22%, respectively. However, even if the top 1% (10%) of French income earners get a smaller slice of the cake than their US counterparts, their share in pre-tax national income has increased since the mid-1980s. However, in contrast to the US, the share of the bottom 50% of income earners has risen again since the mid-1990s, whereas it has continued to decline in the US. In China, too, the distribution of income has become considerably more unequal since the late 1970s. However, thanks to China's rapid economic development and strong income growth, bottom and medium income earners have seen their income rise considerably in real terms.
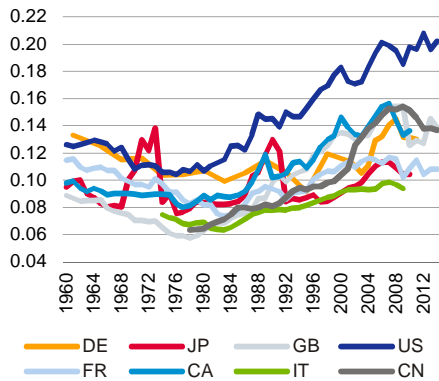
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[2]   See https://wid.world/

The share of top 1% income earners has increased significantly since the 1980s in many countries | 16

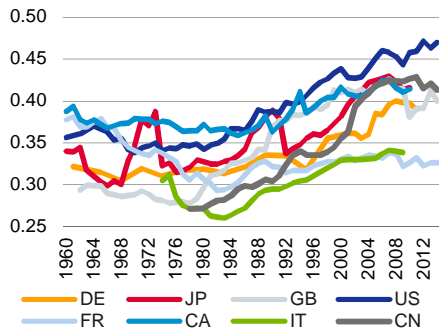Share of top 1% income earners in pre-tax national income, percentile

Source: World Inequality Database

In the US, the top 10% income earners receive today almost 50% of pre-tax national income | 17

Share of top 10% income earners in pre-tax national income, percentile
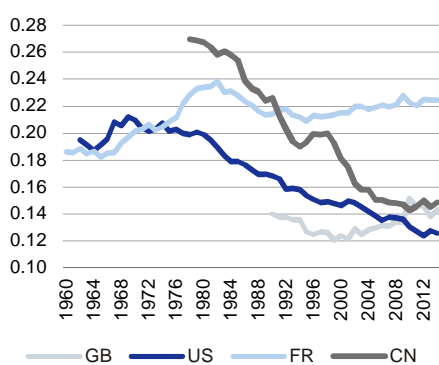

Source: World Inequality Database

In the US, the bottom 50% of income earners receive only 12% of pre-tax national income | 18

Share of bottom 50% income earners in pre-tax national income, percentile

Source: World Inequality Database

... but declined in an international comparison

Even though inequalities have increased within individual countries in the last few decades, they have declined in a cross-country comparison. This is a favourable effect of globalisation and of the economic upswing in many emerging markets. Economists Waldenström and Hammar (2019) found in a recent study that global inequalities have declined considerably over the last few decades as important emerging markets have caught up to the developed markets (above all China and India). According to this study, the global Gini coefficient (for net income) has declined from roughly 65.3% in the 1970s to about 50.2% in 2015, and the share of the top ten percent of the global population in total net global income has declined from about 50.1% to 34.5%. At the same time, the share of the bottom 50% of income earners worldwide in total global income has doubled, from 9.4% to 18.9%.

National inequalities considerably smaller after redistribution

As a rule, net income (i.e. income after redistribution measures in the form of taxes and transfers) is much more equally distributed than market income. This is what the OECD data for the Gini coefficient before and after government redistribution measures show (Charts 21 and 22). Moreover, relative poverty, as measured, for example, by the share of the population earning less than 60% of the median income, has remained largely stable across numerous countries (Chart 23).

Inequality is not only a result of economic factors

The German Council of Economic Experts (Sachverständigenrat; SVR) conducted a thorough analysis of income inequality in Germany in its Annual Report for 2017/18 (2017) and found that there is a discrepancy between actual statistical facts and public perception. It emphasises that the size of the middle class (whose income is between 60% and 200% of the median income) has remained stable at c. 78% during the past 10 years and that numerous redistribution and inequality benchmarks, such as the Gini coefficient or the share of households at the brink of poverty, suggest that inequality has remained largely stable in Germany since 2005[3]. Moreover, the Council of Economic Experts points out that a number of non-economic factors may have increased inequality, such as the trend towards smaller households[4], higher immigration and a larger number of studies.

Demographic factors in particular, i.e. ageing, may have had a negative impact on inequality, as income inequalities tend to be much more pronounced among older than among younger people. At the same time, better education opportunities since the 1970s have led to a higher number of people achieving higher education degrees. This, too, may have increased inequalities. Inequalities (based on net income) are much lower among people with low and medium qualifications than among highly qualified workers. Overall, prosperity has increased and low-qualified workers have seen their income rise after redistribution, too. However, these developments also show the problems of such redistribution measures.

Data on the distribution of income in Germany show a close relationship between the level of education and (relative) income. In 2014, university

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[3] See Federal Ministry of Labour and Social Affairs.

[4] Inequality rises with the number of single households in comparison to couples (with or without children) or single parents. This is because small households cannot enjoy scale advantages. According to the Council of Economic Experts, the trend towards individualisation has probably increased inequality.
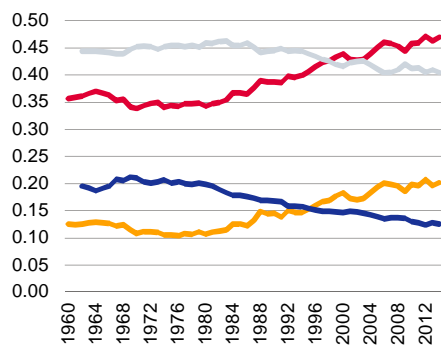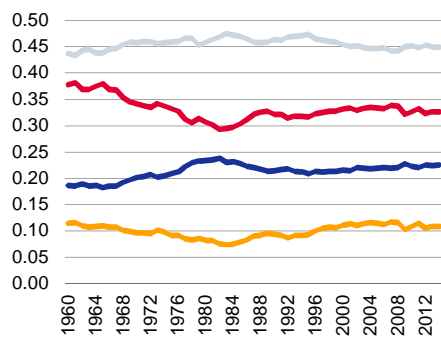
Share in pre-tax national income, percentile `19`
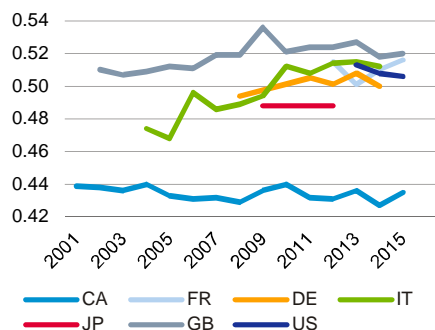
United States

France

Top 1% — Top 10%
Middle 40% — Bottom 50%

Source: World Inequality Database

In Europe income inequality is mitigated more strongly ... `21`

Gini coefficient* (based on disposable income before taxes and transfers), scale from 0 to 1

CA — FR — DE — IT
JP — GB — US

* New income definition since 2012. A value of 0 implies perfect income equality. A value of 1 implies maxiumum income inequality.
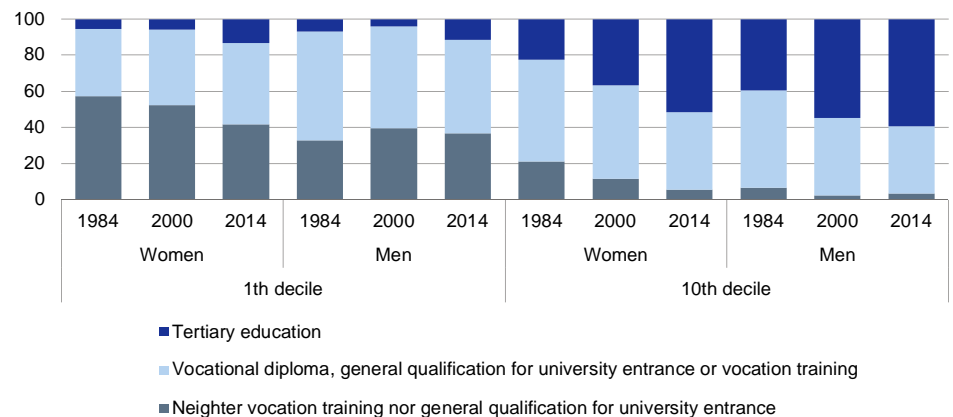
Sources: OECD, Deutsche Bank Research

graduates accounted for only 11.8% (13.4%) of the bottom tenth of male (female) income earners – i.e. those with the lowest income –, but for almost 59.5% (51.6%) of the top tenth (i.e. top income earners). At the same time, 36.6% (41.4%) of the bottom 10% of male (female) income earners had neither done an apprenticeship nor sat their A-levels. Among medium and high income earners (5th and 10th decile), the shares of low-qualified workers were considerably lower, at 15.3% (25.2%) and 3.2% (5.2%) (Chart 20)[5].

This implies that good education policies (vocational and professional training, re-training) are more important than ever in the digital age, as employment and requirements on workers may change rapidly.

Germany: Income distribution and educational attainment `20`

% share of income

■ Tertiary education
■ Vocational diploma, general qualification for university entrance or vocation training
■ Neighter vocation training nor general qualification for university entrance

Source: German Council of Economic Experts

Technical progress and inequality: Some theoretical considerations

Berg, Buffie and Zanna (2016) have developed three different scenarios in order to analyse how "robotisation" may affect growth, investment and demand for labour as well as income trends and income distribution (for a summary of their work see Box 1 in the Appendix). Their theoretical conclusions feed concerns that the digital structural change might considerably increase inequalities in terms of income distribution. We will come back to these ideas in the framework of our scenario analysis of the fiscal impact of an automation-related decline in employment.

3. Opportunities and risks for the welfare state

Digitalisation brings both opportunities and risks for the welfare state and the sustainability of public finances. If the government succeeds in introducing adequate taxes on digitalisation gains and preventing an erosion of the wage-based funding of the social security systems, the digital structural change might even improve the sustainability of public finances. After all, digitalisation may help to reduce the ageing-related financial burdens from both the revenue and the expenditure side.

If, however, we are in for technology-related mass unemployment, the welfare state, which is currently financed largely from taxes and wage-based social security contributions, will be faced with enormous financial challenges, particularly since social security expenditure will increase. And even if
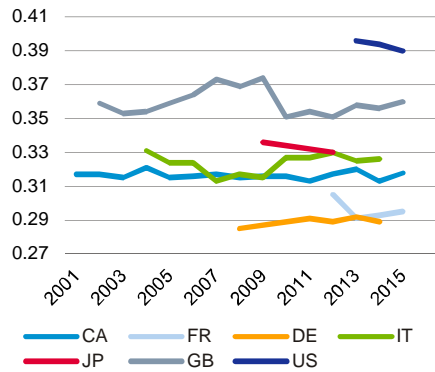
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5   See SVR (2017).

Digital structural change and the welfare state in the 21st century

... by redistributional measures than in the US

22

Gini coefficient (based on disposable income after taxes and transfers), scale from 0 to 1
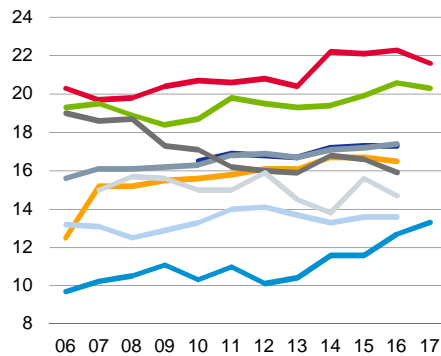
Legend: CA, FR, DE, IT, JP, GB, US

Sources: OECD, Deutsche Bank Research

EU: At-risk-of-poverty rate is much lower after redistribution ...

23

At-risk-of-poverty rate, % (after redistribution*)

... than before taxation and social transfers

At-risk-of-poverty rate, % (before redistribution*)

Legend: EU28, EA19, DE, ES, FR, IT, NL, GB, CH
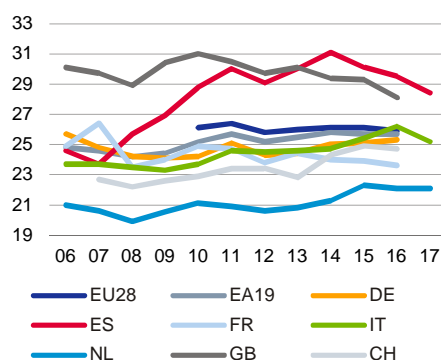
* Cut-off rate: 60% of median equalised income

Source: Eurostat

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employment as a whole stays largely unchanged, the funding basis for the social security system may erode, for example if freelance work (which may be brokered via freelancer platforms run abroad) increases considerably and is not adequately taxed. In this case, the government might try to use other sources of revenue to close the funding gap, for example by increasing taxes on corporate profits or introducing taxes on wealth. However, as international tax competition is considerable and multinational corporates and wealthy individuals clearly try to avoid paying taxes, it is doubtful whether any such attempts would be successful.

Opportunities: Digitalisation may strengthen potential growth and help to bear demographic burdens

Numerous countries are struggling with rising debt, despite low interest rates, ...

Even though fiscal deficits in most developed countries are much lower than at the time of the global financial crisis in 2009 (Germany is even running a fiscal surplus), practically all developed economies are struggling with high debt (Chart 25), which has become considerably more sustainable thanks to the low-rate environment. Nevertheless, many large developed countries will probably run into difficulties in the long term.
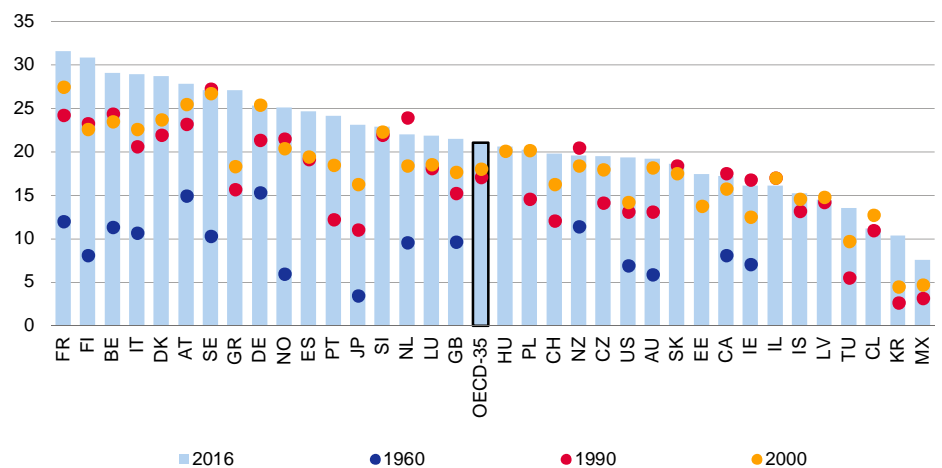
... and ageing will be an additional burden on public finances

First, it is unlikely that interest rates will stay extremely low forever. Second, rapid ageing will result in considerable fiscal pressure in some countries in the medium to long term. A shrinking workforce will lead to lower growth, which will, in turn, have a negative impact on government revenues (taxes, social security contributions). According to a United Nations forecast, several large industrial countries may see their workforce decline rapidly over the coming 40 years. According to the UN's medium-variant scenario, the workforce might decrease by c. 22% in Germany by 2060 and even by c. 25% and 30% in Italy and Japan, respectively (Chart 28). Another negative effect of ageing is that the smaller workforce will have to finance an ever larger share of steadily rising ageing-related government expenditure by its taxes and social security contributions

OECD: Social spending has increased significantly since the 1960s
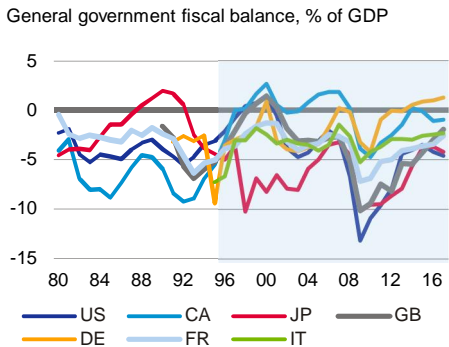
24

Public social spending, % of GDP

Legend: 2016, 1960, 1990, 2000
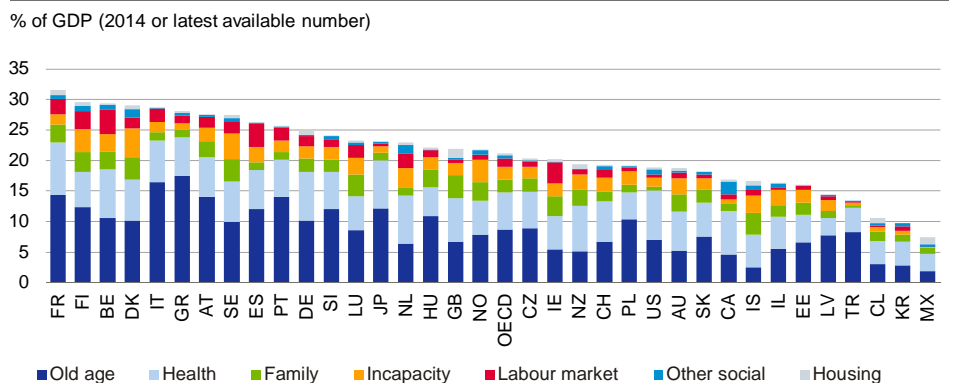
Source: OECD

(pensions, healthcare, old-age care), unless the statutory retirement age is raised and/or social security spending (for example pensions) is cut.

Many developed countries are already struggling with high (social security) expenditure

Numerous countries are already struggling with high social security expenditure, which has risen steadily and considerably over the last few decades. In 2016, France was the OECD country which spent the largest share of its government revenues on social security (more than 30% of GDP; Chart 24). In fact, a striking

Most sovereigns in the G7 economies are posting fiscal deficits ... `25`

General government fiscal balance, % of GDP

Germany, the United Kingdom, France, Italy and Spain: Fiscal balance according to Maastricht definition.
US, Canada and Japan: Fiscal balance according to IMF definition.

Sources: IMF WEO, AMECO, Deutsche Bank Research

OECD: Old age and health related spending account for the bulk of social spending `26`

% of GDP (2014 or latest available number)

Source: OECD

number of large European countries (for example France, Italy, Germany or Spain) spend much of their funds on social security systems (OECD average: c. 20%).

In contrast, social security expenditure is relatively small in the US and Canada (Chart 24). A breakdown of the expenditure shows that old-age-related spending (e.g. pensions) and healthcare expenditure are clearly the largest items in the budget. In addition, this spending is rising strongly over time, largely due to ageing (Charts 26, 30 and 31).

Digitalisation as an opportunity to boost growth and prosperity

In view of almost full employment, a lack of qualified workers and rapid ageing in some countries, digitalisation offers considerable opportunities in terms of growth and prosperity. A shrinking workforce and a lack of qualified labour are already capping potential growth in numerous developed countries. Against this background, fears of technology-related unemployment seem unfounded (as of yet). Investment in robots and machinery will not necessarily lead to lower employment, but may help to cushion the negative impact of the decline in the workforce. This means that the automation measures by companies are not (only) a risk, but (also) an opportunity to ensure fiscal sustainability.

... and continue to struggle with large public debt levels `27`

Gross general government debt, % of GDP

Germany, the United Kingdom, France, Italy and Spain: Government debt according to Maastricht definition.
US, Canada and Japan: Government debt according to IMF definition.

Sources: IMF WEO, AMECO, Deutsche Bank Research

Working-age population could shrink in many countries according to the UN `28`

Working-age population, index: 2015=100

Medium variant projections by the United Nations

Sources: United Nations, Deutsche Bank Research

Working-age population might fall considerably in many countries | 29

Working-age population, % population
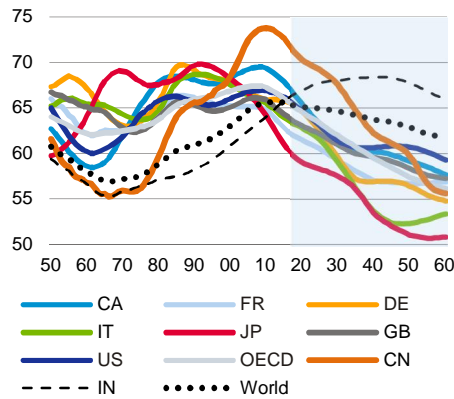
Medium variant projections by the United Nations

Sources: United Nations, Deutsche Bank Research

Public spending on social security ... | 30

Public spending on social security, % of GDP

* excluding Canada

Sources: OECD, Deutsche Bank Research

... and health are high and keep rising steadily | 31

Public spending on health, % of GDP

* excluding Canada

Sources: OECD, Deutsche Bank Research

Risks: Digitalisation may make it more difficult to tax corporates effectively and result in an erosion of tax revenues

Technology-related mass unemployment may lead to funding difficulties

If automation leads to more pronounced labour-market polarisation (and technology-induced unemployment), governments will need to re-think how to fund the social security systems. After all, in this case (wage) tax and social security contributions would erode and welfare spending would jump. This would reduce financial leeway for other growth-supporting and urgently needed expenditure, for example on education. Governments might ultimately try to raise other taxes to fund the deficits, such as higher corporate taxes or wealth taxes. However, the key question is whether they would be able to increase revenues from these types of tax sufficiently to compensate revenue losses from wage taxes.

Corporate profits are taxed at considerably lower rates than income from work

As a matter of fact, average tax rates on corporate profits are currently much lower than those on wage income in most countries. In addition, many countries have seen their corporate tax revenues decline in relation to GDP and to total fiscal revenues over the last few decades, even though corporate profits have often been high. Why are tax rates on corporate profits lower? Why do governments prefer to fund their spending from wage tax revenues than from taxes on corporate profits or wealth income? One possible explanation is that capital is more mobile than labour and that the international competition in the area of capital and corporate taxation is fierce. As a matter of fact, no country is an island when it comes to (corporate) taxation; it has to take into account the tax policies of its peers if it does not want to fall behind in the competition for companies and lose jobs and taxes to other countries, where taxation rules are more favourable. In addition, multinationals try to avoid taxation, and this endeavour is made even easier by digitalisation.
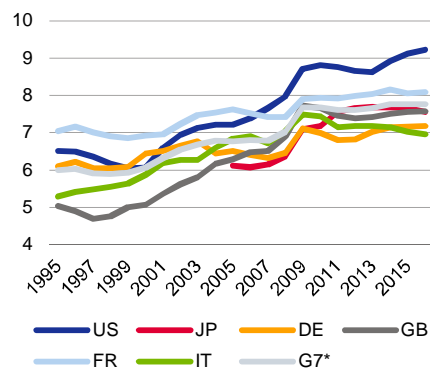
Profit shifting and tax avoidance by multinationals ...

Globalisation in particular has triggered a global tax competition, which has made it easier for large multinationals to legally minimise their tax burden by choosing their domicile carefully, creating complex corporate structures and using tax avoidance models. Digitalisation seems to make it even easier for multinationals to avoid taxes, as many of them are now able to offer their products and services around the globe without being necessarily physically present at the place where value is created and profits are made. Common tax avoidance strategies are (a) shifting profits to low-tax countries, (b) benefiting from tax credits in high-tax countries, (c) using tax arbitrage by relying on misaligned or contradictory tax rules in different countries, (d) taking advantage of double taxation agreements ("treaty shopping") or (e) retaining profits at subsidiaries abroad or returning them to the parent company with a delay. The so-called "Double Irish Dutch sandwich", a well-known tax avoidance strategy, is a good example of the complex strategies multinationals use to avoid/reduce taxes.[6]

According to calculations by Zucman, Torslov and Wier (2018), the share of multinational corporate profits in aggregate global corporate profits has risen from c. 4% in the 1980s to currently more than 15% and during the same time

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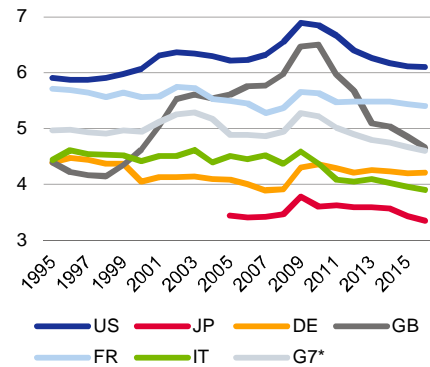[6] See IMF (2013). Box 5. Tricks of the Trade. Page 47–48.

Digital structural change and the welfare state in the 21st century

Public spending on education has
fallen or stagnated relative to GDP   32

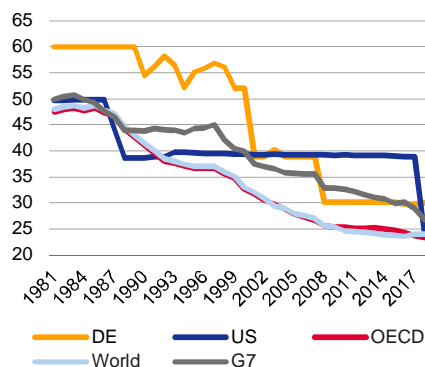Public spending on education, % of GDP

* excluding Canada

Sources: OECD, Deutsche Bank Research

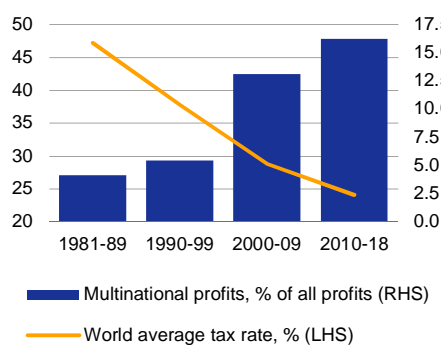Statutory corporate tax rates have
fallen across the globe   33

Top statutory corporate income tax rate, %

Source: Zucman, Gabriel, Thomas Torslov und Ludvig
Wier (2018). The Missing Profits of Nations. June 5, 2018.

Global corporate tax competition and
the rise of multinational corporates   34

Source: Zucman, Gabriel, Thomas Torslov und Ludvig
Wier (2018). The Missing Profits of Nations. June 5, 2018.

the global (average) corporate tax rate has declined from more than 45% to less than 25% (Chart 34). The study says that multinationals shift almost 40% of their profits to tax havens each year in order to save on corporate taxes. In 2015 alone, these profit shifts totalled c. USD 617 bn, with about USD 236 bn (40%) being steered to EU tax havens (in particular Ireland, the Netherlands, Luxembourg or Malta). The remaining c. USD 381 bn were sent to low-tax countries outside the EU, above all in the Caribbean (c. 15.7% of the total profit shifts), Singapore (11.4%) and Switzerland (9.4%).

... result in major corporate tax losses in countries with high tax rates

The resultant tax losses for the EU are thought to amount to c. 18% of total corporate taxes, with Germany (c. USD 16.3 bn or 27.9%) and France (USD 10.7 bn or 21.0%) being the biggest losers. US losses are estimated to come to USD 56.8 bn or 14% of total corporate tax revenues (12% for the OECD as a whole).

In an increasingly capital-driven economy, high-tax countries with large welfare states will need to face enormous challenges

If digitalisation leads to major shifts in the distribution of income (in favour of corporate/wealth income and at the expense of wage income), high-tax countries affected by tax avoidance will come under increased financial pressure to counteract profit shifting more decisively, if necessary even by unilateral measures. Even today, countries are trying at the OECD/G20 level to find global consensus solutions to international (corporate) taxation, with the aim of preventing tax avoidance by multinationals and achieving an adequate taxation of digital business activities (the so-called Base Erosion and Profit Shifting Project or "BEPS Initiative" for short). Due to the complexity of the issue and the different interests of high and low-tax countries (or the losers and winners of profit shifting), it seems unlikely that a consensus will be reached in the near future. Moreover, there will always be an incentive for some countries to opt out of the BEPS Initiative rules in order to gain a (tax) advantage.

# 4. Fiscal burdens of mass unemployment

Basic data

Most governments use a mix of taxes and social security contributions to fund their budgets. While tax revenues are levied on a broad basis, such as income of natural or legal persons (direct taxes), consumption expenditure or the use or consumption of certain goods or services (e.g. VAT, import tariffs, vehicle or insurance tax, eco taxes etc; indirect taxes), social security contributions, which make up a large share of government budgets, are levied exclusively on wage income. In order to gauge the potential funding gaps which might arise under an unfavourable scenario for the welfare state (high structural, technology-related mass unemployment and significant wage and income inequalities), we need data on (1) government revenues and expenditure (both the totals and the breakdown by sources of revenue and spending items, respectively), (2) the tax base from the national accounts (denominator) for any taxes and social security contributions (numerator), and (3) the resultant, average tax rates on labour and capital.

Digital structural change and the welfare state in the 21st century

EU: Estimated tax losses due to profit shifting by corporates `35`
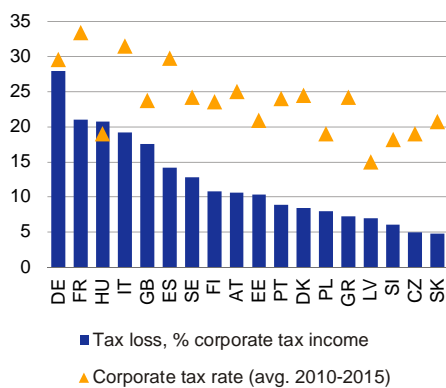
- Tax loss, % corporate tax income
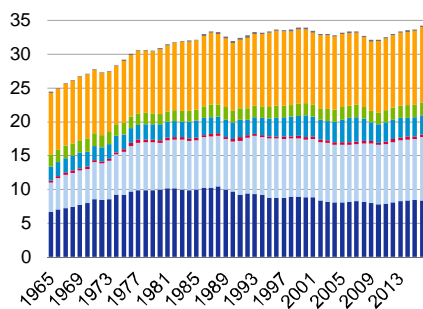- Corporate tax rate (avg. 2010-2015)

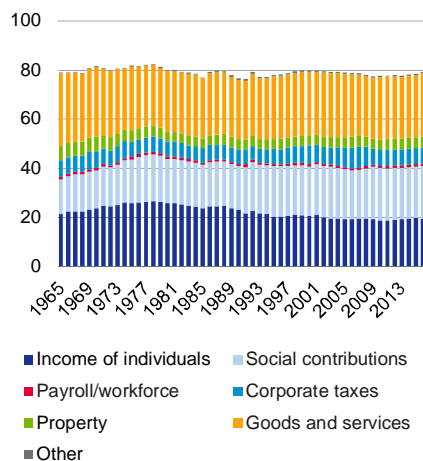Source: Zucman, Gabriel, Thomas Torslov und Ludvig Wier (2018). The Missing Profits of Nations. June 5, 2018.

OECD: Structure of tax revenue (incl. social security contributions) `37`

OECD average, % of GDP

OECD average, % total government revenue

- Income of individuals
- Social contributions
- Payroll/workforce
- Corporate taxes
- Property
- Goods and services
- Other

Sources: OECD, Deutsche Bank Research

Our structural and scenario analysis of tax revenues and average tax rates is based on data from the OECD and the European Commission (EC), which provide us with a detailed overview of developments over time and of the structure of government/tax revenues for a large group of developed and emerging markets. The Global Revenue Statistics Database or the Revenue Statistics Database contain comprehensive sets of data about the tax/contributions revenues of OECD member states.
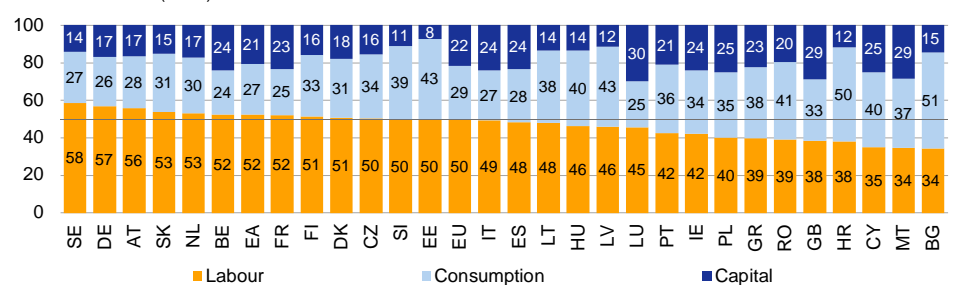
EU: Tax revenue (incl. social security contributions) according to type of tax base `36`

% of GDP (2016)

% of tax revenue (2016)

- Labour
- Consumption
- Capital
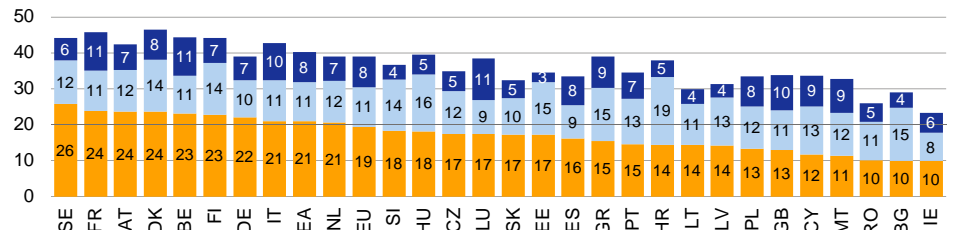
Sources: European Commission, Deutsche Bank Research

Comprehensive and cross-border data on the tax structures of the EU member states are available from the EC, for example from its internet site (Data on Taxation) and its annual "Taxation Trends in the European Union" report (see EC (2018)). Both sets of data enable us to break down revenues by (a) the type of revenue or tax (such as taxes on the income of natural or legal persons, social security contributions by employers and employees, capital gains taxes, wealth taxes, consumption taxes etc) and (b) the type of revenue or tax base (taxes and contributions can be based on income from labour or taxes, on consumption or on capital). Together with data from the national accounts, which enable us to estimate the aggregated tax base for labour and capital in a given economy, we can calculate the average tax burden or "implicit tax rate" (ITR) on labour and corporate income. We provide a detailed description of the calculation method in the appendix (Box 2), where we also discuss issues concerning the measuring and interpretation of ITRs.

In case of massive shifts in the distribution of national income, the government will lose wage tax revenues, but see revenues from corporate and wealth taxes rise at the same time. Under the negative scenario described above, the net effect on overall government funding will depend not only on the decline in employment and aggregate wages, but also on the (relative) tax burden on labour and capital income (i.e. the difference between the taxation of labour and capital or wage and corporate income)[7].

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[7] The pessimistic scenario is based on scenario 3 outlined in the appendix. In this case, GDP or national income to be distributed will not decline. Quite the contrary; they will even rise thanks to technological progress. However, the distribution of income will be highly unequal, with labour
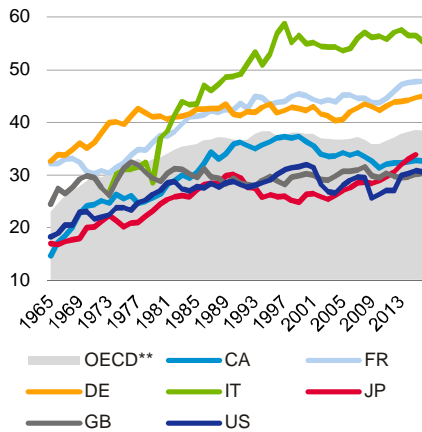
Description of our scenario analysis

Three dimensions: Direction, strength and pace of the total effect

We will distinguish between three levels or dimensions of the overall effect on employment (and, consequently, government finances) in our scenario analysis for the EU countries. The (net) impact on employment may be positive at best and negative at worst (first dimension: direction of the overall effect). In addition, it is unclear whether the effect will be moderate or considerable (second dimension: strength of the overall effect). And finally, time is of importance as well: the overall effect of digitalisation may be sudden, gradual or temporary (third dimension: pace and persistence of the overall effect). Since we want to gauge the potential fiscal burdens on the welfare state, we will focus on the negative outcomes in our analysis. We do not make any assumptions as to how quickly the welfare state may be hit or whether the effects will be temporary or persistent (third dimension); rather, we will only deal with the first two dimensions.

Assumptions concerning structural unemployment and average wages

Our first scenario of a "singular" economy (which is dominated by capital) assumes that employment (i.e. the number of employees) declines by 50%, that aggregate wages halve[8] and that corporates can turn their wage savings completely into additional profits (scenario 1a). While GDP does not decline in this scenario (in fact, it will even rise, as described in Box 1), there will be a structural shift from wage to corporate income.

In a second scenario (a less serious version of the first scenario), we assume that the number of employees and aggregate wages decline "only" by 25% (scenario 2a)[9]. Our scenarios 1b and 2b are derived from these two scenarios and assume additionally that the average wage level for the remaining employees, which cannot be substituted, rises by 30% (15%) under the scenario in which employment declines by 50% (25%). This is based on the idea that, if employment declines, the productivity of the remaining employees (those with complementary skills) may rise considerably, and so may their wage level.

Our two alternative scenarios (1b and 2b) assume that productivity and wages (i.e. average wages for the remaining workers) rise more strongly if employment declines by a larger extent, as automation will mainly replace low and moderately qualified workers, but not highly qualified labour. The "b" scenarios are similar to "economy 3" in Box 1, which suggests that both capital owners and highly qualified workers will benefit from "robotisation".

The labour tax wedge has increased significantly over time `38`

Implicit tax rate on labour*, % (approximated by using OECD data)

* Approximation based on the ratio between (1) the sum of personal income taxes, social security contributions and payroll/workforce taxes and (2) the sum of compensation of employees and payrol/workforce taxes.
** Simple average.

Sources: OECD, Deutsche Bank Research

Corporate income taxation has been trending lower `39`

%

The ITRs were calculated on the basis of the traditional EC method and using OECD data. They apply for the total corporate sector (financial and non-financial corporates).

Sources: OECD, Deutsche Bank Research

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losing out and capital gaining. Aggregate wages will decline both in absolute terms and relative to national income (and the distribution of wages will become more unequal as well, at the expense of lower qualified workers and to the advantage of qualified labour), and corporate profits and capital income will rise both in absolute terms and as a share of GDP. If there is no change to current taxation, tax revenues from labour will decline both in absolute terms and as a share of GDP (assuming that the likely increase in taxes on top incomes is not sufficient to offset the revenue losses stemming from the decline in employment) and corporate and wealth taxes will rise both in absolute terms and as a share of GDP.

[8] This is a simplifying assumption. The decline in aggregate wages if employment is slashed by half depends on which workers lose their jobs. If most of them worked for a below-average wage, the average wage level would rise and aggregate wages would decline by less than half.

[9] Strictly speaking, employment (and, in turn, aggregate wages) would decline to zero in a "singular" economy. Since we "only" assume a decline in employment by 50% or 25%, the economies in our scenarios have gone only half or one quarter, respectively, of the way towards a singular economy.
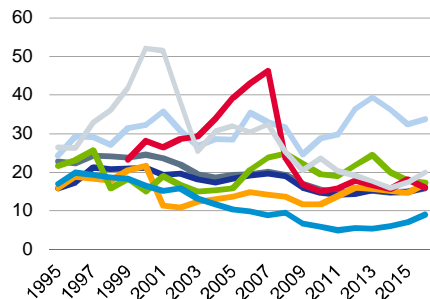
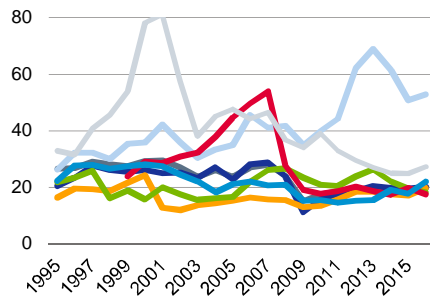# Digital structural change and the welfare state in the 21st century

EU: Average taxation of corporate income (implicit tax rate*) `40`

% (traditional EC method)

% (new EC method excl. dividends)

EU28 — EA19 — DE — FR — IT — ES — NL — GB

* approximated using Eurostat data
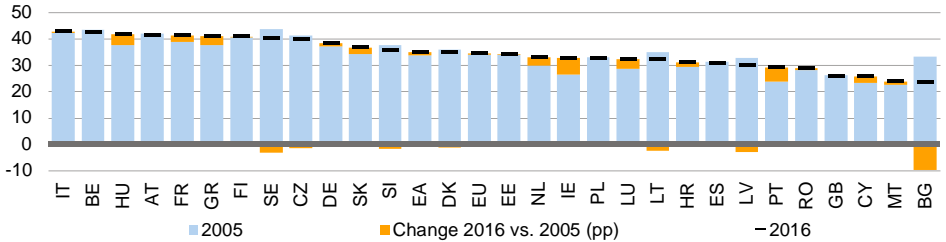
Sources: Eurostat, European Commission, Deutsche Bank Research

Serious tax losses in case of a technology-induced decline in employment

All scenarios assume that the decline in aggregate wages will lead to an equivalent increase in corporate profits, which will then be subject to tax according to the ITRs for corporate profits. The ITRs used for our calculations are based on both the traditional EC method and the new EC method (excluding dividends). As it is notoriously difficult to measure/estimate ITRs and gauge the actual effective tax burden on corporates (see Box 2 in the appendix), we have included an alternative calculation based on the effective tax rates (ETRs). In contrast to ITRs, ETRs are not based on macro, but on micro data. Since most EU countries levy considerably higher taxes on wage income than on corporate profits, the public finances will deteriorate significantly in all four negative scenarios because the losses in wage tax revenues (wage taxes, social security contributions) caused by the decline in employment will not be fully offset by higher corporate tax revenues. In addition, government spending on social security will rise. These findings are based on the simplified assumption that governments cannot adjust the size of overall spending towards the "new" revenue level (in order to close any emerging fiscal gaps) and that existing spending will increase (at least) in line with GDP growth.

EU: Average taxation of labour `41`
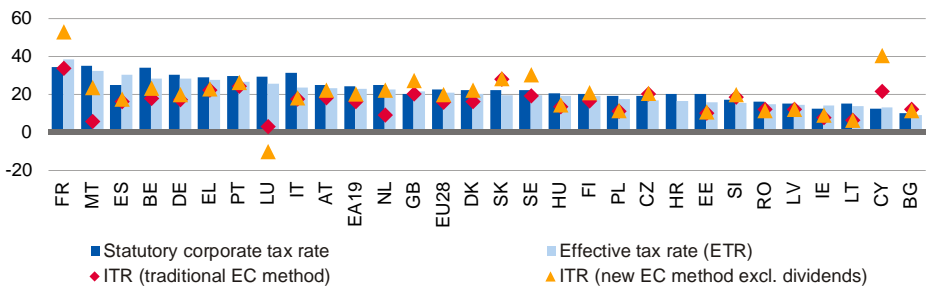
Implicit tax rate on labour, % (based on the EC method)

■ 2005 ■ Change 2016 vs. 2005 (pp) — 2016

Sources: European Commission, Deutsche Bank Research

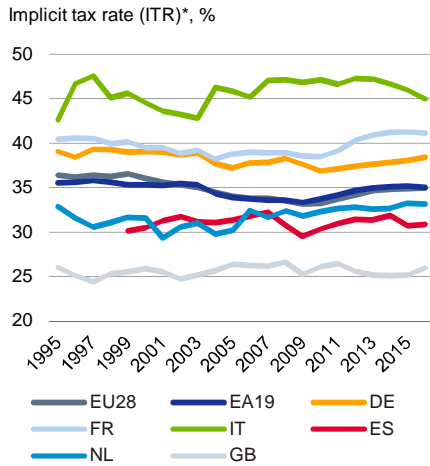**EU: Tax burden indicators for corporate income/profits** `42`

% (2016)

■ Statutory corporate tax rate   ■ Effective tax rate (ETR)
♦ ITR (traditional EC method)   ▲ ITR (new EC method excl. dividends)

Sources: European Commission, ZEW, Eurostat, OECD, Deutsche Bank Research

EU: Average taxation of labour income `43`

Implicit tax rate (ITR)*, %

* approximated using Eurostat data

Sources: Eurostat, European Commission, Deutsche Bank Research

Unemployment benefits depend on a country's median income

In addition, we assume for all four scenarios that the welfare state provides unemployed people with a share of the median equivalent income of the economy (basic social security). We put the unemployment benefits at 50% of the median equivalent income, i.e. the lower end of what most economies are willing to tolerate in terms of relative poverty. As a rule, people are regarded as (comparatively) poor or in danger of becoming poor if their income is below 60% of the median income ("at-risk-of-poverty rate"). This means that our negative scenarios cover the complete fiscal burdens (tax losses plus higher spending on unemployment and social security benefits). Overall, the net fiscal burden is a function of four exogenous variables in our scenario analysis: the strength of the decline in employment, the trend in average wages, the difference between the ITRs on wage income and corporate profits (based on data from 2016) and the height of unemployment or social security benefits expressed as a percentage of the median income.

Decline in wage ratio and technology-related mass unemployment would lead to significant and sustained fiscal deficits

Deficits of up to 10% of GDP if employment declines by half

Under scenario 1a (employment declines by half, the average wage level is unchanged despite the higher productivity of remaining employees and the state provides unemployment or social security benefits worth 50% of the median income to every person on the dole), the EU countries would be faced with major funding challenges. The combination of tax losses stemming from lower wage tax revenues and higher profit-based tax revenues and higher social security expenditure would, on average, lead to fiscal deficits ranging from 6.6% to 8.4% of GDP in the EU. This range results from three different estimates for corporate tax rates in our simulations. The deficit is biggest (c. 8.4% of GDP) if we use an ITR of c. 15.9%, as calculated pursuant to the traditional EC method. When using the ITR of c. 19.8% (according to the new EC method) or an ETR of roughly 20% (for the non-financial sector), the deficits will be somewhat smaller, but still very high, at 6.7% or 6.6% of GDP, respectively (Chart 48). The deficits for the euro area are similar to those for the EU as a whole; they amount to 6.5% on the basis of the ETR, to 6.9% for the ITR calculated according to the new method and to 8.7% for the ITR calculated according to the traditional method.
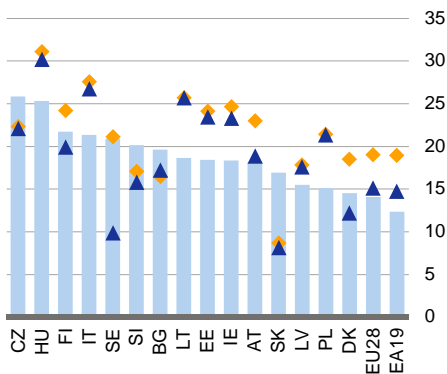
EU: Difference in the taxation of labour and corporate income*   44

Percentage points

EU: Micro-based effective tax rates for the non-financial corporate sector   45

Effective tax rate (ETR)*, %

■ ETRs for non-financial corporates (ZEW)

◆ ITR (traditional EC method)

▲ ITR (new EC method excl. dividends)

* based on 2016 data

Sources: European Commission, Eurostat, ZEW, Deutsche Bank Research

* calcualtions by the ZEW

Sources: ZEW, European Commission, Deutsche Bank Research

Among the larger EU countries, Finland, Austria, Sweden, Italy and Germany would be hit hardest, with the deficits coming in at 9.8% of GDP for Finland and 8.6% of GDP for Germany (averages for the three estimates; Chart 48). These countries would have to cope with particularly large net fiscal burdens because they levy high taxes on wage income, which means that they would be faced with significant tax losses in case of mass unemployment. Portugal (4.7% of GDP), the UK (4.9% of GDP), France (5.0%) and Ireland (5.2%) are the larger EU countries where the impact would be below the average. While in France, too, the government would lose a significant share of its wage tax revenues, much of this loss would be replaced by higher corporate tax income, as taxes on corporate profits are relatively high in France and hence the difference between wage and corporate tax rates is smaller. In the UK, the lower-than-average burden is due to the fact that wage taxes are relatively moderate in comparison to other EU countries and wage tax rates are, overall, not much higher than corporate tax rates.

If employment declines by "only" 25%, the average fiscal gap in the EU would still amount to up to 4% of GDP

In scenario 2a (employment declines by 25%, i.e. half the rate assumed in scenario 1a, and average wages remain unchanged), the fiscal burden for most EU countries would be considerably lower than in the first scenario because both tax losses and expenses for unemployment and social security benefits would be significantly smaller (chart 48). Nevertheless, the annual deficits for the EU and euro-area countries would average between c. 2 ½ and 4% of GDP, which means that the EU countries would have to cope with major fiscal problems even if net job losses were considerably smaller, at 25%.
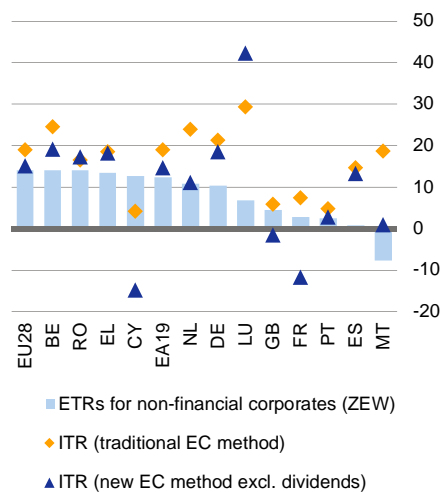
Productivity-related rise in average wages would cushion the negative impact on government finances somewhat

If highly qualified workers can secure higher wages on the grounds of their higher labour productivity (after all, their skills are complementary to capital use), the fiscal challenge for the welfare states will be somewhat more moderate than in the two scenarios outlined above, which assume that average wages remain unchanged. After all, higher average wages for those employees who are still working mean that only part of the wage-related "savings" from automation is turned into corporate profits. The remainder will go to highly qualified workers and be subject to higher taxation (provided that highly qualified workers are relatively immobile; this assumption might well be called into question). As a result, tax losses and, in turn, fiscal deficits in the EU countries will be smaller.
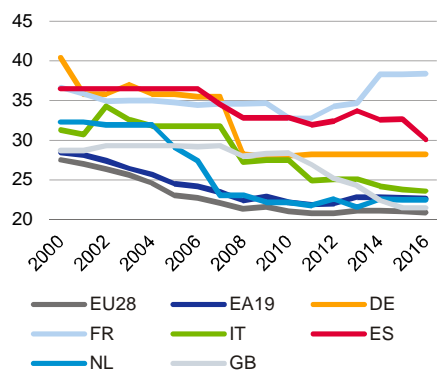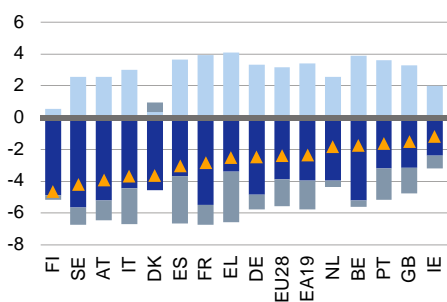
Digital structural change and the welfare state in the 21st century

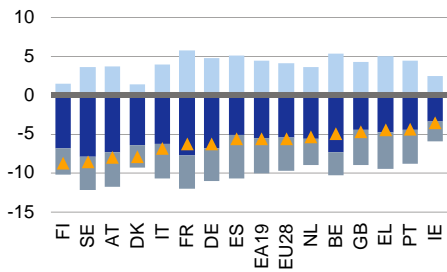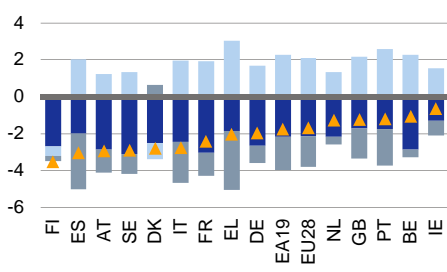## Decomposition of the net fiscal effects as a percentage of GDP
Scenario 1a
`46`
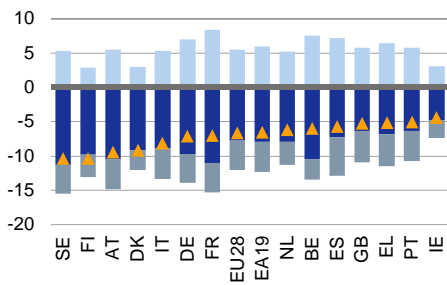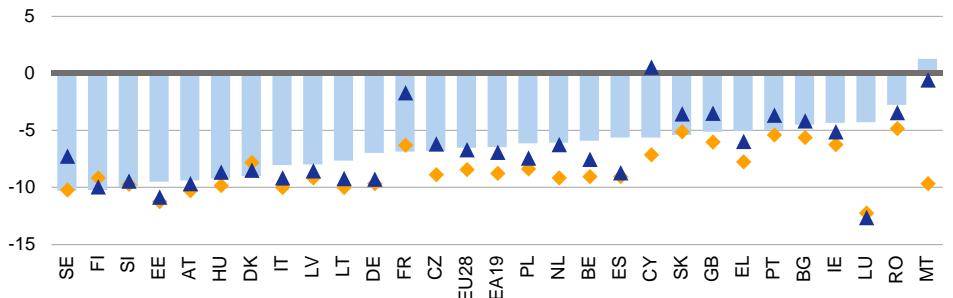

Scenario 2a

Scenario 1b

Scenario 2b

- Costs related to payments to unemployed
- Gain related to increase in corporate taxes
- Costs related to loss in labour taxes
- Net fiscal costs

Scenario analysis assumption: Any additional corporate income is taxed by governments at the prevailing ETR levels. EA19 and EU28: Excluding Croatia. ITRs for Croatia could not be calculated due to lack of contemporary data.
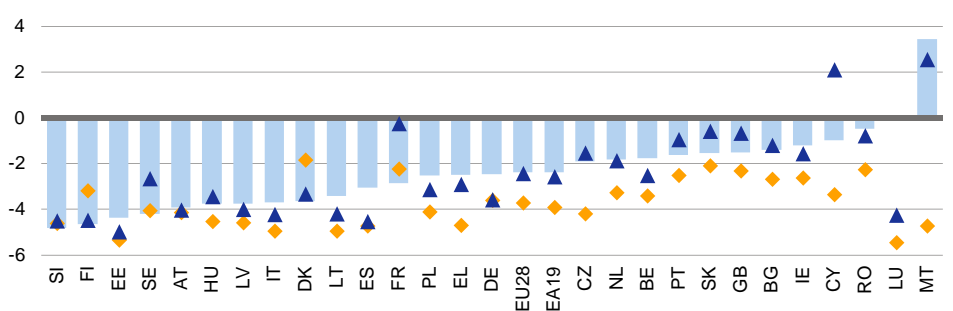
Sources: European Commission, Eurostat, Deutsche Bank Research

EU: Net fiscal effects in the event of technological unemployment (% of GDP)
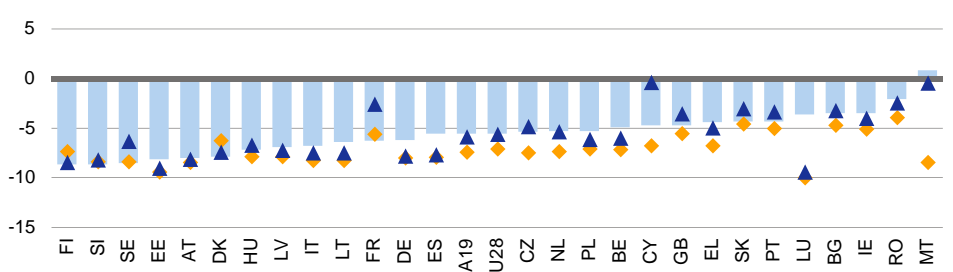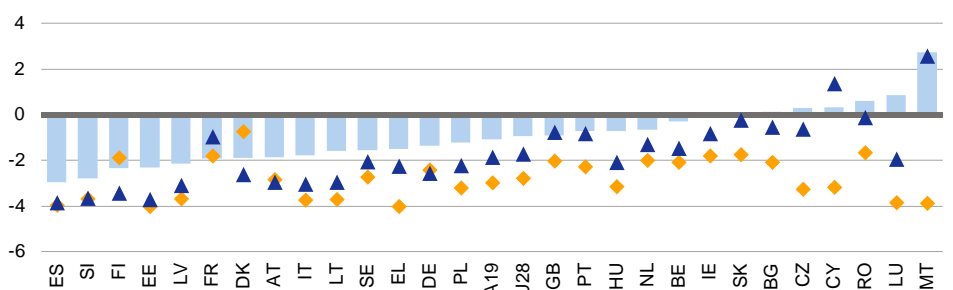### Scenario 1a: Employment: -50%, constant average wage
`47`

Scenario 2a: Employment: -25%, constant average wage

Scenario 1b: Employment: -50%, average wage: +30%

Scenario 2b: Employment: -25%, average wage: +15%

- ETRs
- ITR (traditional EC method)
- ITR (new EC method excluding dividends)

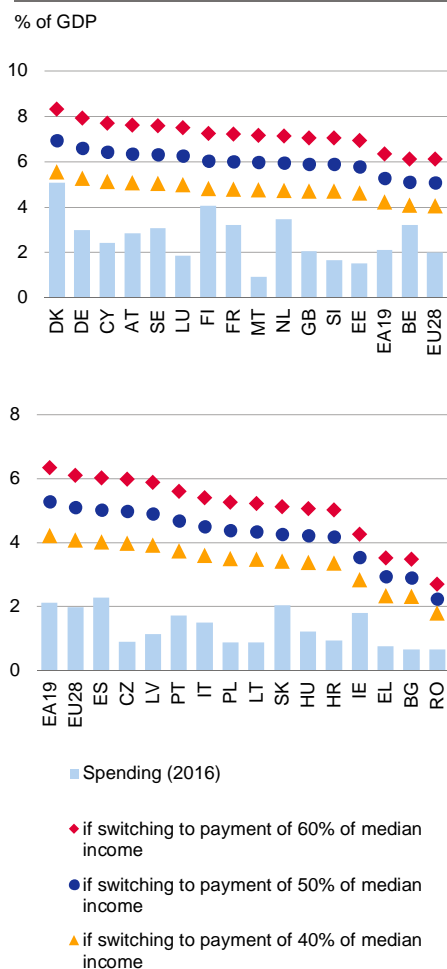EA19 and EU28: Excluding Croatia. ITRs for Croatia could not be calculated due to lack of contemporary data.

Sources: European Commission, Eurostat, Deutsche Bank Research

EU: Public spending on unemployment and social benefits today and if switching systems 48

% of GDP

Spending (2016)

◆ if switching to payment of 60% of median income

● if switching to payment of 50% of median income

▲ if switching to payment of 40% of median income

Sources: Eurostat, Deutsche Bank Research

The calculations are as follows: If employment declines by half and, in a simplified scenario, aggregate wages do the same, average wages will need to rise by 100% to keep aggregate wages at the same level as before. If employment declines by 25%, average wages will need to increase by 33% to keep the wage ratio at its former level. As such rises appear somewhat utopian, we assume that average wages rise by 30% in scenario 1b and 15% in scenario 2b. While higher average wages will not prevent the drop in the wage ratio, they will buffer it to some extent and thus lead to a smaller decline in tax revenues. Whereas the EU countries would have to shoulder fiscal burdens between 6.6% (based on ETRs) and 8.4% of GDP (ITRs according to the traditional method) if employment declined by 50% and the average wage level remained unchanged, the deficits would drop to c. 5.6% – 7.2% of GDP if average wages rose by 30%. The analysis results obviously depend to a considerable extent on the corporate tax rate used for the calculations. Since, for most countries, the ITRs (according to both the traditional and the new EC method) are lower than the ETRs calculated by the ZEW for non-financial corporates (Chart 42), net fiscal burdens are considerably higher when ITRs (rather than ETRs) are used for the calculations. In some EU countries, such as Luxembourg or Malta, the differences are quite significant. Bearing in mind the weaknesses of the macro-based ITRs (see Box 2 in the appendix), we should be careful when interpreting the results and never lose sight of the picture as a whole. Moreover, we should bear in mind that our scenario analysis is based on ITRs for 2016 and ETRs for 2017. The effective corporate tax rates, as based on the ZEW data, have declined considerably in several EU countries, for example Hungary, Portugal or France. This implies that the theoretical net fiscal burdens in our negative scenarios will rise if we use (more) recent ITRs for the calculations for these countries. Chart 49 gives an overview of the fiscal burdens which the EU countries will need to shoulder under the negative scenarios. It shows the median, the maximum and the minimum net fiscal burdens, as calculated on the basis of the three different estimates for corporate tax rates.

Finally, we will take a look at the fiscal burden under the four scenarios while assuming different levels of unemployment and social security benefits. So far, we have assumed that unemployed workers receive benefits equivalent to 50% of the median equivalent income. We will now analyse how the total burden changes if this ratio is lower or higher (40% or 60% of the median income, respectively).

Chart 50 shows that, assuming a decline in employment by 25% and 50%, respectively, a rise in social security benefits by 10 pp will increase the total fiscal burden by about one or by half of a percentage point of GDP, respectively (averages for both the EU and EMU countries). The burden will rise by an above-average rate in Denmark, Germany, Luxembourg and Sweden, as overall and median equivalent incomes are relatively high in these countries. Overall, the calculations show that even if the social security benefit is reduced to only 40% of the median equivalent income the fiscal burden for the EU countries will remain high and not much lower than if the benefits are equivalent to 50% of the median equivalent income (5.3% vs 6.3% of GDP under scenario 1a or 1.7% vs 2.2% under scenario 2a).
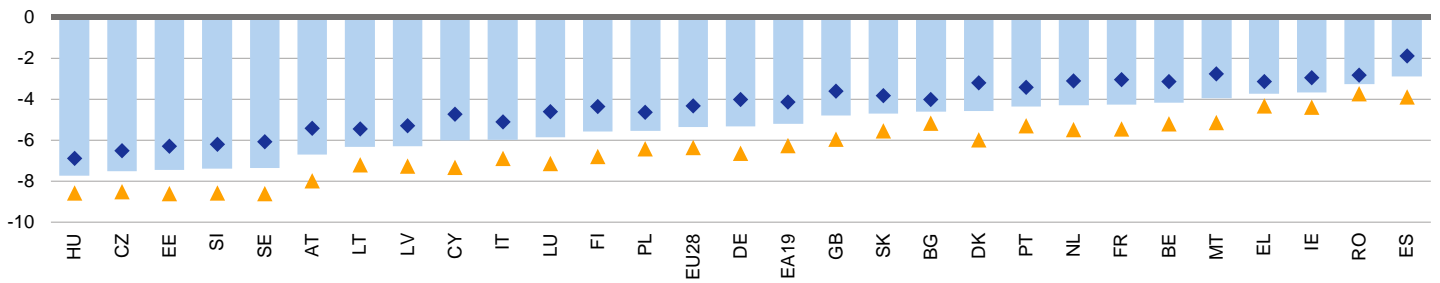
Digital structural change and the welfare state in the 21st century

EU: Net fiscal effects based on varying guaranteed minimum income* (as a percentage of GDP)
Scenario 1a: Decline in employment by 50% and constant average wage
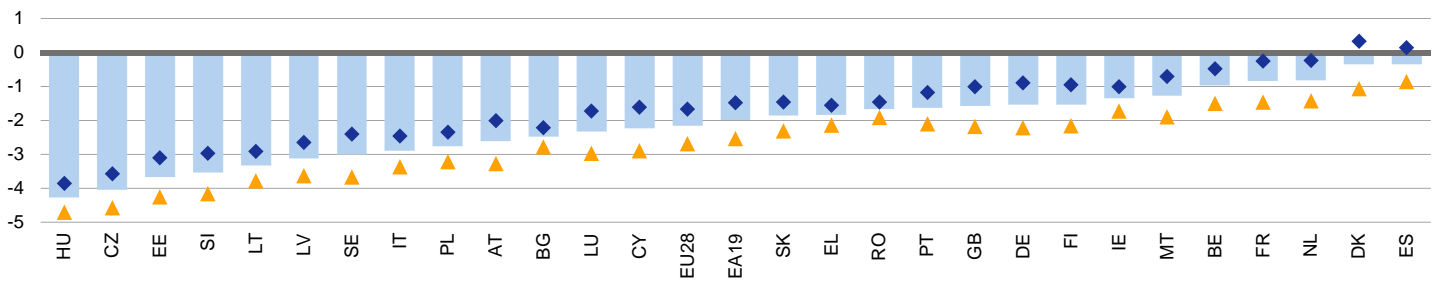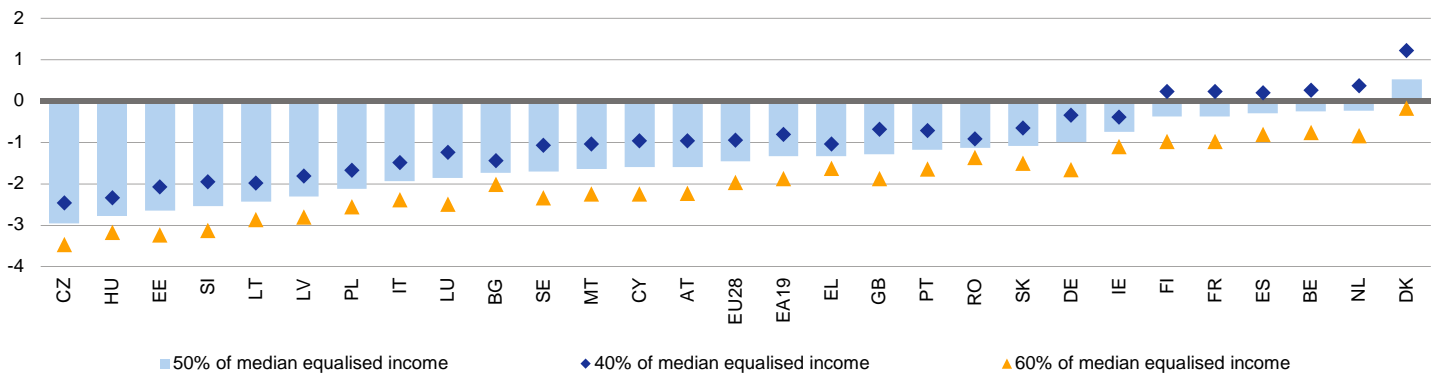
49
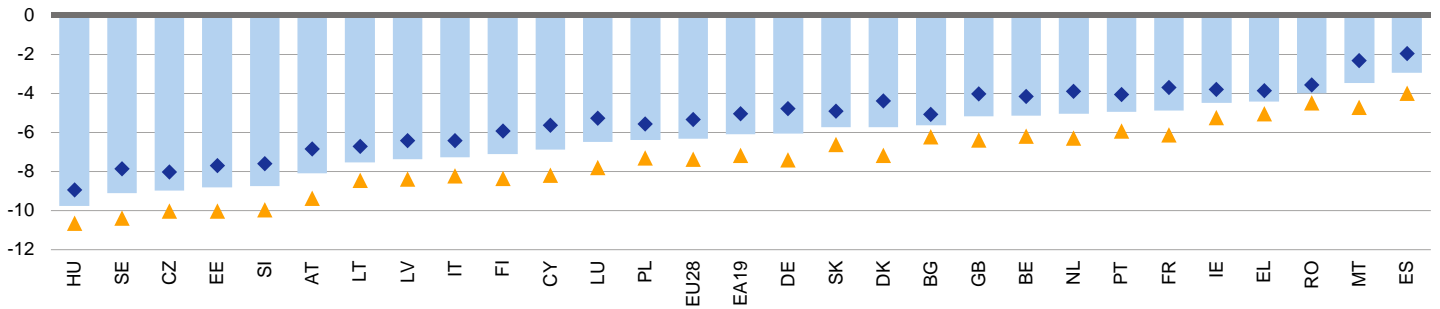
Scenario 1b: Decline in employment by 50% and increase in the average wage by 30%

Scenario 2a: Decline in employment by 25% and constant average wage

Scenario 2b: Decline in employment by 25% and increase in the average wage by 15%

■ 50% of median equalised income   ◆ 40% of median equalised income   ▲ 60% of median equalised income

* in percent of the median equalised income.
Scenario analysis assumption: Any additional corporate income is taxed by governments at the prevailing ETR levels.
EA19 and EU28: Excluding Croatia. ITRs for Croatia could not be calculated due to lack of contemporary data.

Sources: Eurostat, European Commission, OECD, Deutsche Bank Research

In case of widespread automation and structural mass unemployment governments will need to find new answers to the funding question ...

The results of our scenario analysis for the EU countries show that many European welfare states would need to re-think the funding of their state social security systems if a vast, digitalisation-related automation wave led to structural mass unemployment. This is due to the fact that corporate revenues and profits are currently taxed at considerably lower rates than employees' wages, largely because of intensive global tax competition during the last few decades. If employment drops massively because human labour is replaced by machinery, robots, computers and/or AI and if the wage ratio dips while corporate profits increase, most countries will have to deal with major tax losses and higher social security expenditure.

If automation reduced employment by 50% (see the results of the study by Frey and Osborne (2013)) and average wages remained unchanged (scenario 1a), the EU countries would have to deal with an enormously high funding gap of c. 7% of GDP on average. And even under our most favourable negative scenario (scenario 2b), which foresees a less drastic decline in employment by "only" 25% and a productivity-related increase in average wages by 15%, the EU countries would be faced with a potential deficit of almost 2% of GDP on average. Germany, the biggest EU country, would have to cope with a fiscal burden of up to almost 10% of GDP if employment declined by half (scenario 1a). And even under the scenario which assumes considerably higher average wages for the remaining employees the fiscal burden may rise to up to 8% of GDP (scenario 1b). If employment declined "only" by half that percentage, i.e. by 25%, Germany would still have to fund significant deficits of between 2.5% and 3.6% of GDP.

... and consider fundamental changes to taxation policies

If digitalisation really leads to mass unemployment and a massive shift of income from wage earners to entrepreneurs and capital owners, governments will obviously need to close the funding gap by increasing tax revenues from other types of income. They may increase tax rates, broaden the tax base or combine both. Since wages are already subject to significant (wage) taxes and social security contributions in many EU states and thus make a significant contribution to social security funding, governments might need to close "digitalisation-related" funding gaps by levying higher taxes on consumption, corporate profits, capital income or wealth. A follow-up study will focus on the resultant, potential problems and hurdles and the amount of any potential additional taxation. Managers, economists and policymakers have already presented a number of different concepts to ensure a more equal distribution of income under one of the negative scenarios. They include higher taxes on the main beneficiaries of automation and digitalisation gains (in particular companies and capital owners), the introduction of a robot, data and/or digital tax, a radical overhaul of the tax system towards a tax on value added or the introduction of a universal basic income. These concepts, their advantages and disadvantages and their costs (for example for universal basic income) will be discussed in another follow-up study.
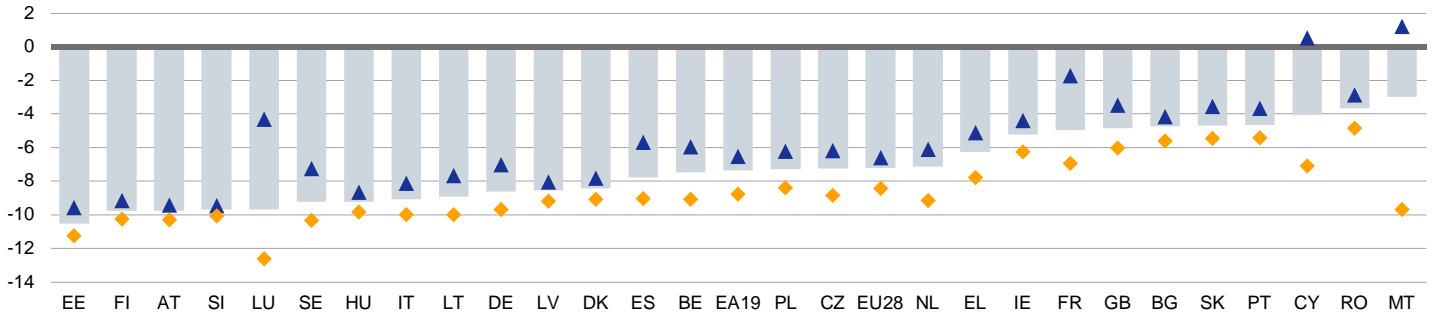
# Digital structural change and the welfare state in the 21st century

EU: Net fiscal effects in the negative scenario of technological unemployment (as a percentage of GDP)
Range estimates based on different estimators for the average corporate income tax rate
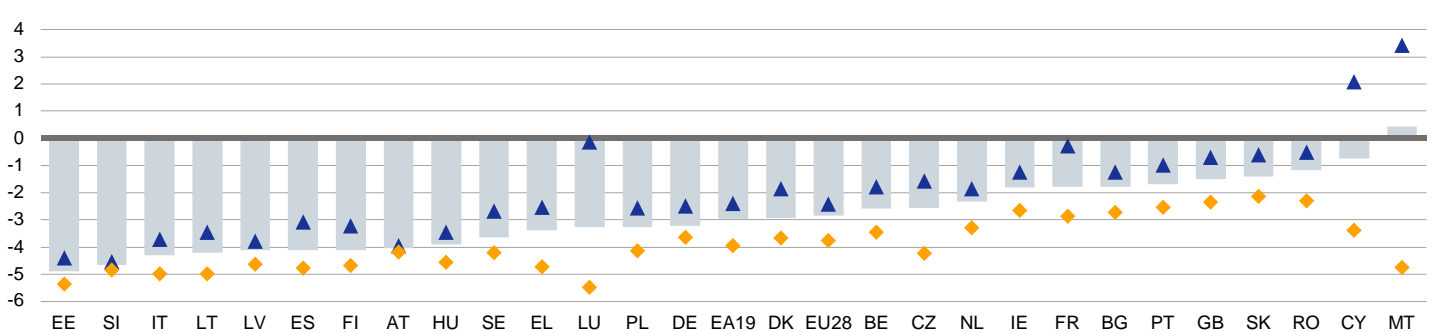
`50`

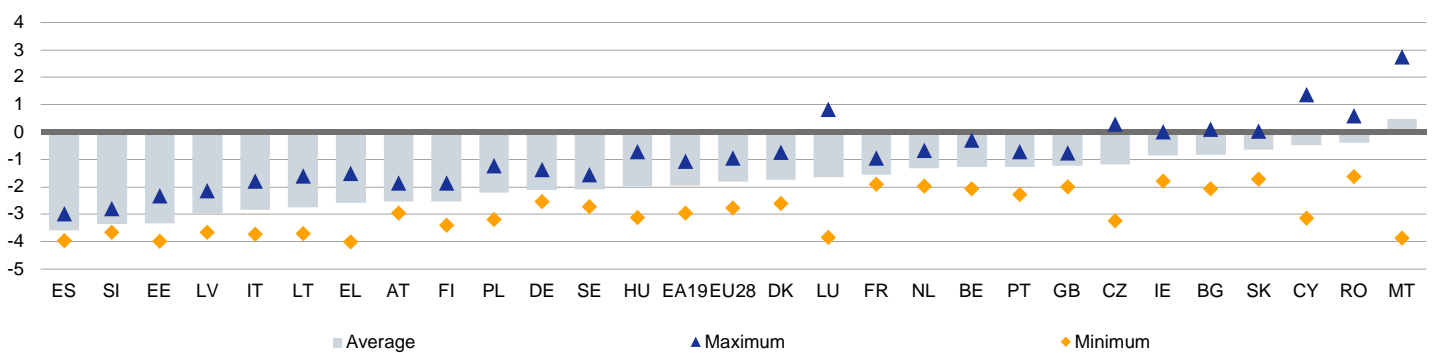Scenario 1a: Decline in employment by 50% and constant average wage

Scenario 1b: Decline in employment by 50% and increase in the average wage by 30%
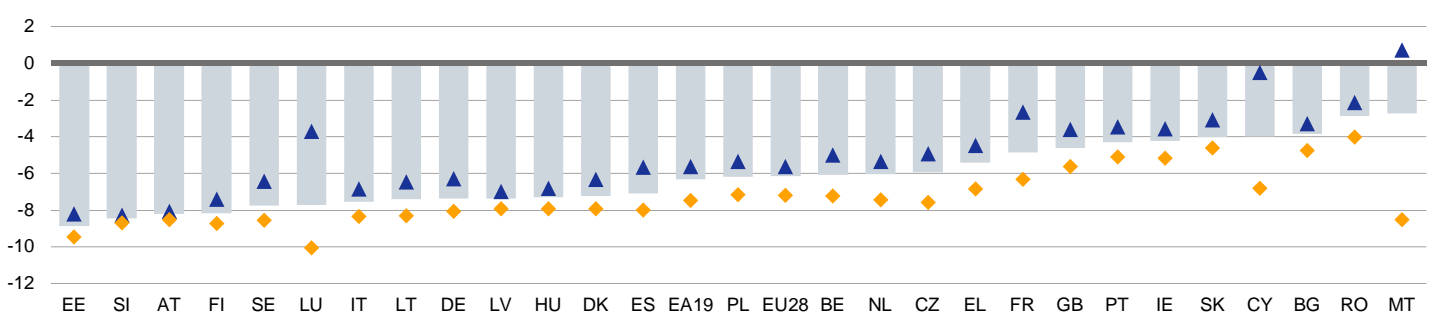
Scenario 2a: Decline in employment by 25% and constant average wage

Scenario 2b: Decline in employment by 25% and increase in the average wage by 15%

■ Average   ▲ Maximum   ◆ Minimum

EA19 and EU28: Excluding Croatia. ITRs for Croatia could not be calculated due to lack of contemporary data.

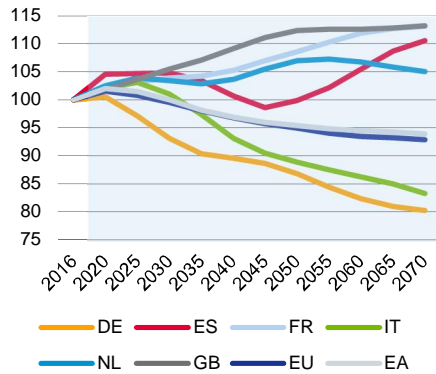Sources: European Commission, Eurostat, Deutsche Bank Research

Employment projections by the EC `51`

Employment (persons aged 15-64 years),
index: 2016=100

Legend: DE, ES, FR, IT, NL, GB, EU, EA

Sources: European Commission, Deutsche Bank Research

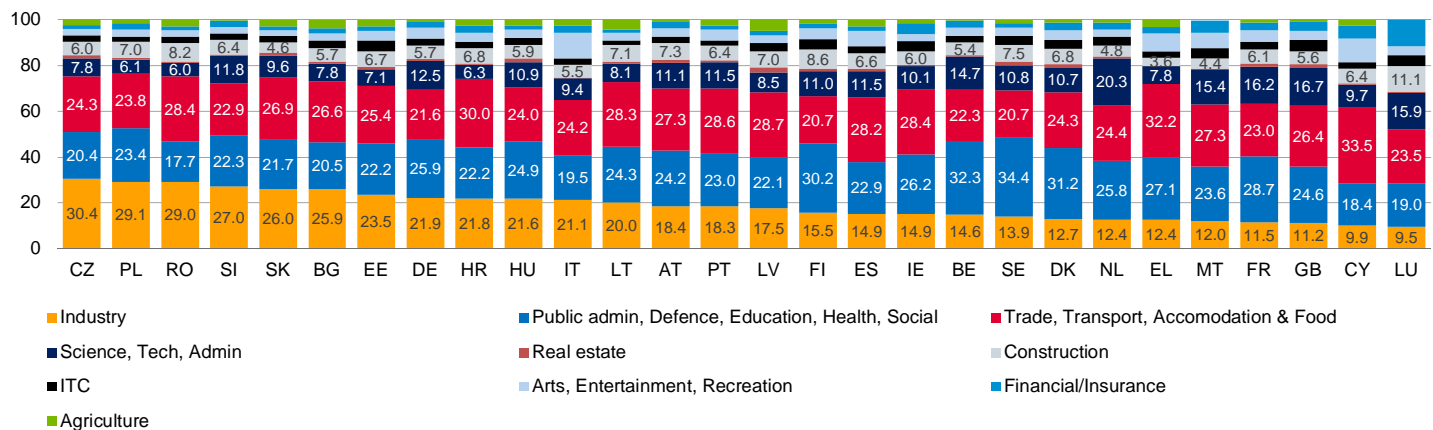### Final remarks on the interpretation of the results of our scenario analysis

The results of our scenario analysis only indicate the necessary tax adjustments the EU countries will need to make in case of an automation-related decline in employment. The analysis is based on data from 2016 (or 2017 for the ETRs) and the simplified assumption that all EU countries will be hit to the same degree by a decline in employment. However, as the economic structures are different, the impact on the individual economies will differ as well.

If, for example, manufacturing jobs are lost (because industrial robots are increasingly used for production), economies with a broad industrial base will suffer more than service-oriented economies, where jobs in the social sector may be more important. However, this does not necessarily mean that service-oriented economies will not undergo major job losses. For example, processes in the banking or insurance sectors which are currently done by human workers (such as credit reviews) may be automatised with the help of AI. Our scenario analysis does not take into account the structural differences between the EU countries (for example the proportion of employment in the different sectors), but focuses only on the difference between the (relative) taxations of corporate revenues/profits and wage income. In addition, our scenario analysis does not take into account different ageing developments in different countries. For example, countries with rapidly ageing populations, which may already be suffering from a lack of qualified labour, might be hit less by an automation-related decline in employment than those where the labour supply remains high and the workforce grows.

EU: Structure of employment in the EU countries (domestic concept; national accounts) `52`

Share of employees, % total employees (2017)

- Industry
- Public admin, Defence, Education, Health, Social
- Trade, Transport, Accomodation & Food
- Science, Tech, Admin
- Real estate
- Construction
- ITC
- Arts, Entertainment, Recreation
- Financial/Insurance
- Agriculture

Sources: Eurostat, Deutsche Bank Research

EU: Employment projections by the European Commission until 2030 `53`

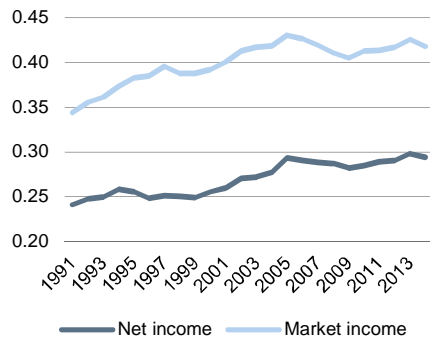Employment (persons aged 15–64 years), Index: 2016=100
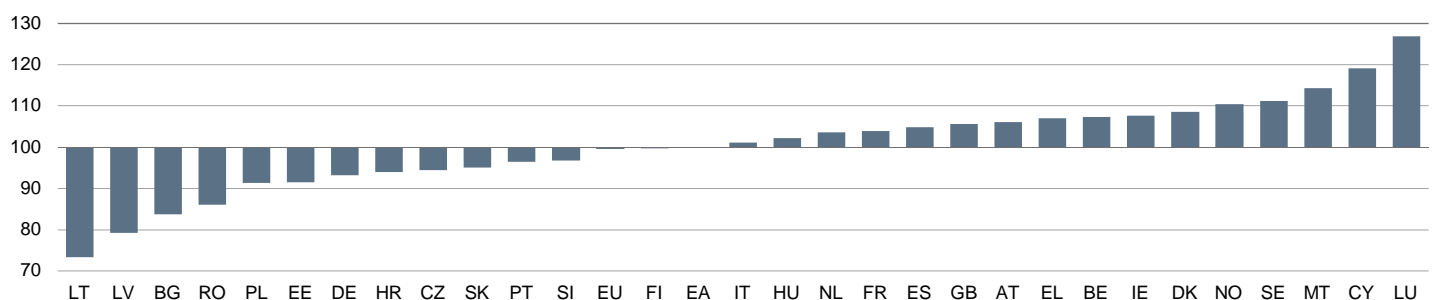
Sources: European Commission, Deutsche Bank Research
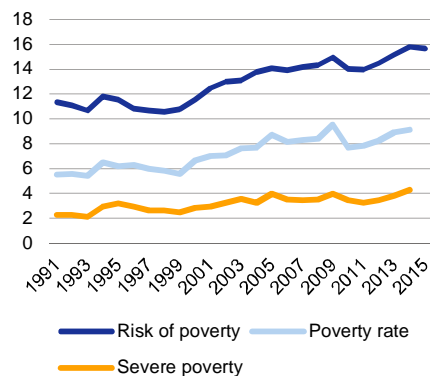
5. Conclusion

Germany: Income inequality 54

Gini coefficient: 0 (perfect equality);
1 (maximum inequality)

— Net income — Market income

Source: German Council of Economic Experts

Germany: Poverty indicators 55

% of population

— Risk of poverty — Poverty rate
— Severe poverty

Source: German Council of Economic Experts

Germany: Development of market income 56

Index: 1991=100

— 1th decile — Median
— 9th decile
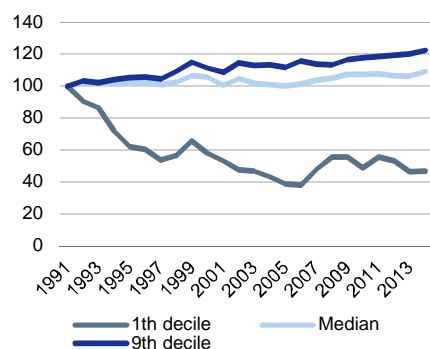
Source: German Council of Economic Experts

As during former automation waves, society is quite rightly wondering whether the automation-related prosperity gains will indeed be a benefit for society as a whole or only for a few. Right now, the most pertinent question is whether the market can ensure a just distribution of the automation-related benefits or whether they will accrue only to a small group of wealthy capital owners. Even though income distribution within individual countries has become considerably more unequal than a few decades ago and even though this is to some extent a result of technological progress and globalisation, there is, despite automation and digitalisation, currently no sign of a dramatic increase in income inequality.

Rather, income inequality, as measured by the Gini coefficient, has been mostly stable in Germany since 2005. This applies to both market and net income, i.e. before and after redistribution efforts (Chart 54). Economies are not struggling with unemployment any more, but with a lack of qualified labour, which is likely to intensify as society ages. This development might dampen potential growth considerably. Moreover, official redistribution measures help to reduce income inequality significantly in comparison to the differences in market incomes before taxes and transfers. This proves that redistribution is indeed taking place (Chart 54). While the at-risk-of-poverty rate has risen since the end of the 1990s, its increase has been slow since 2005 (Chart 55). In addition, the rate is not exceptionally high in an international comparison. The poverty rate and the share of those who are seriously impoverished have developed similarly. Overall, German social and redistribution policy seems to be an effective instrument to combat poverty.

Nevertheless, it is highly uncertain how the recent automation and digitalisation wave will affect the labour markets, the economy and the public finances in the long run. It is impossible to determine the potential impact of digitalisation on the structure and sustainability of social security systems. Still, the effect need not necessarily be negative. In fact, numerous rapidly ageing societies may improve their chance of remaining prosperous despite a shrinking workforce, and the sustainability of public finances may increase. Ageing Germany, for example, might benefit enormously from digitalisation. Much will depend on the pace of change and on political measures which may shape the transformation. Education policy in particular will play a key role. Good and efficient education policies (school and university education as well as vocational training and re-training) may help to ensure that positive complementary effects more than outweigh potential negative substitution effects on the labour market. This would counteract a more unequal distribution of income.

As we have explained in this study, numerous developed countries will need to deal with enormous financial challenges and re-think their funding structure if production becomes more capital-intensive, technological progress causes mass unemployment and the wage ratio shrinks rapidly. This is because, due to the significant gap between tax rates on labour and capital – or wages and corporate profits – in many countries, any additional corporate tax revenues will probably not be sufficient to offset the revenue losses from declining (wage) taxes and social security contributions. At the same time, expenditure on unemployment and social security benefits looks set to increase. Moreover, governments might find it very difficult to close the funding gaps in the negative scenarios by raising taxes on the beneficiaries of digitalisation (e.g. corporate and wealth income). Raising corporate or wealth taxes in order to regain fiscal elbowroom under one of the negative scenarios would require a high degree of international political coordination and cooperation in the area of tax policy. However, it is highly difficult even today to find a consensus how to deal with multinationals' efforts to shift profits and avoid taxes and to adapt the international tax system to the situation in the 21st century.
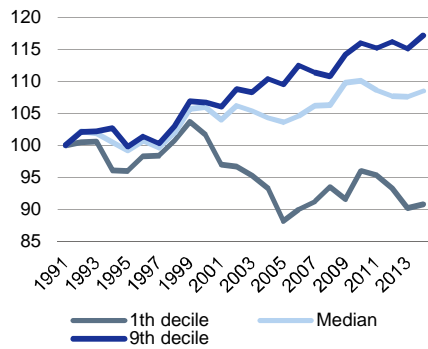
Germany: Development of net income | 57

Index: 1991=100

1th decile
9th decile
Median

Source: German Council of Economic Experts

As long as it is unclear whether robots and humans will become colleagues or competitors (and how strong the impact on employment and productivity is likely to be), society is probably well advised not to make radical changes to its tax and social security systems. Instead, policymakers should focus on education policy and on adapting the international tax system, particularly in the area of corporate taxation, to the situation in the 21st century. Global solutions to the tax problem would be preferable to national solo efforts.

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Appendix

Box 1: Robotisation and distribution of income

Economy 1: Robots and humans as "perfect substitutes"

Robotisation leads to a 'singular' economy dominated by capital and to major inequalities in terms of income and wealth distribution

Berg, Buffie and Zanna (2016) claim that, in a world where robots – a new type of capital goods – become a perfect substitute for (human) labour, a small increase in robot productivity will be sufficient to increase income inequalities drastically. As the combined supply of labour from humans and robots rises, wages will decline, at least in a market economy. With robots becoming relatively cheaper, demand for and prices of traditional capital goods, such as buildings or machinery and equipment, will initially decline as well. This means that wages for human workers in these sectors will decline, too. As prices fall, the capital yield of traditional capital goods will rise again and drive demand and output upwards. This should lead to higher investment in both robots and traditional capital goods, which means that these two types of investment will increasingly dominate the economy.

Capital will gain importance as an input factor, and output will rise steadily despite the decrease in employment. As robots only produce, but do not consume goods, total income will rise and need to be distributed. At the same time, wages will decline both in absolute and relative terms and unemployment will increase for structural reasons. As work-related income declines, workers' consumption will decrease as well, whereas capital owners (who will initially use much of their income for investment purposes) will consume more, both in absolute and relative terms.

Under this scenario, with robots and humans being perfect substitutes on the labour market, the wage ratio will steadily decline and reach 0% on the margin. At the same time, the share of capital owners or entrepreneurs (in simplified terms: corporate profits) in total distributable income will rise and may reach 100% in an extreme case. As capital input increases steadily both in relative and absolute terms, and capital (wealth) is much less equally distributed than income even now, the distribution of income will become increasingly unequal in this scenario. If tax policy remains unchanged and income from work is still taxed at considerably higher rates than corporate or wealth income, the fiscal burden will be significant, even though the effects of higher overall income on the one hand and lower tax rates on a rising share of the tax base on the other will partially cancel each other out.

Economy 2: Robots and humans as "imperfect substitutes"

While robotisation will raise income in the long run, it will also increase economic imbalances, both in the short and in the long term. If robots and humans are not perfect, but imperfect substitutes on the labour market, the distribution effects of robotisation will be similar to those under the first scenario, but be less extreme. If we assume that robot productivity rises considerably during the coming decades, but that robots cannot fully replace humans on the labour market, the impact on income distribution will still be negative. The increased use of robots will initially weigh on demand for traditional capital goods and, consequently, on wages in these sectors. In the medium term,

however, investment in traditional capital goods will rise again, as in the scenario described above. As human productivity rises in the wake of closer collaboration with robots and traditional capital goods, wages will increase after some delay (inclusive growth). According to a model developed by Berg, Buffie and Zanna (2016), it will take roughly 20 years until the productivity effect outweighs the impact on substitution. Under this scenario, capital will increasingly, but not completely dominate the economy. Even though economic imbalances will increase, real wages will ultimately be much higher than in "pre-robotisation" times. Nevertheless, social policy will be in for a major challenge, particularly during the phase in which wages decline. During the transition period, the government will need to support numerous people with social security benefits.

Economy 3: Robots, "qualified" and "unqualified" humans

Robotisation will lead to a polarisation of society, with winners (capital owners and qualified workers) and losers (unqualified workers) and a dramatic increase in economic inequality

In their third scenario, Buffie and Zanna (2016) assume that robots and two types of human workers exist next to each other. On the one hand, there are 'qualified' workers who have special skills and cannot be replaced by robots (complementary skills). These "special skills" do not necessarily include what is traditionally regarded as a good education; they may simply be human qualities, such as creativity, empathy or similar features. On the other hand, there are 'unqualified' workers who do not have special skills and can easily be replaced by robots on the labour market (almost perfect substitutes).

As in the first two scenarios, the additional capital input will result in higher per-capita income, and the share of capital in distributable income will increase. At the same time, there will be a polarisation on the labour market. While the wages of qualified workers will rise on the back of increasing labour productivity (both in absolute terms and relative to those of unqualified workers), the wages of unqualified workers will decline both in relative and absolute terms, and there is no chance of their recovery in the medium to long term. In this scenario, income distribution imbalances will increase dramatically. Ultimately, unqualified workers will lose out under this scenario, whereas capital owners and qualified workers (the winners) will enjoy a steady rise in prosperity. According to model calculations for a baseline scenario, the real wages of unqualified workers may drop by 40% within 50 years and their share in total income may decline from 35% to 11%.

Box 2: Measuring the effective tax burden

Implicit tax rate (ITR) calculated on the basis of macro data

Once every year, the European Commission (EC) updates and releases the ITRs on labour income (employed labour)[10] and on (private) consumption[11], which are calculated on the basis of tax statistics and national accounts. An appendix on the methodology describes the data sources and the calculation method for these implicit tax rates.

ITR on private consumption

The implicit tax rate on (private) consumption is calculated using the ratio between consumption tax revenues (numerator) and households' consumption expenditure (national accounts; domestic concept) (denominator). Taxes on consumption include VAT, import tariffs, eco taxes, taxes on financial or capital-market transactions and consumption taxes such as vehicle taxes, tobacco taxes etc.

ITR on (employed) labour

The implicit tax rate on employed labour is an aggregated estimate for the effective average tax burden on employed labour income. It is calculated using the ratio between the aggregate tax revenue from taxes on labour income (numerator) and the total compensation of employees in an economic territory (domestic concept) (denominator). The ITR on labour is calculated for employed labour only, i.e. excluding taxes on social security transfers or pensions. Taxes on labour income include the share of income tax revenues stemming from wage taxes, obligatory contributions to the social security system by employees and employers and any payroll taxes paid by employers. The denominator includes the total remuneration of employees in an economy and any payroll taxes paid by employers.

ITR on capital (income)

While tax statistics and national accounts make it relatively easy to calculate and interpret tax revenues from taxes on labour and consumption and their bases, it is highly difficult to construct and interpret the implicit tax rate on capital (as a whole) and its sub-components (such as wealth income, corporate profits, real-estate taxes etc). This is due not only to the fact that 'capital' is a highly complex entity, which can take very different forms and exhibit different characteristics, but also to the problems concerning the (statistical) availability of the macroeconomic data needed to calculate the (tax) base.

The term "capital"

In its widest definition, "capital" includes physical capital (such as machinery and equipment, robots, IT systems or real estate), immaterial goods (such as licences or patents), financial investments (such as equities or derivatives) and savings (such as bank deposits). Government taxes on capital include taxes on profits from commercial ventures (corporate profits) and any other taxes and levies necessarily related to commercial activity (such as property taxes on

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[10] See EC (2018). Annex B: Methodology and explanatory notes. P. 263 et seq. A detailed overview of taxes on labour is available on p. 264 (Box C.2: Definition of taxes on labour).

[11] See EC (2018). Annex B: Methodology and explanatory notes. P. 263 et seq. The types of tax on consumption are listed on p. 263 (Box C.1: Definition of taxes on consumption).

commercial buildings or vehicle taxes on company cars). As a rule, taxes on capital are levied on either corporate and wealth income or on assets[12].

Challenges related to the calculation and interpretation of ITRs on capital

According to the EC, a number of factors may distort the ITRs on capital and make their interpretation more difficult. For example, ITRs on capital tend to be highly sensitive to cyclical fluctuations. In addition, there is often a significant delay between the time when the tax base (for example corporate profits) is generated and the time when taxation actually takes place. This makes ITRs a less informative figure. For example, loss deferrals and deductions from earlier business years may distort the ITR of a highly profitable year to the downside because the numerator (the actual tax payment) declines and the denominator (the profit as set out in the national accounts) rises. Similarly, a boom phase may lead to significant income from sales on the asset or real-estate markets, which means that the government receives unexpectedly high revenues from related taxes. As a result, the ITR is distorted to the upside. Moreover, structural changes to corporate financing may distort the ITRs, for example if companies shift from tax-deductible loan financing to non-tax-deductible equity financing during a phase of declining interest rates.

The EC describes different methods to estimate the effective tax burden on capital in its methodology; however, all of them have their weaknesses. The ITR on capital may be calculated using the ratio between the total of all capital-related taxes (corporate and wealth income plus taxes on assets) (numerator) and the broadest definition of "capital" as a base (denominator). While this indicator gives the effective average tax burden on all types of capital, it is extremely difficult to interpret and has major weaknesses in terms of construction. The numerator includes all capital-related taxes (profit taxes as well as taxes on sales of assets, inheritances or gifts), but the denominator does not cover all types capital (for example, it does not include the taxation base for certain asset holdings, such as the value of an equity holding which, if sold, will generate taxable income from sales). As a alternative, ITRs for capital income or different types of capital income are calculated, which are based on a narrower definition of capital, but are easier to interpret. These include the ITRs on (a) capital income as a whole (commercial and wealth income) and its sub-components such as (b) commercial income by corporates (revenues, profits) and (c) commercial income by self-employed workers and household wealth income.

Definition and other problems related to the calculation of ITRs

The European Commission is currently working on a review and further development of its calculation method(s) for the ITRs on capital and will not release these figures until further notice. However, the definition and calculation problems are not limited to the calculation of ITRs on capital, but also apply to the calculation of the implicit tax burden on labour.

The EU and OECD tax statistics define four main categories of direct government tax revenues, namely (a) income taxes paid by natural persons, (b) income or profit taxes paid by corporates, (c) social security contributions from employers, employees and self-employed persons and (d) payroll taxes paid by corporations. This allows a rough breakdown of direct tax revenues into taxes on labour and taxes on capital (income). However, the tax statistics do not contain any information about how much of the total taxes paid by natural persons stems from different types of income (such as wages, interest income, dividends, rents or commercial activity or self-employment). In order to gauge the effective tax burden on labour, the EC uses data or calculations/estimates of

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[12] See EC (2018). Annex B: Methodology and explanatory notes. Box C.3: Definition of taxes on capital, Box C.4: Definition of taxes on the income of corporations and Box C.5: Definition of taxes on capital and business income. Pp. 265 -66.

the national ministries of finance of the EU member states to estimate the shares of (a) income from employment, (b) income from self-employment, (c) income from social transfers and pensions and (d) income from capital income in total tax revenues from income taxes paid by natural persons[13].

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[13] See EC (2018). Annex B: Methodology and explanatory notes. Pp. 284 -95.

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