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This *Survey* is published on the responsibility of the Economic and Development Review Committee of the OECD, which is charged with the examination of the economic situation of member countries.

The economic situation and policies of Germany were reviewed by the Committee on 26 October 2020. The draft report was then revised in the light of the discussions and given final approval as the agreed report of the whole Committee on 24 November 2020.

The Secretariat's draft report was prepared for the Committee by Andrew Barker, Ze'ev Krill, Alexandra Effenberger, David Gierten, Maximilian Reisch and Verena Weber under the supervision of Mame Fatou Diagne. Statistical research assistance was provided by Corinne Chanteloup. Publication coordination was provided by Poeli Bojorquez. The Survey benefitted from contributions by Jean-Victor Alipour and Michaela Haderer.

The previous *Survey* of Germany was issued in June 2018.

Information about the latest as well as previous Surveys and more information about how *Surveys* are prepared is available at http://www.oecd.org/eco/surveys.

BASIC STATISTICS OF GERMANY, 2019

(Numbers in parentheses refer to the OECD average)*

LAND, PEOPLE AND ELECTORAL CYCLE					
Population (million)	83.1		Population density per km²	235.0	(37.9)
Under 15 (%)	13.0	(17.7)	Life expectancy (years, 2018)	81.0	(80.6)
Over 65 (%)	22.1	(17.6)	Men	78.6	(78.0)
Foreign-born (%)	16.2		Women	83.3	(83.3)
Latest 5-year average growth (%)	0.5	(0.6)	Latest general election	September 2017	
ECONOMY					
Gross domestic product (GDP)			Value added shares (%)		
In current prices (billion USD)	3,867.6		Primary sector	0.8	(2.4)
In current prices (billion EUR)	3 454.7		Industry including construction	29.7	(26.1)
Latest 5-year average real growth (%)	1.6	(2.2)	Services	69.5	(71.4)
Per capita (000 USD PPP)	56.3	(46.7)			
GENERAL GOVERNMENT Per cent of GDP					
Expenditure	45.1	(40.6)	Gross financial debt	68.1	(110.0)
Revenue	46.6	(37.6)	Net financial debt	27.6	(65.0)
EXTERNAL ACCOUNTS					
Exchange rate (EUR per USD)	0.89		Main exports (% of total merchandise exports)		
PPP exchange rate (USA = 1)	0.74		Machinery and transport equipment	48.0	
In per cent of GDP			Chemicals and related products, n.e.s.	15.5	
Exports of goods and services	47.0	(54.2)	Manufactured goods	11.8	
Imports of goods and services	41.1	(50.6)	Main imports (% of total merchandise imports)		
Current account balance	7.2	(0.3)	Machinery and transport equipment	37.0	
Net international investment position	71.0		Chemicals and related products, n.e.s.	13.9	
			Miscellaneous manufactured articles	12.9	
LABOUR MARKET, SKILLS AND INNOVATION					
Employment rate for 15-64 year-olds (%)	76.7	(68.7)	Unemployment rate, Labour Force Survey (age 15 and over) (%)	3.1	(5.4)
Men	80.5	(76.2)	Youth (age 15-24, %)	5.8	(11.7)
Women	72.8	(61.3)	Long-term unemployed (1 year and over, %)	1.2	(1.4)
Participation rate for 15-64 year-olds (%)	79.2	(72.8)	Tertiary educational attainment 25-64 year-olds (%)	29.9	(38.0)
Average hours worked per year	1 386	(1 726)	Gross domestic expenditure on R&D (% of GDP, 2018)	3.1	(2.4)
ENVIRONMENT					
Total primary energy supply per capita (toe)	3.6	(3.9)	CO_2 emissions from fuel combustion per capita (tonnes)	7.9	(8.3)
Renewables (%)	14.6	(10.8)	Water abstractions per capita (1 000 m^3, 2016)	0.3	
Exposure to air pollution (more than 10 µg/m^3 of PM2.5, % of population, 2017)	90.3	(58.7)	Municipal waste per capita (tonnes, 2018)	0.6	(0.5)
SOCIETY					
Income inequality (Gini coefficient, 2017)	0.29	(0.31)	Education outcomes (PISA score, 2018)		
Relative poverty rate (%, 2017)	10.4	(11.5)	Reading	498	(487)
Median disposable household income (000 USD PPP, 2017)	29.8	(24.0)	Mathematics	500	(489)
Public and private spending (% of GDP)			Science	503	(489)
Health care	11.7	(8.8)	Share of women in parliament (%)	30.9	(30.7)
Pensions (2017)	10.2	(8.6)	Net official development assistance (% of GNI, 2017)	0.67	(0.37)
Education (primary, secondary, post sec. non tertiary, 2017)	3.0	(3.5)			

* Where the OECD aggregate is not provided in the source database, a simple OECD average of latest available data is calculated where data exist for at least 29 member countries.

Source: Calculations based on data extracted from the databases of the following organisations: OECD, International Energy Agency, International Monetary Fund.

Executive summary

The economy is in recession

The German economy experienced a severe contraction in 2020 (Table 1) following a decade-long expansion**.** The initial COVID-19 outbreak was brought under control with less stringent containment measures than in many countries thanks to high health sector capacity and early testing, tracing and isolation of cases. Resurgence of the virus in October led to renewed nationwide containment measures in November, including closure of hospitality and entertainment venues, while retail as well as schools remained open.

The economy has been hit hard by the collapse in global trade. Germany exports a large part of its output, particularly manufactured capital goods. Key trading partners in Europe have been badly affected by the crisis and stalling global investment has seen demand for capital goods plunge.

Table 1. A deep recession in 2020

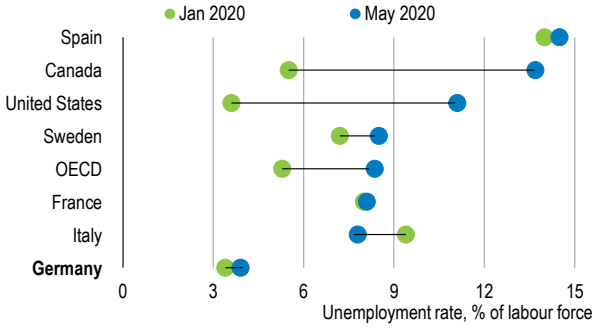
	2020	2021	2022
Gross domestic product	-5.5	2.8	3.3
Unemployment rate	4.2	4.8	4.3
Fiscal balance (% of GDP)	-6.3	-4.4	-1.8
Public debt (gross, Maastricht, % of GDP)	73.9	76.2	75.8

Source: OECD Economic Outlook 108 database.

Increasing unemployment was cushioned by the government-supported short-time work scheme. Short-time work bore a much bigger part of the reduced demand for labour than did unemployment (Figure 1), with almost 20% of all dependent workers in short-time work in April 2020. An extended downturn would increase the need for resource reallocation, in which case consideration should be given to more active labour market policy, such as training or placement assistance.

A strong government response to the crisis has reinforced health system capacity while protecting jobs and firms. Loans, guarantees, grants and equity injections safeguarded liquidity, while a recovery package is supporting consumption and investment. These measures notwithstanding, bank vulnerabilities should be monitored closely as corporate and household defaults are liable to increase. There is around EUR 140 billion (4¼ per cent of GDP) of discretionary stimulus in 2020. The rate of consolidation needs to be carefully managed, as a rapid withdrawal of support could derail the recovery, particularly if underlying growth is weak.

Figure 1. Increases in unemployment were cushioned by short-time work



Note: Data for United States refer to June. Temporary layoffs are included in unemployment figures for the United States and Canada but not for the other countries.
Source: OECD Short-Term Labour Force Statistics database.

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Structural reforms and infrastructure investment can support the recovery

The COVID-19 crisis exacerbates structural challenges from weak external demand and the energy transition. Policy needs to facilitate the shift to cleaner energy and new technologies in the automotive industry, while accelerating progress on digital transformation.

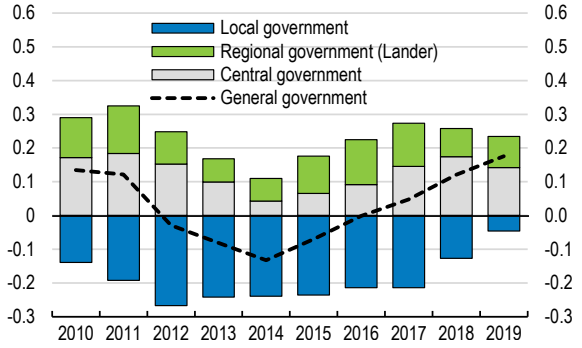
Infrastructure investment, which is critical for digital transformation and decarbonisation, has been insufficient and could be an important part of the recovery. Public investment has stepped up since 2014 (Figure 2) and further spending on low-emission transport, digitalisation and health has been announced. These are key areas where more investment is needed, along with social housing, early childhood education and electricity networks. Two decades of low investment have left a backlog, while construction and administrative capacity and cumbersome planning procedures constrain delivery.

Infrastructure governance reforms and active federal government support are needed to overcome capacity constraints. Independent infrastructure planning advice would improve alignment across sectors and provide greater certainty for construction sector companies to expand capacity. Further streamlining planning processes, cooperation between agencies and

more attractive employment conditions for public sector planners would help. Municipalities' revenues have been hit hard by the crisis and measures to partially compensate for shortfalls will be insufficient to make up the backlog of municipal investment in transport infrastructure and schools.

Figure 2. Public investment has recovered, but net municipal investment is still negative

Net public investment[1] by level of government, % of GDP



1. Public gross fixed capital formation less depreciation
Source: OECD National Accounts database.

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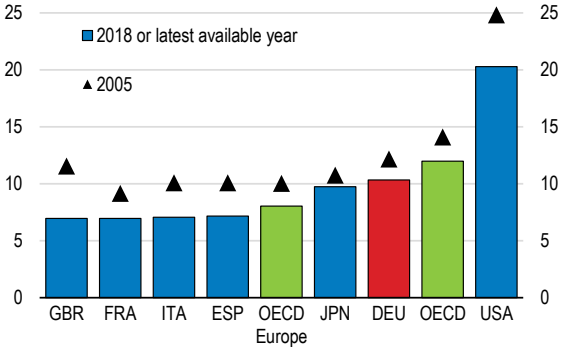
Germany made considerable progress on climate change policy in 2019, which must not be derailed by the COVID-19 crisis. Key steps include introduction of emissions pricing in transport and heating, increased support for electric vehicles and charging stations, higher targets for renewable power generation, and a commitment to cease coal-fired generation by 2038 at the latest. Despite success deploying renewables in the electricity sector over the past two decades, emissions are high (Figure 3).

Further policy steps are needed to meet the target to reduce greenhouse gas emissions by 55% by 2030. Coal-fired generation should be reduced ahead of schedule via stronger price signals, which is a cost-effective way to decrease emissions. Stronger price signals would also promote more efficient waste management. Energy efficiency requirements on new buildings are high, but energy efficient renovations need to increase by at least 50% to meet the 2050 goal of a near climate-neutral building stock. The transport sector is unlikely to meet its 2030 abatement target. Further action is needed on pricing for fuels, vehicles and roads, while providing alternatives through sustainable transport modes.

Figure 3. GHG emissions per capita are high compared with other European countries

Total greenhouse gas emissions per capita[1]



1. Excluding land use, land use change and forestry; thousand kilograms per capita.
Source: OECD Environment Database.

StatLink https://doi.org/10.1787/888934200299

Unleashing digital transformation

Germany is a world leader in technology and engineering, but lags on digital transformation. Access to high-speed broadband networks could be improved, particularly in rural areas. Mobile data usage and connection speeds are also low. Firms in Germany are behind in the adoption of key ICT tools required to create value with data, such as high-speed broadband and cloud computing (Figure 4).

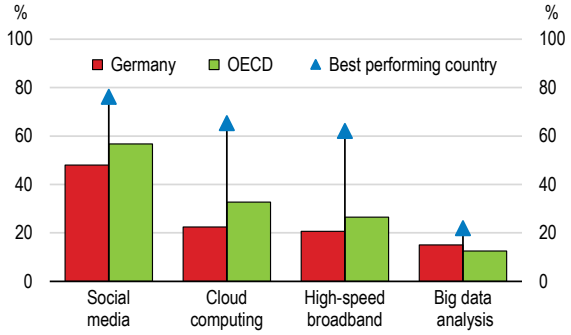
To improve connectivity, administrative processes should be streamlined and competition enhanced. The ambitious goal for nationwide gigabit Internet coverage by 2025 is welcome, as are public broadband subsidies, if used efficiently. However, the disbursement of funds has been slow. Long approval processes delay progress, particularly in relation to rights of way required to build infrastructure. The entry of a fourth network operator to the mobile market is a positive development and should be supported by regulatory policy for this to increase competition and outcomes for consumers.

Barriers to firms' adoption of advanced ICTs and investment in knowledge-based capital need to be addressed. Innovation and productivity are held back by firms' sluggish adoption of advanced ICTs that are crucial to create value with data, SMEs' difficulties to access bank financing, a low initial cap on new research and development tax incentives and digital security concerns. More

venture capital is essential to finance start-ups with high growth potential and related financing instruments could become more effective by avoiding complexity and scaling up later-stage funding.

Figure 4. German firms lag in the adoption of advanced ICT tools and activities

% of firms (10+ employees), 2019 or latest year available



Note: Excludes firms from the financial sector. High-speed broadband are subscriptions with 100+ Mbps.
Source: OECD ICT Access and Usage by Businesses database.

StatLink https://doi.org/10.1787/888934200318

The COVID-19 crisis increases the importance of accelerating progress towards digital government and a data-driven public sector. Germany has been slow introducing digital public services, but progressing on high-impact services is now a priority. Greater efforts are also needed to enhance collaboration across levels of government and access to open government data.

Strong foundational skills help people adjust to new technology. The impact of good numeracy and literacy skills on earnings and employment is higher in Germany than in most OECD countries, reflecting strong demand for these skills. Better acquisition of foundational skills, especially for those with disadvantaged backgrounds, would help reduce inequality, secure opportunities for upward intergenerational mobility and support future participation in adult education.

If teachers have the right complementary skills, digital technologies can enhance students' skills and engagement. Germany is lagging other OECD countries in using digital technologies in schools and the skills of teachers to use them effectively. Countries have been tackling the need for ICT training through a range of policies, from compulsory training, to national accreditation standards or certification for teachers.

The crisis risks exacerbating labour market inequalities

Upward earnings mobility is weak and school closures due to COVID-19 risk further increasing the gap between advantaged and disadvantaged students. Youth, women and low-wage workers are more prone to unemployment as they are concentrated in some industries that are being hit heavily by the crisis.

Reducing high effective tax rates would remove one impediment to moving to jobs with higher earnings. Taxation of labour income is high; reducing this while strengthening environmental, property and capital income taxation and removing exemptions would improve incentives and increase efficiency. Building on Germany's success with social partnerships can help firms and workers weather the economic downturn through training, collective agreements and continuing with effective social dialogue for setting minimum wages.

The gender wage gap is high and has declined little over the past two decades. One factor is the high share of part-time work among women, particularly mothers. Improving further the availability of high quality, full-time childcare and encouraging longer parental leave by fathers would strengthen sharing of child care and support female employment. Women account for a very small proportion of management positions. Improving pay-transparency laws, broadening quotas, improving accessibility of STEM and ICT fields of study, and supporting greater flexibility on working hours and teleworking are key levers to promote gender equality.

The share of the workforce covered by occupational licensing is the highest in the OECD. Occupational licensing reduces competition, pushing up prices and holding back productivity and job mobility. Licensing is likely to be particularly costly for immigrants who cannot use their skills, and in the construction sector where labour shortages hold back investment.

Housing shortages in urban areas prevent people moving closer to jobs. Lack of availability of developable land and stringent rent control hold back the housing supply response. Rent controls introduced in 2015 have not been found to have a negative effect on construction so far, but tighter measures such as the rent freeze in Berlin risk restricting mobility.

MAIN FINDINGS	KEY RECOMMENDATIONS
Macroeconomic policies to support the recovery	
Fiscal policy is highly expansionary and an immediate return to a tight deficit limit under the debt brake could derail the recovery.	Stand ready to give further support if the recovery is weak. Gradually remove fiscal support once the recovery is well underway. Pursue planned fiscal consolidation while addressing long-term challenges.
Structural reforms and infrastructure investment for a sustainable recovery	
Public investment has picked up since 2014, but not enough to resolve the infrastructure backlog. Future needs will increase with the energy transition, digital transformation and ageing.	Further increase spending on high quality public investment, including through funding to municipalities.
Capacity constraints in the construction industry and local planning offices hold back the delivery of new infrastructure.	Bolster local planning capacity through inter-municipal cooperation, training and expanding staffing in key technical roles.
The tax burden on low labour income is high, due to high social security contributions, while environmental and property taxation is low and exemptions to inheritance and capital income taxes contribute to high wealth inequality.	Reduce taxation of labour income, while removing inheritance tax exemptions, raising reduced VAT tax rates to the standard rate, and strengthening environmental, property and capital income taxation.
Progress in reducing greenhouse gas emissions has been concentrated in electricity generation, with the transport sector in particular facing considerable challenges to meet its 2030 goal.	Provide low-emissions alternatives through expanding public transport and charging networks, urban planning that creates proximity between people and places they visit for work or leisure, and facilitating telework.
Substantive emissions pricing is being introduced for transport and heating, but inconsistencies in energy taxation remain.	Make emissions pricing more consistent across sectors and fuels.
Unleashing digital transformation	
A very low share of fibre results in low broadband speeds. Public funds for broadband deployment have been disbursed slowly.	Shorten administrative approval times for communication network deployment, including obtaining rights of way, and improve co-ordination between public authorities.
The entrance of a fourth player to the mobile market has the potential to promote competition and innovation.	Support competition through facilitating that the market entrant can obtain national roaming agreements. Consider all market participants when existing spectrum licenses expire.
Firms' investments in knowledge-based capital that is crucial for data-driven innovation, including software, databases, and organisational capital, are low and have hardly increased over the past decade.	Improve conditions for firms to invest in knowledge-based capital, including by reviewing the cap for R&D tax incentives to make them more applicable to mid-range companies.
The share of individuals and firms interacting with public authorities online is growing only slowly and Germany lags behind on open government data; the now mandatory e-procurement could be further improved.	Accelerate progress towards digital government and a data-driven public sector, focusing on high-impact services, collaboration across levels of government and open government data, and systematically collect and use data from e-procurement processes.
The use of ICT in schools lags behind most OECD countries and computational thinking and programming skills have much scope to improve, in particular among women.	Increase ICT training for teachers to ensure effective use of ICTs. Introduce computational thinking earlier (particularly benefitting girls) while avoiding gender stereotypes in education and career guidance.
Increasing labour market inclusion	
High marginal effective tax rates at the bottom of the income distribution create disincentives to expand labour market participation and can trap individuals in low-wage employment.	Reduce marginal effective tax rates for low income earners through slower and more coordinated withdrawal of social assistance, child supplement and housing benefits.
Mothers, even those with older children, often work part time. Flexible work arrangements can reduce part-time work.	Strengthen legal rights to flexible working arrangements for all employees, including teleworking where possible.
Occupational entry regulations affect a high share of the workforce, which leads to higher prices, slows labour market dynamism and hurts the ability of immigrants to use their skills.	Liberalise entry conditions, prioritising sectors subject to supply constraints (such as construction) and preserving the strengths of the vocational education and training system.
Germany has relatively strict rent control, which is associated with lower housing supply elasticities and reduced labour mobility.	Reduce strictness of rent controls in markets where more supply is needed, such as Berlin.

1 Key policy insights

1.1. Investing to hasten the recovery and prepare for the challenges ahead

The German economy is experiencing a severe contraction in 2020 and the recovery will require sustained macroeconomic policy support. Germany managed the initial stages of the crisis well, as high health sector capacity and early testing, tracing and isolation of cases helped bring the initial virus outbreak under control with less stringent containment measures than in many neighbouring countries. A strong government response is protecting jobs and firms, using fiscal space from prudent budgeting before the crisis. The German government has taken a leadership role in establishing the EU Recovery and Resilience Facility, which will support the European recovery through EUR 750 billion in loans and grants to member states funded by new EU debt.

The COVID-19 crisis follows a decade-long expansion during which strong trade performance and domestic demand drove income growth and saw unemployment fall to the lowest level since reunification. Structural challenges loomed, however, from the digital transformation, population ageing and the energy transition. Policy needs to facilitate the shift to cleaner energy and new technologies in the automotive industry, while accelerating progress on digital transformation, which has become even more important due to the pandemic.

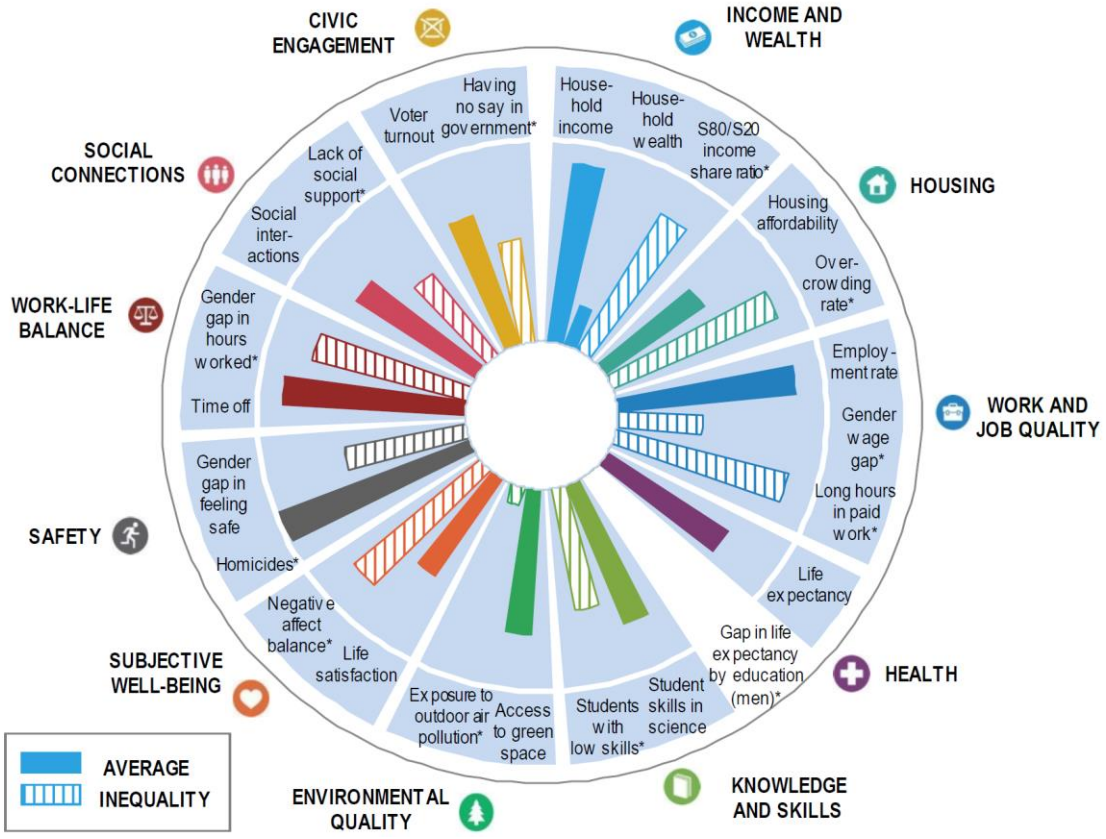
Before the crisis, wellbeing was generally high, with strong incomes, good work-life balance, above-average cognitive skills among students and good access to green space (Figure 1.1). Economic capital, greenhouse gas emissions and labour utilisation have seen consistent improvement over the past decade. However, health outcomes vary considerably by socio-economic status, exposure to air pollution has improved but remains high and the educational attainment of young adults – as measured by the Programme for the International Assessment of Adult Competencies (PIAAC) – and material footprint have worsened.

Income inequality had largely stabilised before the COVID-19 crisis, and due to a high level of redistribution, net income inequality is below the OECD average (Figure 1.2, Panel A). Nonetheless, the relative risk of living in poverty continued to rise, especially among children (Panel B). This happened even as unemployment declined to low levels, while the risk of poverty among the unemployed is the highest in the EU (Eurostat, 2018[1]). While strong government action has saved jobs, increases in the unemployment rate during the crisis may nonetheless push more households below the poverty line. Youth, women and low-wage workers are more prone to unemployment as they are concentrated in some heavily-hit industries. To counter the possibility of rising inequalities in the years to come, reforms will be needed to avoid trapping people in low-income jobs and foster gender equality.

Wealth inequality is high, with an upper decile share of 60%, compared with an average of below 50% in other OECD countries with available data. These data do not take into account some factors that contribute to equity, such as public pension wealth (which is just above the OECD average (Balestra and Tonkin, 2018[2])) or good access to government services such as free education. Drivers of high wealth inequality include low home and equity ownership rates, particularly among middle- and lower-income households, and large net wealth of firms concentrated among the upper decile (IMF, 2019[3]). High wealth inequality could hurt the opportunity for individuals to climb the social ladder. There is a strong association between family background and success at school (OECD, 2019[4]) and children of less wealthy parents show lower educational outcomes from their first year in school (Dräger and Müller, 2020[5]). School closures due to COVID-19 risk further increasing the gap between advantaged and disadvantaged students, due to differences in access to alternative educational activities and devices for online learning.

Figure 1.1. Wellbeing is generally high

Germany's well-being, 2018 or latest available year



Note: This chart shows Germany's relative strengths and weaknesses in well-being compared to other OECD countries. Longer bars always indicate better outcomes (i.e. higher wellbeing), whereas shorter bars always indicate worse outcomes (lower well-being) – including for negative indicators, marked with an *, which have been reverse-scored. Inequalities (gaps between top and bottom, differences between groups, people falling under a deprivation threshold) are shaded with stripes, and missing data in white.

Source: OECD (2020), How's life?, http://www.oecd.org/statistics/Better-Life-Initiative-country-note-Germany.pdf.

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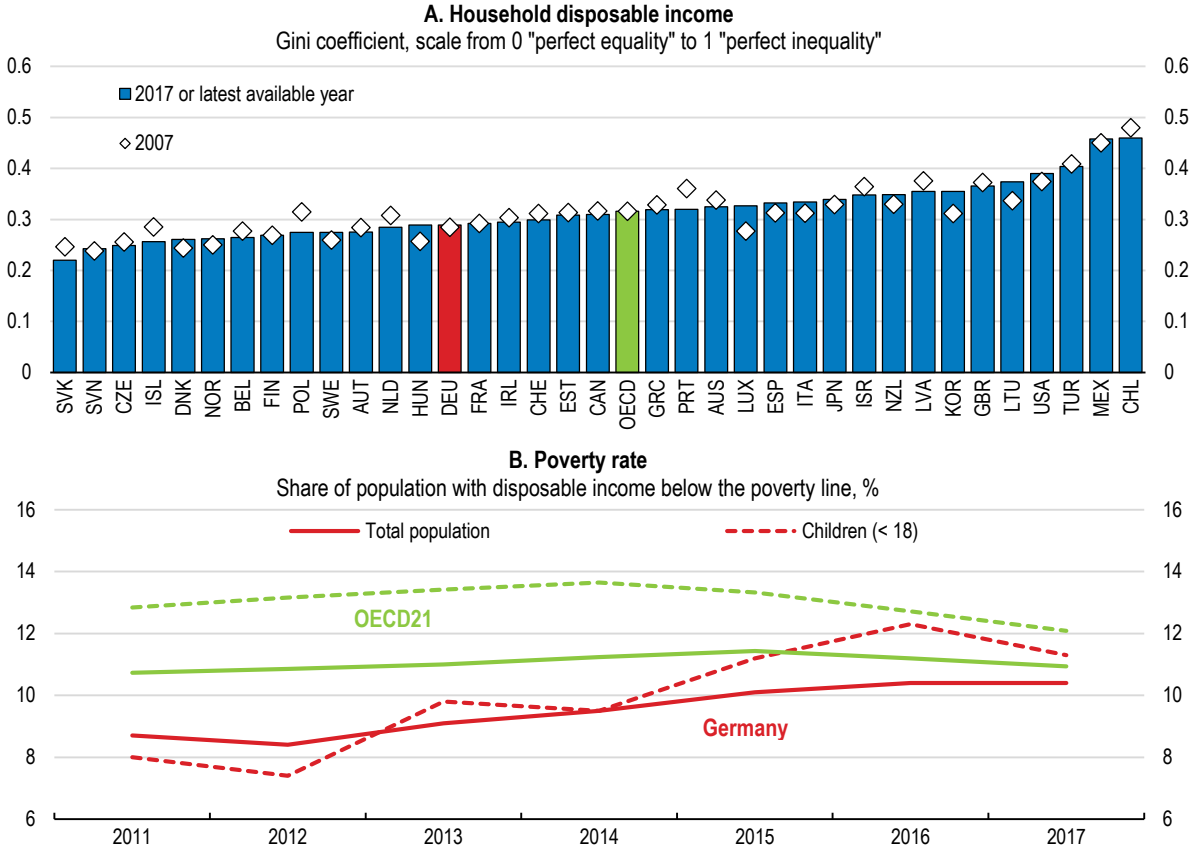
The recovery from the COVID-19 crisis is an opportunity to augment recent progress on climate change policy. Despite considerable success deploying renewables over the past two decades, Germany's greenhouse gas emissions per capita are below the OECD average but higher than most European countries (Figure 1.3) and the reduction in carbon intensity since 2000 has been slower than the OECD average (Figure 1.4, Panel A). Even following recent policy steps including carbon pricing in transport and heating, Germany will need further measures to meet its 2030 target of reducing emissions by 55% relative to 1990 (Umweltbundesamt, 2020[6]; Prognos, 2020[7]). There is scope to improve governance, as ministerial accountability for annual sectoral targets encourages short-term fixes and the independent expert council has a narrower mandate than successful examples like the UK Committee on Climate Change.

Aside from the critical need to slow climate change globally, reducing fossil fuel use can improve wellbeing within Germany. Despite improvements over the past two decades, 90% of the German population is exposed to small particle pollution above the WHO-recommended threshold of 10 micrograms per m^3 (Figure 1.4, Panel B), which is worse than the OECD average and causes about 60 000 premature deaths per year (EEA, 2019[8]). The largest sources are commercial and household emissions, industrial processes and road transport (EEA, 2019[9]). Applying recent EU evidence (Dechezleprêtre, Rivers and Stadler, 2019[10]) to Germany suggests worker productivity could be at least 1% higher if average exposure

was below the WHO threshold. Estimates for the UK suggest that national co-benefits could fully offset the resource costs of moving to net zero emissions by 2050 (UK Committee on Climate Change, 2019[11]).

Figure 1.2. Income inequality has largely stabilised, and is below the OECD average



Note: The poverty threshold is set at 50% of median disposable income. OECD21 is a simple average of the 21 OECD countries with data for all years.
Source: OECD Income Distribution database (IDD).

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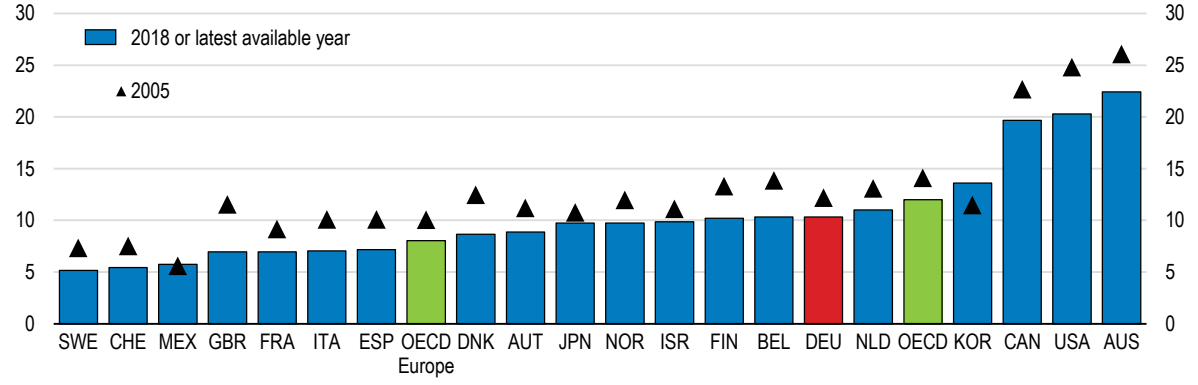
Figure 1.3. Greenhouse gas emissions per capita are high compared with other European countries

Total greenhouse gases excluding land use, land use change and forestry, thousand kilograms per capita



Source: OECD Environment Database.

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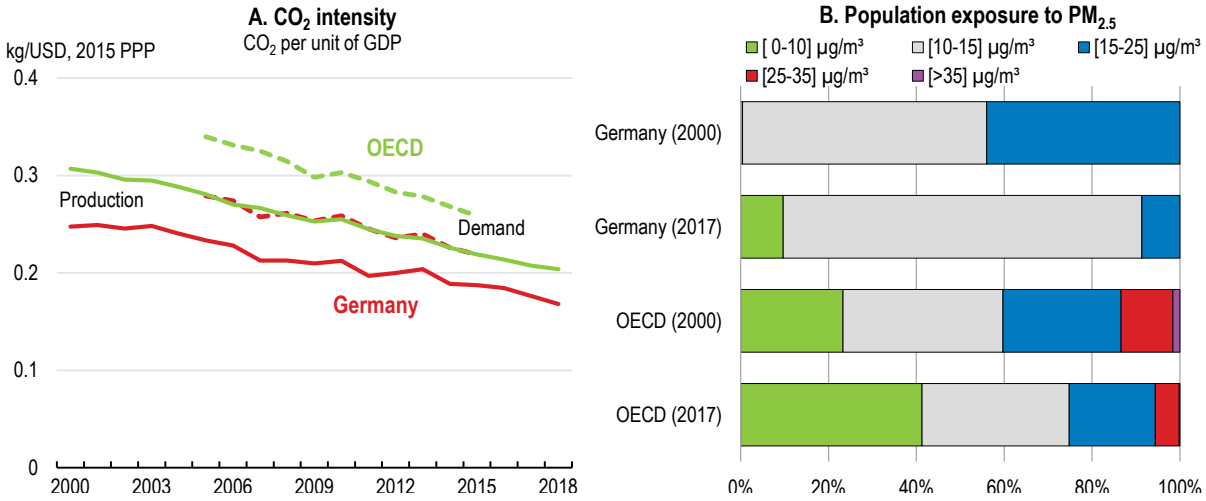
Figure 1.4. Carbon intensity and air pollution have improved



Note: WHO air quality guidelines are for annual mean exposure to PM2.5 not exceeding 10µg/m^3.
Source: OECD (2020), Green Growth Indicators, OECD Environment Statistics (database); OECD National Accounts (database); OECD (2020), Exposure to air pollution, OECD Environment Statistics (database).

StatLink https://doi.org/10.1787/888934200394

Barriers to resolving Germany's public investment backlog need to be removed for infrastructure investment to contribute to the recovery. Lack of investment is holding back the transition to greener energy and transport, expansion of early childhood education, as well as productivity benefits of adopting digital technologies. The government is boosting public investment and incentives for private investment through setting aside EUR 50 billion as part of its recovery package. Sufficient fiscal capacity needs to be dedicated to well-directed public investment, including increased transfers to municipalities, while resolving local planning and construction industry capacity constraints. Connectivity bottlenecks in communications infrastructure require streamlining of administrative approvals and public funding while facilitating competition, for example through infrastructure sharing. Increased investment in social housing should be paired with better targeting.

Strengthening the foundations for the digital transformation is crucial to enable the German economy to adapt to structural challenges, with potential benefits for productivity, growth and well-being. The COVID-19 crisis heightens the importance of going digital, as firms' reliance on ICT tools and activities, including for teleworking, remote learning and healthcare while maintaining social distancing increase demands for high-speed broadband, teachers' ICT skills and telemedicine, all of which are behind in Germany. Foundational and ICT specialist skills are also important as the workforce adapts to the digital age, with better foundational skills holding potential to reduce inequality, secure opportunities for upward intergenerational social mobility and increase future participation in adult education.

Against this backdrop the Survey has three main messages:

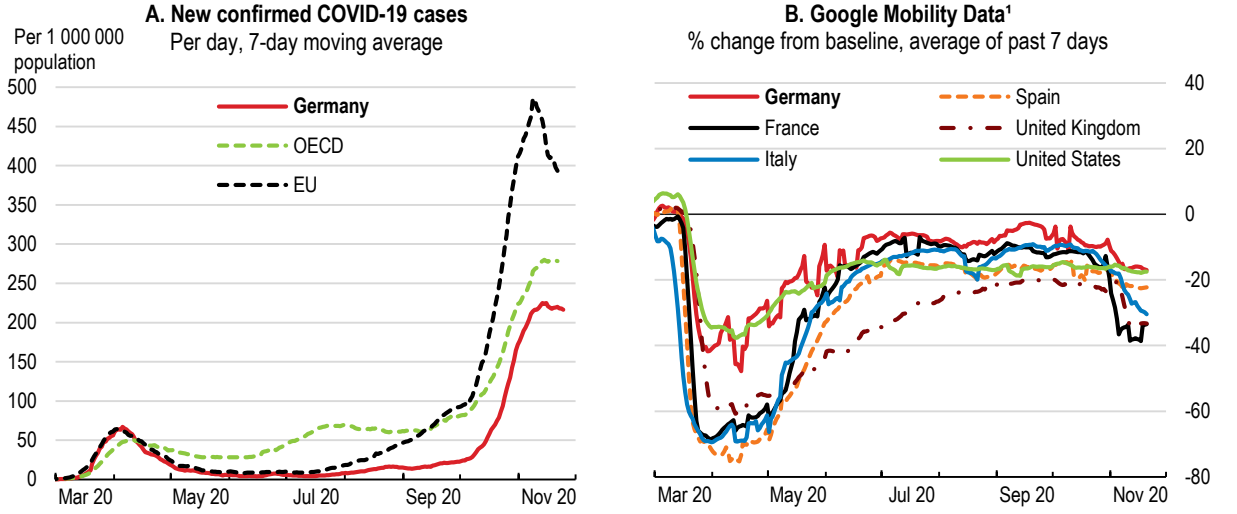
- A strong government response to the COVID-19 pandemic has reinforced health system capacity while protecting jobs and firms. To aid the recovery, fiscal support should be withdrawn only gradually, labour market inclusion promoted and barriers to infrastructure investment removed while improving infrastructure governance.
- Digital transformation should be accelerated through enhancing fixed and mobile communication network coverage and quality, skills development, and easing barriers to technology diffusion, which include low investment in knowledge-based capital, digital security concerns, slow progress towards digital government, and sluggish business dynamism.

- Continuing to boost investment in clean transport and energy infrastructure will support the economic recovery while contributing to the deep greenhouse gas emissions cuts needed. Sharper and more consistent price signals could efficiently bring down emissions in transport, buildings and electricity, as well as reduce waste by incentivising circular economic activities.

1.2. Germany has weathered the initial stages of the COVID-19 crisis well, but challenges loom

High health sector capacity and early testing, tracing and isolation of cases (including asymptomatic ones) contributed to bringing the first wave of the virus under control with less restrictive containment measures than in other major European countries (Figure 1.5). Before the pandemic started, Germany had a high number of intensive care beds per capita, the vast majority equipped with ventilators, and above OECD average numbers of doctors and nurses per head of population. More widespread use of digital technology in health care (Chapter 2, Box 2.3) would allow preparation for further waves of infection without compromising access and continuity of care for other patients.

Figure 1.5. Coronavirus cases in the first wave were brought under control with moderate restrictions on mobility



1. Average of retail/recreation, grocery/pharmacy and workplace indicators.
Source: OECD calculations based on European Centre for Disease Prevention and Control (ECDC); Google LLC, Google COVID-19 Community Mobility Reports, https://www.google.com/covid19/mobility/.

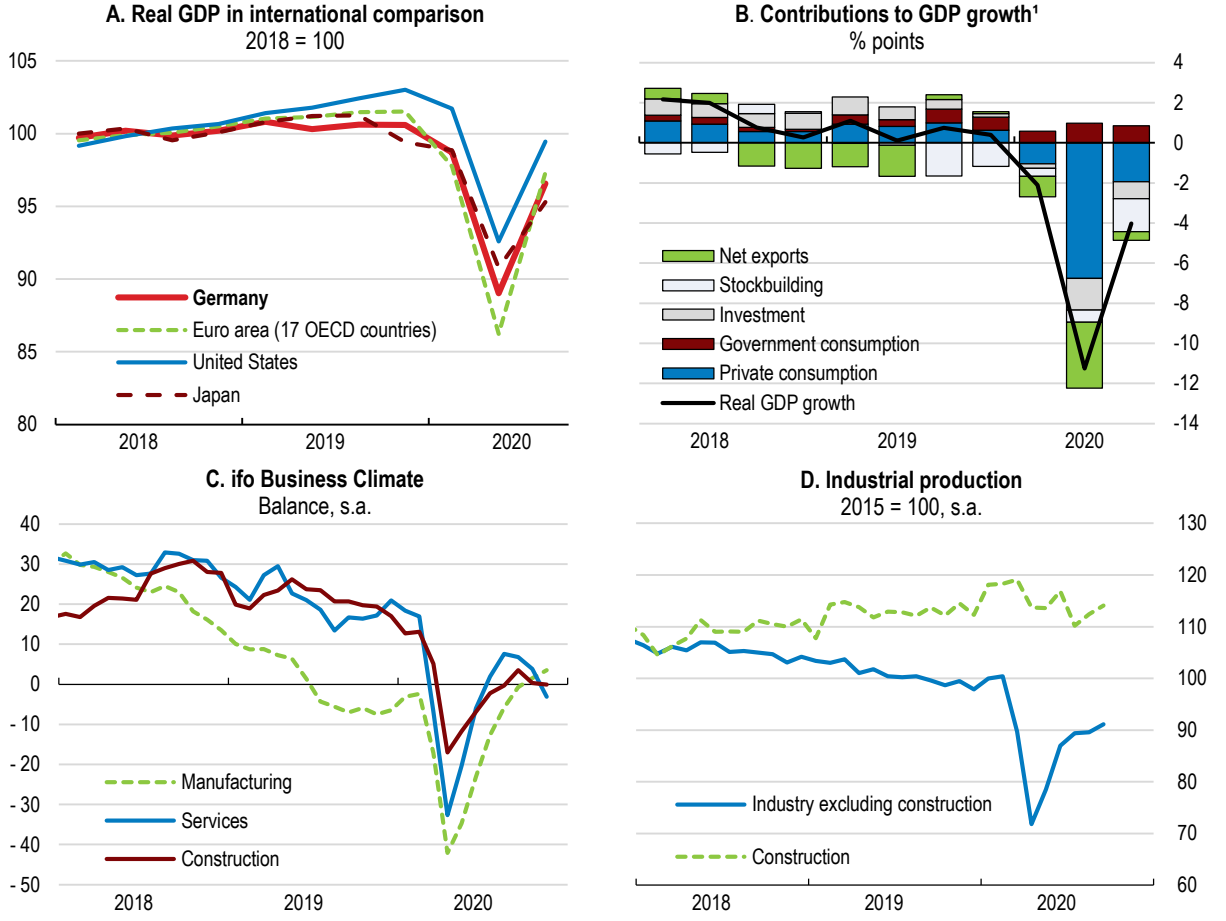
StatLink https://doi.org/10.1787/888934200413

The economy contracted sharply in 2020

Economic activity contracted sharply during the first half of 2020, though less than in many neighbouring countries. Growth was slow entering the crisis (Figure 1.6, Panel A) and the collapse in private consumption and exports (Panel B) ended early signs of a recovery in business confidence (Panel C). Industrial production fell sharply (Panel D) but held up in construction, which was largely allowed to continue under containment rules. Comprehensive government support protected jobs and firms during the crisis (Box 1.1), allowing a quick restart in most sectors as containment measures were eased in May 2020. Accommodative monetary policy and expanded asset purchases by the ECB also helped by supporting aggregate demand. Resurgence of the virus in October 2020 has created uncertainty and triggered renewed nationwide containment measures in November. These measures were less strict than

those in the spring as retail and schools remained open, but nonetheless the closure of restaurants, hotels and entertainment venues reduced activity. GDP contracted by about 5½ per cent in 2020 (Table 1.1).

Figure 1.6. The COVID-19 crisis triggered a substantial economic contraction



1. Contribution to GDP growth relative to the same quarter of the previous year.
Source: OECD Economic Outlook database; ifo business Survey; Statistisches Bundesamt.

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The German government's strong action to underwrite liquidity and support small businesses is preventing a wave of insolvencies, but risks of business failure will increase if disruptions to economic activity endure (OECD, 2020[12]). Where the government supports firms via equity injections, it is important to minimise distortion to market selection by calibrating support to what is needed as well as targeting firms whose financial distress is related to the crisis, and which are likely to return to profitability. Support should be subject to clear conditions as regards the state's entry, remuneration and exit, in accordance with the European Commission's 2020 Amendment to the Temporary Framework for State Aid measures. There are opportunities to improve governance of state ownership in Germany via separation between commercial and public service activities and ensuring that the public body that exercises ownership rights is different to the body that regulates the sector (OECD, 2020[13]).

Box 1.1. Germany's fiscal response to the pandemic

The protective-shield package

The first fiscal package in March 2020 was backed by a supplementary budget of EUR 156 billion (4.5% of GDP) to finance additional spending and cover reduced revenues. Health measures included procurement of protective gear, financial support to hospitals for keeping beds empty and increased funding towards vaccine research and development. To provide liquidity support to firms several measures were put in place. A EUR 50 billion hardship fund for self-employed individuals and small-business owners was set up to cover operating costs. Unlimited credit supply was guaranteed through new and existing programmes of the national development bank KfW, while government loan guarantees were increased. For larger firms, an economic stabilisation fund was established providing EUR 100 billion for equity injections, EUR 400 billion of guarantees for corporate liabilities, and a credit authorisation of EUR 100 billion to the KfW for refinancing purposes. The supplementary budget also made a separate EUR 357 billion increase to the guarantee framework. Tax deferrals and a temporary suspension of the obligation to file insolvency provided additional relief.

To protect jobs, the existing short-time work scheme was extended through lower eligibility thresholds, reimbursement of social-security contributions by the labour agency, increased wage replacement rates after more than three months, eligibility for temporary-agency workers and lifting restrictions on second jobs. Households were further supported by extended unemployment benefits, eased access to social and child benefits, and an eviction ban for tenants.

Labour market measures, notably short-time work, were extensively used, while there was little call on equity injections under the stabilisation fund (EUR 6.4 billion allocated) and guarantees (EUR 3.7 billion) as of 15 September 2020 and the hardship fund was underutilised (EUR 14.3 billion). Loans by KfW stepped up considerably, though EUR 44.4 billion in coronavirus-related commitments as of 15 September still represent only 12% of the increase in its guarantee framework. Most measures expire at the end of 2020, with notable exceptions being: extended unemployment benefits (31 March 2021), the economic stabilisation fund (end 2021) and short-time work (end 2021 for those on short-time work by the end of 2020).

The recovery package

The second package announced in June amounted to EUR 130 billion (3.8% of GDP) of spending in 2020 and 2021, with some further spending in later years. To finance the package, a second supplementary budget of EUR 61.8 billion was adopted. Measures to boost consumption include a reduction in value added tax (VAT) rates (from 19% to 16% and from 7% to 5%) between July 1 and December 31 2020 estimated to cost EUR 20 billion, a family bonus of EUR 300 per child and an increased subsidy for the purchase of electric cars. A follow-up hardship fund of EUR 25 billion for self-employed and small-business owners and further tax measures (such as a more generous loss carry back) support firms. Stabilising the renewables surcharge on electricity and keeping social-security contributions below 40% reduce burdens for both households and industry. Reimbursements for a loss in revenue and increasing the federal share for some social benefits provides financial relief to municipalities of roughly EUR 10 billion in 2020.

About EUR 50 billion seeks to respond to long-term challenges through public and private investment in the domains of digital transformation, education, health and green energy. The government plans to bring some already-planned public investment forward to 2020 and 2021, increase investments in childcare and all-day schooling, broadband and public transport, and accelerate the use of digital tools in administration and the health sector. Private investment will be encouraged by accelerated

depreciation rules, increased R&D tax incentives and direct subsidies for research on digitalisation, e-mobility and energy transition including hydrogen technologies.

In addition to these federal support packages, states launched programmes for their local economies. The EU Recovery and Resilience Facility will support the European recovery and foster resilience, including through an expected EUR 23 billion in grants to Germany in the period up to 2026.

Table 1.1. A deep recession in 2020

Germany	2017	2018	2019	2020	2021	2022
	Current prices EUR billion	Percentage changes, volume (2015 prices)				
GDP at market prices	3 263.3	1.3	0.6	-5.5	2.8	3.3
Private consumption	1 705.5	1.5	1.6	-6.2	3.2	4.0
Government consumption	648.2	1.2	2.7	4.2	1.6	0.9
Gross fixed capital formation	667.5	3.6	2.6	-4.3	2.0	3.9
Final domestic demand	3 021.2	1.9	2.1	-3.5	2.6	3.3
Stockbuilding[1]	13.1	-0.1	-0.7	-1.0	-0.5	0.0
Total domestic demand	3 034.2	1.8	1.3	-4.5	2.1	3.3
Exports of goods and services	1 541.6	2.5	1.0	-11.1	4.5	4.5
Imports of goods and services	1 312.5	3.8	2.6	-9.6	3.0	4.7
Net exports[1]	229.1	-0.4	-0.6	-1.2	0.8	0.2
Memorandum items						
GDP without working day adjustments	3260.0	1.3	0.6	-5.2	2.8	3.2
GDP deflator	_	1.7	2.2	1.4	0.8	1.2
Harmonised index of consumer prices	_	1.9	1.4	0.4	1.1	1.3
Harmonised index of core inflation[2]	_	1.3	1.3	0.7	1.1	1.3
Unemployment rate (% of labour force)	_	3.4	3.1	4.2	4.8	4.3
Household saving ratio, net (% of disposable income)	_	10.9	10.9	16.6	15.2	12.7
General government financial balance (% of GDP)	_	1.8	1.5	-6.3	-4.4	-1.8
General government gross debt (% of GDP)	_	69.5	68.1	82.5	84.7	84.3
General government debt, Maastricht definition (% of GDP)	_	61.7	59.5	73.9	76.2	75.8
Current account balance (% of GDP)	_	7.5	7.2	7.0	7.2	7.1

1. Contributions to changes in real GDP, actual amount in the first column.
2. Harmonised index of consumer prices excluding food, energy, alcohol and tobacco.
Source: OECD Economic Outlook 108 database.

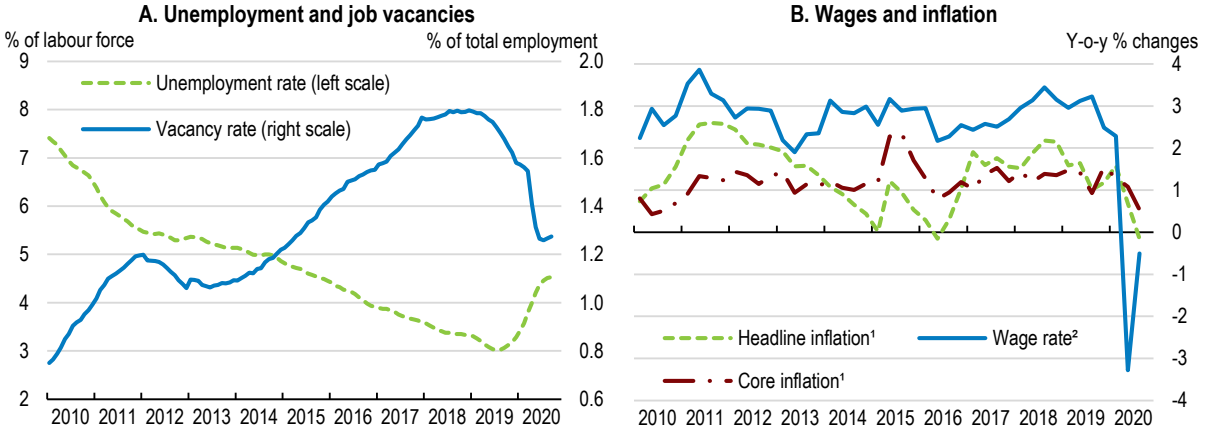
The temporary VAT reduction during the second half of 2020 (Box 1.1 above) is stimulating private consumption. Previous examples suggest that the increase in consumption is mainly driven by bringing forward purchases of durable goods (Crossley, Low and Sleeman, 2014[14]). The VAT cut supports higher private consumption to the extent that the change in costs is passed on to consumers. Full pass-through would see prices fall by 1.8% (Bundesbank, 2020[15]). However, pass-through is unlikely to be total and may not be higher than 0.75, as was observed in the longer (13-month) VAT cut in the UK in 2008 and the 2007 permanent VAT rise in Germany (Carare and Danninger, 2008[16]). The additional effect on private consumption is expected to be around one per cent in the second half of 2020, which represents a fiscal multiplier of about one half. This is a high multiplier for a tax reduction and provides a rapid response to the drop in demand, but is still lower than estimated multipliers of about one for public investment and consumption (IMF, 2020[17]). Because temporal substitution effects dominate, an increase in prices and a decrease in private consumption, of a similar magnitude, can be expected in early 2021.

The temporary VAT cut is transparent and was implemented quickly after the lockdown ended. Broad application reduces the risks of lobbying to favour some industries over others. Even though it

is progressive as a share of income, most support goes to households from the top half of the income distribution. Ideally, by the time the VAT cut ends, the recovery would be sufficiently robust to withstand the hit to consumption. This will not necessarily be the case in January 2021.

The crisis reversed a decade of declining unemployment (Figure 1.7), though the increase was cushioned by the well-established short-time work scheme, whereby the government subsidises wage payments for employees whose hours are cut at companies in temporary distress. In April 2020, about 6 million workers or just under 20% of all dependent employees were in short-time work, significantly more than during the peak in 2009 (1.4 million). Although unemployment increased substantially in some heavily-hit sectors (Figure 1.8), firms have still relied more on short-time work than lay-offs compared with the global financial crisis (Weber and Gehrke, 2020[18]). In general, short-time work was well suited to protect viable jobs during the financial crisis when sectoral composition changed little. An extended downturn with virus containment measures continuing to affect some sectors over several years would increase the need for reallocation of labour. In view of the risk that the prolongation of more generous short-time work until the end of 2021 might lock workers into less productive jobs (Hijzen and Martin, 2013[19]), relaxed conditions for access and extended duration will only be available where short-time work began up to 31 December 2020 or 31 March 2021 respectively. Plans to end full reimbursement of social security contributions in June 2021 are welcome as this will make it more costly for firms to hold on to workers in non-viable jobs. This will also increase the incentive of employers to offer training for employees in short-time work, as 50% of social security contributions can then be waived. More active labour market policy, such as increased training opportunities or placement assistance, should also be considered. Some extension of short-time work was justified, however, as even with a swift recovery the labour market is unlikely to recover fully by the end of 2021. Falling wages and spare capacity will keep near-term inflation low.

Figure 1.7. Unemployment has increased and wage pressures are muted



1. Inflation refers to harmonised consumer price index (HICP) and core inflation excludes energy, food, alcohol and tobacco.
2. Average nominal wage per employee.
Source: OECD Economic Outlook database; Statistisches Bundesamt.

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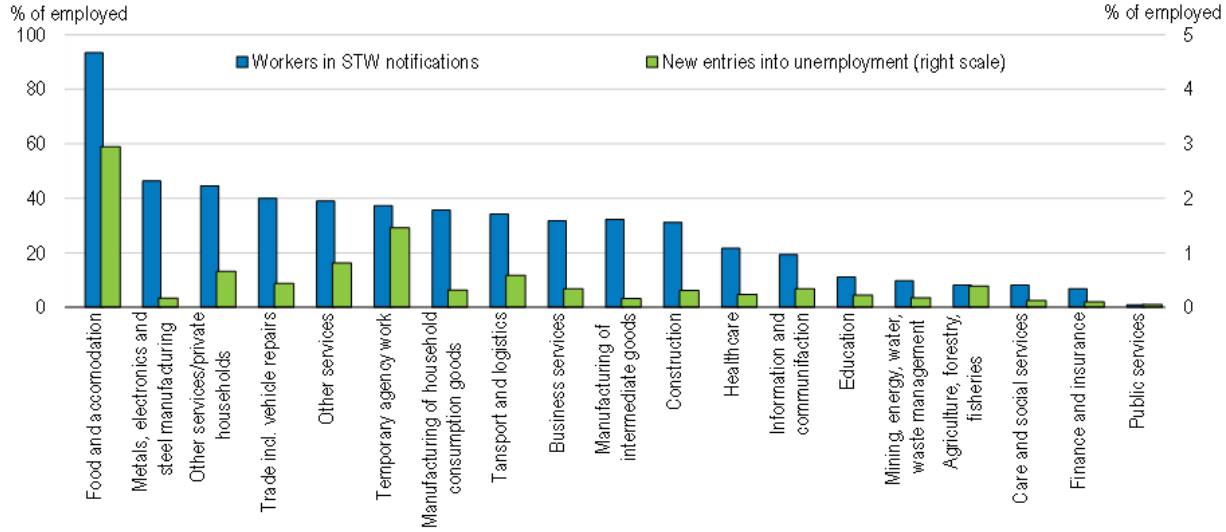
Figure 1.8. Job losses and recourse to short-time work vary across sectors

Cumulative share of employees within sector mentioned in notifications of STW in March and April 2020 & share of previously employed individuals entering unemployment



Note: New entries into unemployment measure the cumulative number between the cut-off dates of mid-March and mid-May in comparison to the previous year. In line with the calculations of the share of workers mentioned in STW notifications by the Bundesagentur für Arbeit, the number of entries into unemployment are also relative to the number of employees within each sector at the end of September 2019.
Source: Bundesagentur für Arbeit; own calculations.

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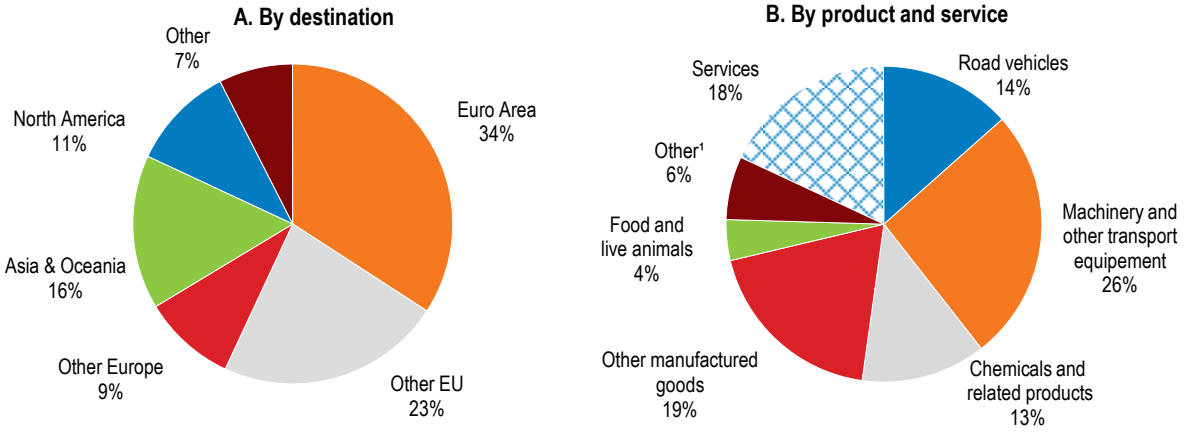
The German economy faces an enduring challenge from weak export demand, which will slow the recovery and mean it will need to be fuelled primarily by domestic demand. European countries, many of which were hit hard by the crisis, account for the majority of exports (Figure 1.9, Panel A). The concentration of German exports in capital goods (Panel B) exacerbates the challenge, as global investment has fallen due to uncertainty and weak demand. The automotive manufacturing industry faces weak demand as well as longer-term structural challenges (Box 1.2). As an open and trade-intensive economy strongly linked to global value chains, Germany relies heavily on export demand to fuel growth (Figure 1.11). Strong investment demand from China was an important source of growth following the global financial crisis: China accounted for 17% of German goods and services export growth in the decade from 2009, well above its 7% export share. Developments are likely to be less favourable this time as the Chinese economy slows and shifts towards consumption-led growth. Further increases in trade barriers, including due to the United Kingdom's exit from the EU single market, are one of several downside risks to the outlook (Table 1.2). There are also potential upsides to trade if key trading partners recover more rapidly than expected, or to growth more generally if there were signs that an effective treatment or vaccine could be widely deployed earlier than late 2021.

Declines in the current account surplus during the crisis are primarily due to falling global demand for capital goods, which is set to continue into 2021. Germany's large current account surplus reflects the gap between (high) saving and (low) domestic investment. The household saving rate remained steady at a high level in the decade leading up to the crisis, even as strong wage growth increased the labour share of income. However, corporate net saving turned negative in 2018 and 2019. Further success in increasing high quality public investment (see below) has potential to increase the growth rate, strengthen domestic demand and thus lead to a more sustained reduction in the current account. Policies promoting entrepreneurship, diffusion of new technologies, and skills would increase business investment in Germany. Measures in the recovery package to shorten the discharge period for bankruptcy to three years, support R&D and accelerate digital transformation are thus welcome. Tax reductions on low labour income, in addition to strengthening work incentives, would also help by boosting consumption. Measures to reduce

inequality such as removal of inheritance tax exemptions are also important to reduce the effect of skewed wealth distribution on private saving and thus the current account balance (IMF, 2019[3]).

Figure 1.9. Manufactured capital goods dominate exports, with Europe the major destination

Exports of goods and services, % of total, 2018



1. Other category includes crude materials and inedible materials, mineral fuels, lubricants and related materials, animal and vegetable oils, fats and waxes, commodities and transactions, n.e.s.
Source: OECD International Trade Statistics.

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Table 1.2. Events that could lead to major changes in the outlook

Vulnerability	Possible outcomes
Multiple COVID-19 outbreaks over several years	Curtailment of activities where distancing is a concern, leading to firm failures and increased unemployment. Consumer and business uncertainty holding back consumption demand and investment, while depressed global demand weighs on exports, particularly of capital goods.
Financial amplification of COVID-19 crisis	Corporate and household defaults, weak demand for loans and low interest rates could trigger insolvencies among banks. Interbank relationships and guarantees have the potential to create systemic problems, leading to liquidity shortages and a protracted recession. Systemically important institutions risk creating too-big-to-fail problems for regulators.
Economic scarring effects from the COVID-19 crisis	Depressed long-term growth due to disrupted job matches, weak investment, supply chain disruption and failure of some sectors to recover where consumer preferences change.
Further increases in trade barriers globally	A new wave of protectionism would lower global trade and would be particularly harmful for Germany's export-dependent economy and international supply chains, even more so if barriers to trade in automotive products increase. The United Kingdom's exit from the EU single market could reduce German exports by 2.5% and GDP by up to 0.5% if this were to occur without a trade agreement, with the automotive manufacturing industry particularly badly affected (Centre for European Policy Studies, 2017[20]; Lawless and Morgenroth, 2019[21]; Felbermayr et al., 2017[22]).

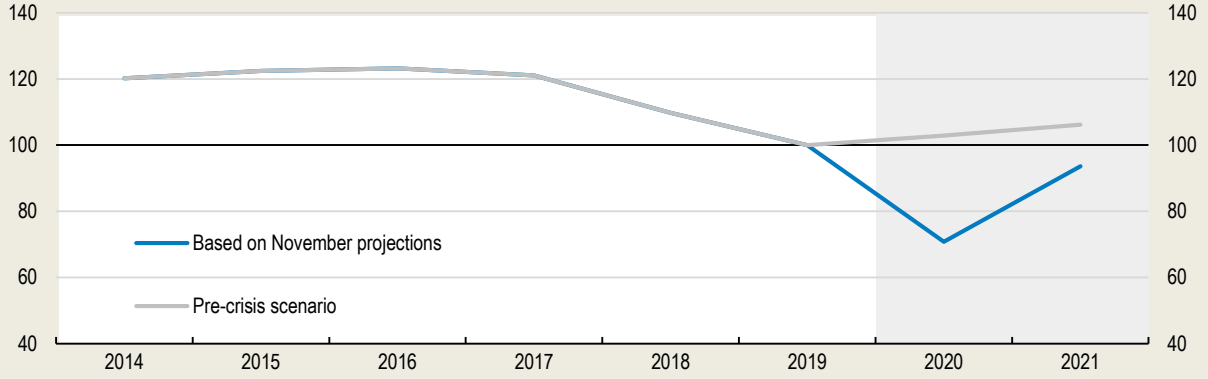
Box 1.2. The uncertain outlook for automotive manufacturing

Demand for cars is estimated to have plunged in 2020, mainly due to the severe recession in Europe, before recovering – but not making up for lost sales – in 2021 (Figure 1.10). There is high uncertainty around future demand for cars, including the effect of the VAT reduction, new incentives to purchase electric vehicles and COVID-19-induced changes in consumer behaviour. The pandemic has forced many employees to work remotely, a trend that may continue, reducing demand for cars. Conversely, reluctance to use public transportation would increase demand for private cars.

The COVID-19 crisis adds to existing challenges from the transition to alternative power trains, electrification in particular. Electric cars contain fewer and simpler parts, and vehicle batteries – the most valuable component of electric cars – are not yet manufactured in Germany or by German manufacturers. Therefore, fast penetration of electric cars is expected to cause job losses and a decline in GDP (Heymann, 2020[23]). According to the Institute for Employment Research (IAB), if 23% of new cars are electric by 2035, 114 000 German jobs would be at risk and GDP would decline by 0.6 per cent (Mönnig et al., 2019[24]). Other notable challenges are the increasing share of digital value in core products, a domain in which Germany is not an international leader, and the effect of changes in mobility patterns, particularly in cities, that are shaping the role, use and demand for cars (Chapter 2). An increase in trade barriers when the UK leaves the EU single market has been estimated to potentially reduce car exports from Germany to the UK by up to 15% by 2030 relative to business as usual (Karlsson, Melin and Cullinane, 2018[25]). Already between 2016 and 2019 there was a 26% decline (VDA, 2020[26]) due to depreciation of the pound and weaker demand.

Figure 1.10. Weak and uncertain demand in the wake of COVID-19

Demand for German made cars, index 2019 = 100



Note: Demand for cars manufactured in Germany is projected using OECD Economic Outlook forecasts and the historical relationship between car sales and fundamental drivers. The latter includes GDP per capita, population, unemployment and real oil prices, based on a panel of 56 advanced and emerging market countries for the years 2000–2010 (Klein and Koske, 2013[27]). Structural changes of the last decade, such as electrification and shared mobility, and policies implemented to support car demand are not taken into account.

Source: International Organization of Motor Vehicle Manufacturers (OICA); World Bank (2020) World Development Indicators Database; OECD Economic Outlook 108 (December 2020).

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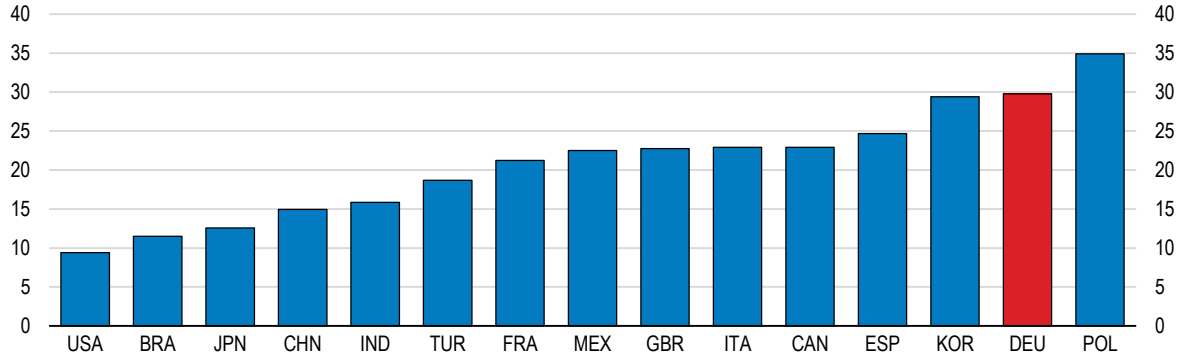
Figure 1.11. Germany relies heavily on foreign demand

Share of domestic value added embodied in foreign final demand, % of total domestic value added, 2016



Source: OECD Trade in Value Added (TiVA) database.

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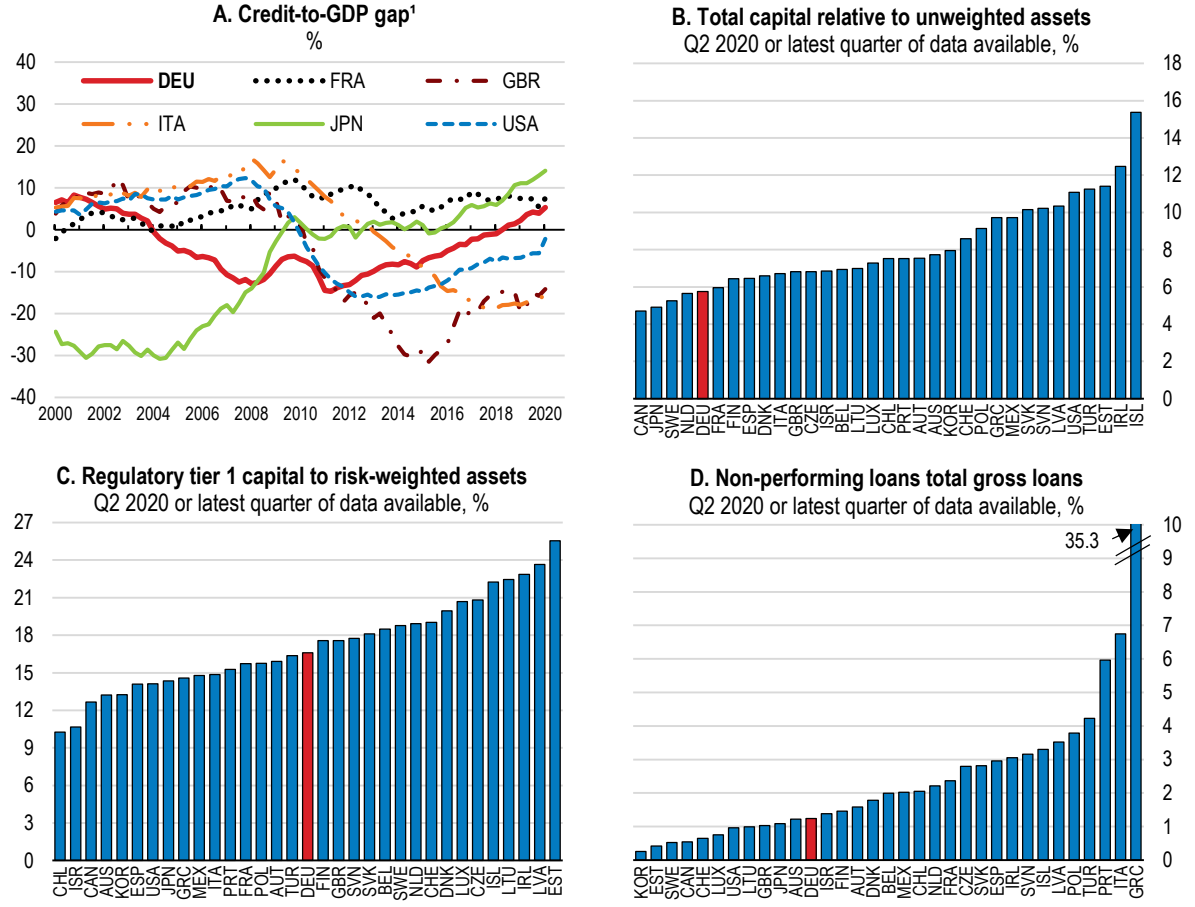
Bank vulnerabilities should be monitored closely

German banks on average have low profitability and medium to high leverage, which heightens vulnerability to increased corporate and household defaults, weak demand for loans and very low interest rates during the COVID-19 crisis. Credit growth has outpaced GDP since 2012 and accelerated in 2019 even as economic growth stalled (Figure 1.12, Panel A). Bank capital has increased relative to assets, though banks are still highly leveraged in gross terms, falling around the middle of the OECD range when the quality of capital and risk weights are taken into account (Panel B and C). The share of non-performing loans remained low as of early 2020 (Panel D). Low profitability hampers the build up of equity and provides incentives for excessive risk taking, while contributing to German banks' slow progress in modernising their IT systems (German Council of Economic Experts, 2019[28]). Some initial indicators suggest that the pandemic may have triggered refragmentation within euro area financial markets (de Guindos, Panetta and Schnabel, 2020[29]), increasing the importance of deepening the capital markets union and removing possible barriers to cross-border banking mergers.

Policymakers need to prepare for severe adverse scenarios. Risks to financial stability were very high at the start of the COVID-19 crisis in March and April 2020, but the fiscal and monetary policy response helped avoid a financial amplification. The reduction of the countercyclical capital buffer and other supervisory measures also helped sustain credit and avoid bank deleveraging. The expected increase in corporate insolvencies is likely to increase pressures on banks, though this has been assessed as manageable if the pattern from previous recessions is followed (Bundesbank, 2020[30]). A more adverse scenario is possible if a sharp rise in corporate insolvencies is coupled with stress in real estate and financial markets. In this case, any need to recapitalise banks should be managed in a transparent manner, subject to proportionality, targeting as well as clear conditions for remuneration and exit. Further attention should be given to mechanisms regarding bank contingent convertible bonds, typically issued by larger banks. While these have been used less in Germany than in several other European countries (Bundesbank, 2018[31]), a forced conversion of these bonds to equity could contribute to broader contagion in European bank funding markets.

The regulatory toolkit should continue to be improved during the recovery (Table 1.3) and income-based macroprudential policies should be included. Their use should be supported by more granular data on borrowers' risk profiles such as income and loan-to-value ratios, as well as credit statistics by region and type of lender. The collapse of Wirecard revealed possible weaknesses in accounting and financial regulation that the German government is working to remedy (Box 1.3). As in other OECD countries (see, for example, OECD (2019[32])) German financial institutions will face risks from climate change through structural changes as well as increasing physical risks.

Figure 1.12. Credit grew faster than output before the crisis and banks have medium to high leverage



1. Credit-to-GDP gap is defined as the difference between the credit-to-GDP ratio and its long-term trend; in percentage points.
Source: IMF Financial Soundness Indicators database; BIS credit-to-GDP gap statistics.

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Table 1.3. Past recommendations and actions taken on financial markets

Recommendations	Action taken
Consider ways to improve the effectiveness of requirements to separate investment banking activities from retail banking. For example, give consideration to including securities held for market-making purposes in separation requirements and to focusing such requirements on derivatives exposures.	The German Bank Separation Act of 2013 requires credit institutions to separate their deposit and credit business and their trading activities on own accounts with financial instruments where certain thresholds are met.
Micro- and macroprudential regulation should address remaining risks emanating from the Landesbanken. Continue restructuring the Landesbanken, including through privatisation, consolidation or focusing on core activities according to a viable business model.	One of six *Landesbanken* was privatised in 2018. The remaining five *Landesbanken* have improved corporate governance and are subject to the same regulatory oversight as private counterparts.

Box 1.3. Government plans to reform financial regulation following the collapse of Wirecard

A multiyear accounting fraud forced Wirecard – a fast-growing German fintech provider of digital payment services – to file for insolvency in June 2020 after its auditor for the previous 10 years stated that it could not confirm the existence of EUR 1.9 billion in cash balances on trust accounts. Most of Wirecard's reported revenues came from three third party acquiring-partners, which processed Wirecard payment transactions outside of Europe due to regulatory reasons such as lack of licenses or other potential risks. Annual auditing of the sources and accuracy of these revenues was flawed. In February 2019, after negative publications led to a sharp drop in the stock price, the Federal Financial Supervisory Authority (BaFin) investigated allegations of market manipulation and introduced a two-month ban of short selling, citing Wirecard's importance and the threat to market confidence. In April 2020, a special audit report, not conducted by the firm's auditor, found that most of Wirecard profits reported from 2016 to 2018 could not be verified. By June banks in the Philippines had informed Wirecard's auditor that documents detailing EUR 1.9 billion in cash balances were spurious.

Wirecard's collapse revealed possible weaknesses in accounting and financial regulation. The Financial Reporting Enforcement Panel (FREP), a private sector body monitoring financial reports of listed companies, was late to intervene and is under-resourced. BaFin can ask FREP to open a probe into a company's financial reports but has no power over the actual process, as it must wait for a FREP probe result before it can start its investigation. The government is developing an "action plan" to strengthen financial regulation, give BaFin new authority and force companies to change their auditors more frequently. Strengthening APAS, the body that oversees auditing firms in Germany, is also under consideration.

Source: The Financial Times, https://www.ft.com/wirecard.

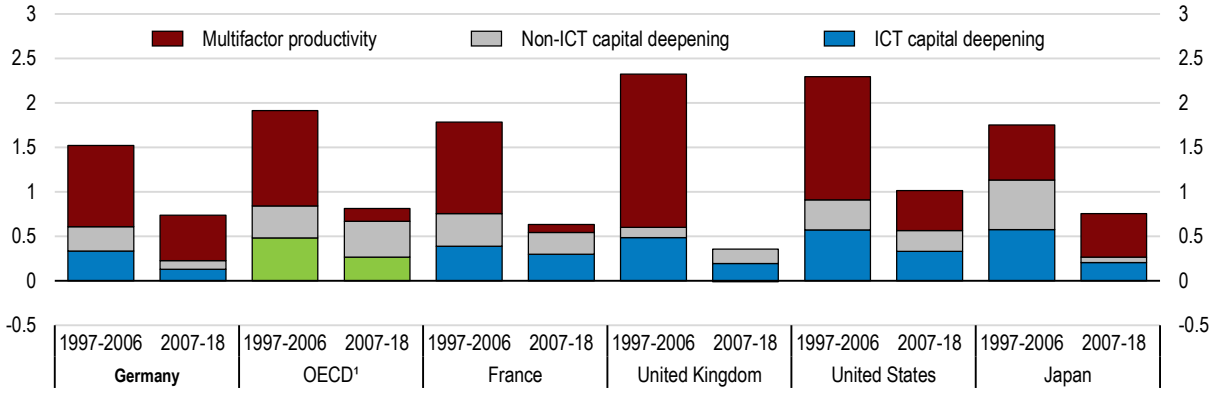
Reviving business dynamism is crucial for productivity growth

The crisis hit Germany following a decade of slow labour productivity growth (Figure 1.13). Although the slowdown was not unique to Germany, its demographics make productivity essential to drive potential growth. The crisis is set to further impair productivity growth as demand declined, investments fell, transactions costs increased and supply chains and schooling were disrupted (di Mauro and Syverson, 2020[33]). Conversely, adoption of new technologies during containment may provide a boost to productivity, as would accelerating digital transformation (Chapter 2).

Diminishing business dynamism is slowing the reallocation of resources and can hurt productivity growth, as well as deepen inequality. Before the crisis, business entry rates were on a continuous decline, alongside decreasing exits and bankruptcies (Chapter 2). Demand shifts due to the pandemic heighten the importance of resource reallocation. Weak incentives to move away from jobs that will eventually disappear, strict occupational regulations, temporary suspension of the obligation to file for insolvency (Box 1.1 above) and barriers to business formation could impede reallocation.

Figure 1.13. Productivity growth has slowed, with little capital deepening

Percentage point contribution to labour productivity growth, annual average



1. Unweighted average of OECD available countries.
Source: OECD Productivity database.

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Regulatory barriers to competition have been reduced and are among the lowest in the OECD. However, a large number of procedures still have to be fulfilled before a business can start to operate, and most professional services are heavily regulated (OECD, 2018[34]). As recommended in previous Economic Surveys, reducing restrictive regulation in professional services (for example by abolishing price regulation for architects and engineers) while safeguarding quality standards and consumer interests could boost competition and reallocation of resources (Table 1.4).

Table 1.4. Past recommendations and actions taken on boosting productivity

Recommendations	Action taken
Ease the conditions for bankrupt entrepreneurs to be discharged of debt after three years, while maintaining adequate safeguards for creditors.	Under a Federal Government draft law from 1 July 2020 the debt relief process will be shortened for entrepreneurs and consumers from six to three years, flanked by measures to prevent abuse.
Create a one-stop shop to process all procedures for starting up a company online.	Within the framework of PSC (point of single contact) it is possible to start a company online.
Reduce restrictive regulation in the professional services, safeguarding quality standards and consumer interests. Reduce exclusive rights, abolish price regulation for architects and engineers, give lawyers more options to deviate from the principle of effort-based remuneration and consider liberalising price regulation for notaries.	The federal cabinet has approved draft legislation to allow fees for architectural and engineering services to be freely agreed, with non-binding reference rates as a default, after the European Court of Justice ruled that the minimum and maximum fees for architects and engineers are not compatible with EU law.
Ease requirements to hold a tertiary level vocational degree or alternatively to have job experience in a leading position, for self-employment in some crafts.	In 2020, mandatory *Meister* qualification was reintroduced in 12 crafts occupations (such as container and apparatus manufacturer, cast stone and terrazzo manufacturer) that had been liberalised in 2004.
Scrutinise compulsory membership and chamber self-regulation in the professional services and crafts chambers for entry barriers and lower entry requirements where possible.	No action taken.
Strengthen the role of the rail transport regulator by improving its investigative and interventional competences. Move to full ex ante regulation of access conditions.	The investigative and interventional competences of the regulator have been strengthened by transposing the 4th EU railway package into national law in 2020.
Strengthen the analysis of the economy-wide impact of regulation. Establish an advisory body tasked with identifying and reviewing regulatory hurdles to higher productivity.	A National Productivity board was established in 2019 to analyse economic productivity and competitiveness developments and challenges. The tasks of this board lie with the German Council of Economic Experts.
Strengthen transparency on the role of lobbies in the design of new legislation and regulation, for example by providing more information in the lobbying register.	Following a federal cabinet decision in November 2018, stakeholder (lobbyist) comments received as part of consultation on draft bills and regulations are to be published during the current legislative period.

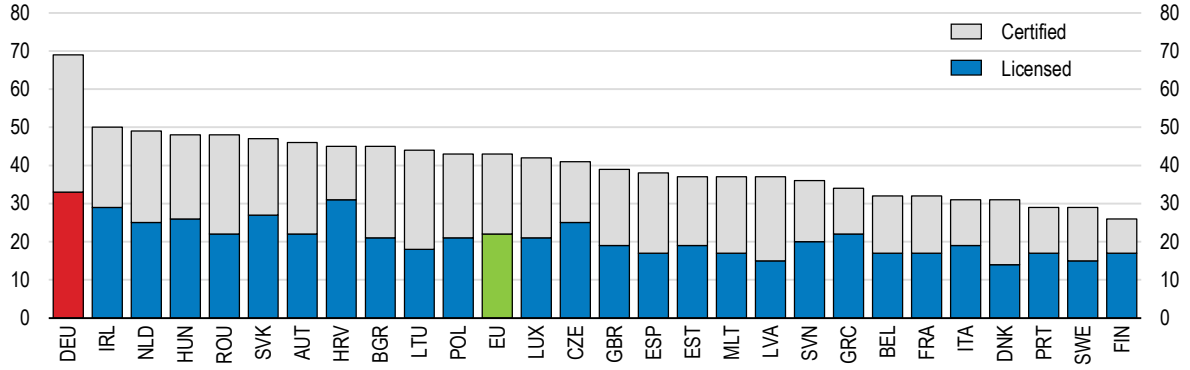
Lowering occupational entry regulations will boost labour market dynamism

Occupational entry regulations affect a significant share of the workforce (Figure 1.14). Entry regulations aim to protect consumers by reducing information asymmetries and standardise skill requirements. Most empirical studies find occupational licencing to have little effect on quality and the creation of skills, although in Germany, the effect on motivation to acquire skills may be stronger due to the strong link to the apprenticeship system. These limited benefits come at the expense of higher prices, primarily due to a reduction in competition, which also hurts productivity (Bambalaite, Nicoletti and von Rueden, 2020[35]). Additionally, entry regulations slow employment transitions and hold down wages for those who would like to enter a particular field, but do not have a licence. Across European countries, having a licence is associated with about 5% higher hourly wages, of which about one third can be attributed to entry restrictions (Koumenta and Pagliero, 2019[36]). In Germany, the self-employed licencing wage premium in crafts and related trades (such as hairdressers) is also higher, at 13% (Bol, 2014[37]).

A liberalisation act from 2004 cut down qualification requirements to open a business in the crafts sector, and nearly doubled the number of new entrants (Rostam-Afschar, 2014[38]) (Biewen, Fitzenberger and De Lazzer, 2017[39]). Nonetheless, in 2020, mandatory qualification was reintroduced in 12 out of the 53 liberalised occupations, on the basis of consumer protection and supporting apprenticeships. Regulators could rely more on certification instead of licencing, and more on quality standards for services rather than for the workers providing them. Reviews on digital platforms have the potential to support quality standards, especially where the purchase of a service has limited effect on others (Farronato et al., 2020[40]). The government should carry out a comprehensive review of the regulated professions and determine whether entry barriers remain justified given their economic costs. Less restrictive occupational licensing would encourage business dynamism and reduce prices. Together with steps taken to increase skills recognition (Chapter 2), it would also allow more immigrants to take advantage of their skills.

Figure 1.14. A high share of occupations are subject to licensing and certification

Share of occupations subject to licensing and certification, %, 2015



Note: Workers in licensed occupations declared that without having a professional certification, licence, or taking an entry exam, it would be illegal to practice their occupations. Workers in certified occupations proclaimed that they have a license, certificate, or that they passed an exam to practice their occupation. However, it would not be illegal to practice their occupations without it. In Germany, entry regulations are particularly strict when it comes to agriculture, craft and technician related occupations and personal services. In professional occupations, entry barriers are above, but closer to those in other European countries.

Source: (Koumenta and Pagliero, 2017[41]) and (Koumenta and Pagliero, 2016[42]), based on the EU Survey of Occupational Regulation.

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Corruption is low, but there is room to improve transparency

Corruption reduces growth by creating business uncertainty, slowing processes, imposing additional costs and eroding trust in governments. In Germany, bribery rates are low (Figure 1.15) and in 2017, only 3% of Germans stated they had experienced a case of corruption, compared with 5% in the EU (European Commission, 2017[43]). Favouritism and close links between business and politics are more significant concerns. For example, a high share of managers in Germany believes that funding political parties in exchange for public influence is a widespread phenomenon (European Comission, 2017[44]).

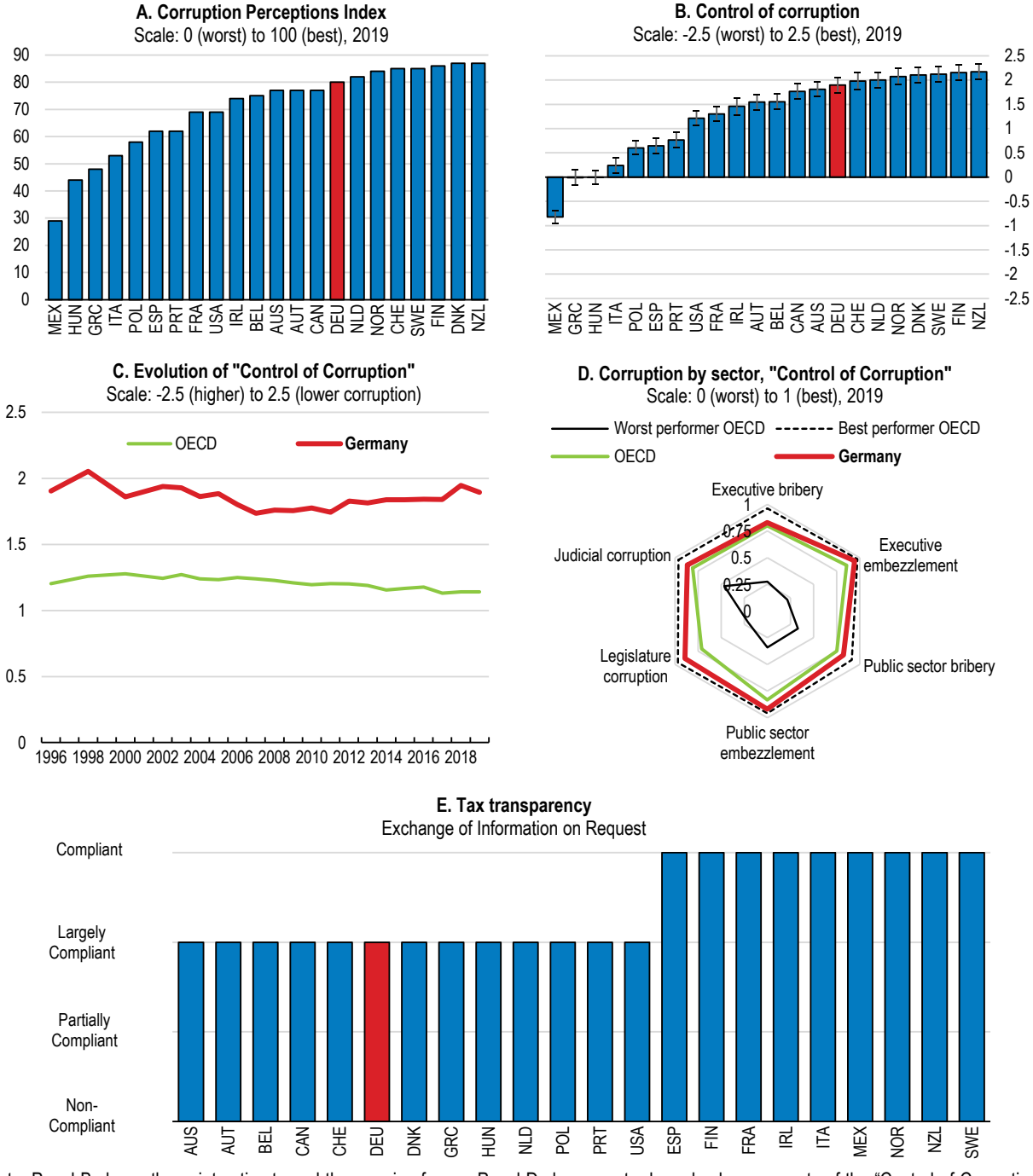
Germany is among the strongest enforcers of the OECD Anti-Bribery Convention. Germany actively uses a variety of sources to detect foreign bribery, including tax authorities. Nonetheless, there is room to improve enforcement, notably by introducing a system of conditional resolutions for legal persons and transparent rules for self-reporting by companies. Together with the in-depth revision of its confiscation regime and the creation of a Federal Debarment Register, implementing the coalition commitment to tie the punitive fine against legal persons to the company's turnover should contribute to making sanctions effective, proportionate and dissuasive.

1.3. Updating fiscal policy to enhance wellbeing

Fiscal policy to support the recovery

Once the recovery is fully established, the pace of withdrawal of fiscal support will need to be carefully managed. The current fiscal stance is strongly expansionary, with around EUR 140 billion (4¼ per cent of GDP) of discretionary spending and tax cuts in 2020. This is appropriate given the scale of the downturn, available fiscal space due to prudent budgeting in previous years and the ECB's limited scope to ease monetary policy further. The budget is not in structural deficit, so withdrawal of support will consist roughly equally of phasing out stimulus measures and automatic stabilisers, but even so will negatively affect growth. A return to the debt brake target (Box 1.4) from 2022 would see debt returning to the pre-crisis level of 60% of GDP even under an adverse growth scenario (Figure 1.16, Panel A). However, the pace of reduction in deficits required to meet the debt brake in 2022 if growth is weak, for example if there are further virus outbreaks, far exceeds that in the wake of the global financial crisis and risks derailing the recovery (Panel B). One option is to allow an incremental move to smaller deficits, as when the debt brake was first introduced. An alternative would be to put enough money into reserves to smooth the consolidation path.

Figure 1.15. Perceived risks of corruption are low



Note: Panel B shows the point estimate and the margin of error. Panel D shows sector-based subcomponents of the "Control of Corruption" indicator by the Varieties of Democracy Project. Panel E summarises the overall assessment on the exchange of information in practice from peer reviews by the Global Forum on Transparency and Exchange of Information for Tax Purposes. Peer reviews assess member jurisdictions' ability to ensure the transparency of their legal entities and arrangements and to co-operate with other tax administrations in accordance with the internationally agreed standard. The figure shows first round results; a second round is ongoing.

Source: Panel A: Transparency International; Panels B & C: World Bank, Worldwide Governance Indicators; Panel D: Varieties of Democracy Institute; University of Gothenburg; and University of Notre Dame; Panel E: OECD calculations based on materials from the Global Forum on Transparency and Exchange of Information for Tax Purposes.

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Box 1.4. German fiscal rules and targets

In the EU Fiscal Compact, ratifying countries, including Germany, have committed to a medium term structural deficit limit of 0.5% of GDP. Countries with a debt-to-GDP ratio well below 60% can target a higher structural deficit of 1% of GDP.

Under its constitutional debt brake, a structural deficit limit of 0.35% of GDP applies to the federal government and, from 2020, balanced budget rules to the Länder. Any deviation from the 0.35% federal target is posted to a control account, with consolidation measures implemented during upswings if the control account exceeds a negative balance of 1% of GDP. Structural borrowing in excess of 0.35% of GDP is only allowed under an emergency situation, as declared in 2020. Surpluses from earlier years allocated to reserves, such as the refugee reserve, can however be used to temporarily fund additional spending. This provides additional flexibility by allowing surpluses to be shifted from one year to another, which can be significant given the size of reserves: the refugee reserve had a balance of EUR 48 billion (1.4% of GDP) at the end of 2019. The control account, which unlike reserves cannot be used to fund structural deficits in excess of 0.35% of GDP, had a balance of EUR 52 billion (1.5% of GDP) at the end of 2019.

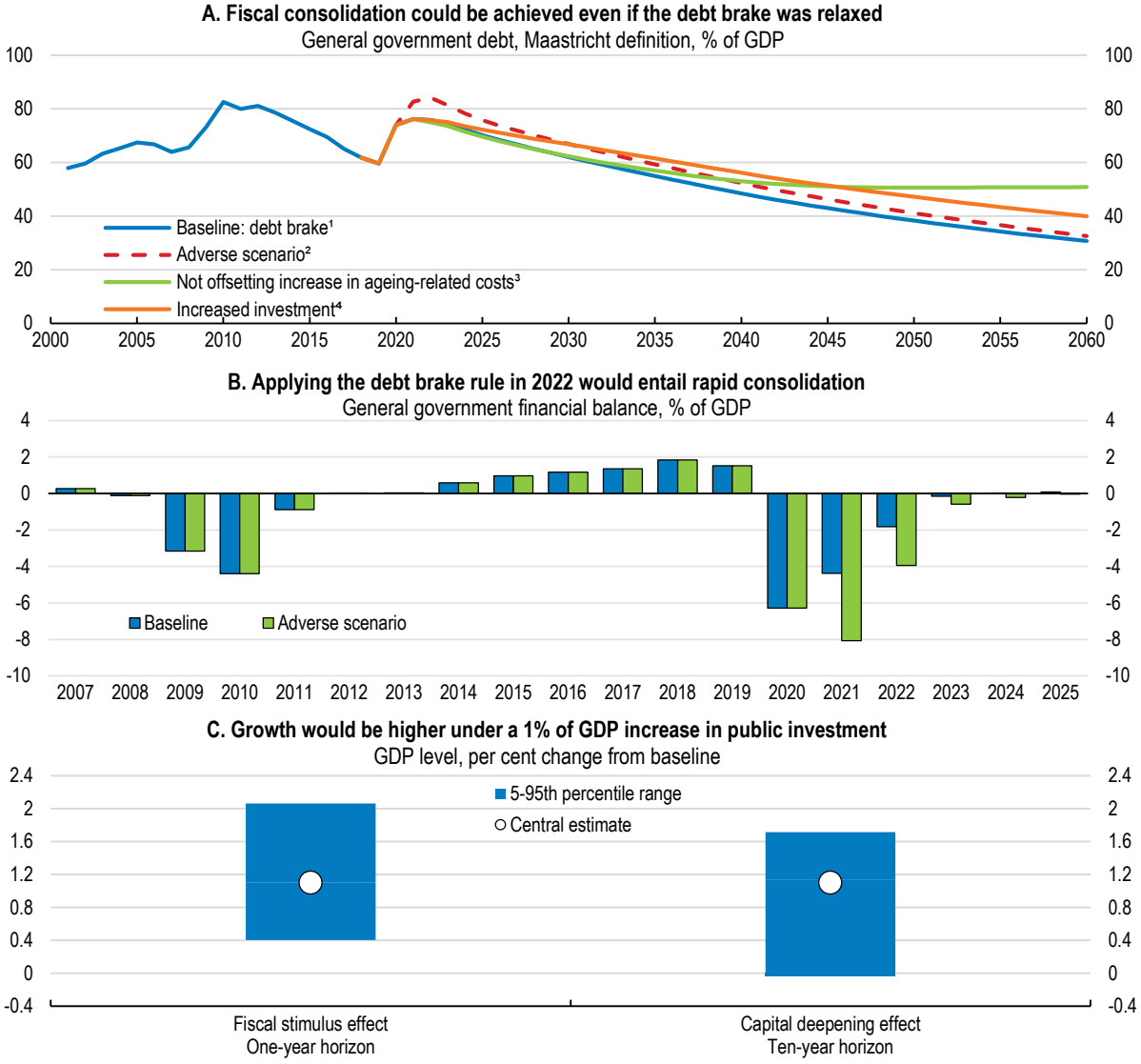
The federal government until 2020 had an additional, more stringent self-imposed fiscal target of a balanced nominal budget, referred to as the "black zero". As for the debt brake, reserves can be used to meet the target, and special funds and other off-budget entities can facilitate some net borrowing.

Source: Federal Ministry of Finance 2019, *German Stability Programme*; Federal Ministry of Finance 2015, *Germany's Federal Debt Brake*.

The debt brake has been effective at overcoming the bias toward deficits in government budgeting and reducing debt, providing fiscal space for exceptional support during the crisis. However, under low real interest rates, debt declines more quickly for a given primary balance and the costs of debt are lower (Blanchard, 2019[45]). Thus, a fiscal rule that was appropriate when adopted in 2009 would now be more restrictive than required to re-stabilise debt in the long term, though this could change again if high global debt triggered an increase in interest rates. Further, there is a difference between the EU Fiscal Compact, which allows for larger deficits once debt falls below 60%, and the debt brake, which would see consolidation continue. This difference is projected to again become relevant in the 2030s as debt falls below this threshold. In the past, fiscal outcomes have consistently been tighter than necessary to meet the debt brake, which contributed to successfully reducing debt but also means care is needed to ensure that *ex ante* budgeting does not impede beneficial spending. A structural deficit limit that is less stringent at lower debt levels but still aligned with the EU Fiscal Compact could be considered to support growth-oriented public investment in the medium to long term, taking into account the political economy of changing the debt brake in the constitution.

Recommendations in this survey would see a slower pace of consolidation in 2022 and sustained higher spending (Table 1.5), leading to somewhat higher levels of debt. Public investment proposed in this survey to resolve the infrastructure backlog and prepare for the energy transition, digital transformation and ageing could be financed without compromising debt sustainability and would boost GDP through immediate fiscal stimulus and long-term capital deepening (Figure 1.16, Panel C; Box 1.5). The long-term increase in spending could go further: expanding spending in line with increases in ageing-related costs (reaching 1% of GDP by 2050) is projected to be consistent with stabilising debt at below 60% of GDP. Tight budgets during the consolidation phase increase the importance of appropriately prioritising spending. As set out in the 2018 *Survey*, broadening the scope of spending reviews (Table 1.6) and integrating them into budgeting procedures would help to set priorities and reallocate funding.

Figure 1.16. The pace of future consolidation will need to be carefully managed



1. The baseline scenario is based on the OECD Economic Outlook No. 108 forecast and the OECD Long-Term Economic Model. The debt brake is reimposed in 2022, with some borrowing enabled in that year through the use of reserves and a small structural surplus from 2023 as up to 0.35% of GDP in federal lending is offset by a small aggregate surplus for the Lander and repayment of exceptional borrowing during the COVID crisis. Structural consolidation in 2023 slows the recovery in that year based on a fiscal multiplier of 0.75. Thereafter GDP is assumed to grow slightly above potential for the next decade and converge to potential growth of around 0.8%. Inflation is assumed to converge to 1.8% by 2024 and the interest rate on government debt to increase slowly, reaching 1.2% in 2030 and 1.8% in 2050. 2. The adverse scenario is based on the double hit scenario in OECD Economic Outlook No. 107, whereby prolonged effects from another virus outbreak disrupt the recovery. Scarring effects mean that there is a permanent loss of output, with potential growth assumed to be 0.2ppts lower for the duration of the analysis. The debt brake is enforced from 2022 onward, though with greater use of reserves in that year to smooth the return to a small structural surplus. 3. The "not offsetting increase in ageing-related costs" scenario allows additional government debt to cover the net cost to government of increases in public pensions, long-term care and health care as a consequence of population ageing, based on European Commission projections. 4. The "increased investment" scenario has a permanent debt-financed 1% of GDP increase in public investment from the baseline scenario. 5. Fiscal stimulus effect in the first year of increased investment estimated using fiscal multiplier estimates from the literature summarised in Gechert and Rannenberg (2018[46]). Capital deepening effect after 10 years estimated using the OECD long-term model (central estimate) and the range of estimates for crowding-in and crowding-out of private investment for Germany from Afonso and St Aubyn (2008[47]).
Source: OECD calculations based on the OECD Economic Outlook 107, 108 and Long-Term Databases, and European Commission (2018), *The 2018 Ageing Report: Economic and Budgetary Projections for the EU Member States (2016-2070)*.

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Table 1.5. Potential fiscal impact of OECD recommendations

	Budgetary impact (annually, % of GDP)	
	Short term (2022)	**Long term (2040)**
Further increase debt-financed public investment	-1.0	-0.3
Increase emissions pricing to at least EUR 60/tonne[1]	0.2	0.0
Eliminate the commuter tax credit	0.2	0.2
Reduce the rate at which transfer payments are withdrawn with increasing income[2]	-0.2	-0.2
Reduce taxation of labour income, while removing inheritance tax exemptions, raising reduced VAT tax rates to the standard rate, and strengthening environmental, property and capital income taxation	-0.1	0.0
Increase the eligibility cap of R&D tax incentives to EUR 10 million[3]	-0.04	-0.05
Total	**-0.9**	**-0.4**

1. Based on a doubling of the carbon price in 2022 from EUR 30/tonne to EUR 60/tonne and just under a doubling of revenue, allowing for lower emissions. 2. Conservative estimate based on adjustment in labour supply and wage rates as well as removal of the withdrawal-free earnings allowance (Bertelsmann Stiftung, 2017[48]). Other simulations show a positive budgetary effect (Blömer, Litsche and Peichl, 2019[49]). 3. Beyond the government's temporary increase to EUR 4 million.
Source: OECD calculations, (Bertelsmann Stiftung, 2017[48]).

Table 1.6. Past recommendations and actions taken on fiscal policy and pensions

Recommendations	Action taken
Introduce spending reviews more broadly at the federal and *Länder* levels and use them to reallocate funding across broad spending fields.	No action taken.
Focus additional pension entitlements on reducing future old age poverty risks, for example by phasing out subsistence benefit entitlements more slowly as public pension entitlements rise. Fund such additional spending from general tax revenue instead of higher payroll taxes.	A basic pension (*Grundrente*) financed from general tax revenue will come into effect in 2021, raising pensions for individuals with low entitlements. Individuals with at least 33 years of contributions will be eligible, the supplement will gradually increase reaching the maximum amount for individuals with 35 or more years of contributions. Additional income of the recipient will be credited against the basic pension only above certain income allowances. Also, some part of the basic pension will be exempt through special allowances for social benefit support in old age and for housing allowances.
Make enrolment in public old-age pension mandatory for the self-employed who are not covered by old-age pension insurance. Open access to public health insurance to all self-employed.	In the coalition agreement of 12 March 2018, the introduction of an obligation to provide for old age was agreed, but legislation was still being drafted in 2020. The federal government's pension commission in May 2020 recommended adjustments to the pension system, including mandatory insurance for self-employed persons and a gender-specific impact assessment of pension system changes (Kommission Verlässlicher Generationenvertrag, 2020[50]).
Index the legal pension age to life expectancy.	The standard retirement age is being gradually increased to 67 years in the year 2031. The pension commission proposed a permanent old-age security advisory body (Alterssicherungsbeirat) to look into the question of further reforms with regard to the legal pension age in 2026.
Raise the pension premium for starting to draw old-age pensions later in life and do not reduce pensions for old-age pensioners who work.	The law on flexible transition from working life to retirement and strengthening of prevention and re-habilitation in working life ("Flexirentengesetz") allows for more self-determined combinations and transitions since 2017, including combining a partial pension and wage earnings without loss of pension entitlement.
Reduce operating costs of subsidised, individual pension plans by improving comparability among providers.	Since 2017, providers of subsidised individual pension plans are obliged to disclose operating costs and how much they reduce yield.
Strengthen insurance against disability, for example by making it easier to claim legitimate private disability insurance benefits	Legislation taking effect in 2019 improved benefits in case of reduced earnings capacity in statutory pension insurance. The qualifying period will be gradually increased to 67 years by 2031. The supplementary period treats individuals with reduced earning capacity in the same way as if they had continued working and paying contributions at their previous average income over the period.
Remove barriers to the portability of civil servant pensions.	No action taken.
Strengthen supervision of direct pension commitments of	No action taken.

employers. Make contributions to the risk-pooling scheme dependent on risk indicators.	
Strengthen experience-rating in employer contributions to work accident and disability insurance.	No action taken.
Include private insurers in the financing system based on the central health fund.	No action taken.
Reduce social security contributions, notably for low income workers.	The earnings range that benefits from reduced social security contributions (midijob) has been extended to EUR 1 300 (from previously EUR 850). Since 2019, the additional health insurance contribution is equally paid by employees and employers (previously only by employees) and contributions to unemployment insurance decreased by 0.1 points each in 2019 and 2020. The contribution rate to long-term care insurance increased by 0.5 points in 2019. A 40% cap on social security contributions was announced in the June 2020 recovery package, financed by the federal budget.
Re-allocate administration of the collection of taxes that accrue to the federal government or are shared between the different layers of government from the *Länder* to the federal government.	No action taken.
Raise the tax rates applying to household capital income towards marginal income tax rates applying to other household income.	No action taken.
Encourage healthy lifestyles by raising taxes on alcohol and tobacco and reviewing regulation.	From 2021 onwards, tobacco advertisement will be further limited, including for tobacco heaters from 2023 and for electronic cigarettes from 2024.

Greening the tax mix

Shifting the tax burden from labour income towards consumption, environmental externalities (Figure 1.17, Panel A), real estate and capital income could support economic growth as well as social and environmental objectives. The tax burden on low labour income is high, reflecting high social security contributions. Property taxes based on outdated valuations (to be updated by 2025), exemptions to inheritance and capital income taxes contribute towards high wealth inequality. As argued in the 2016 *Survey*, tax rates on household capital income should be more closely aligned with personal income tax rates, while inheritance tax exemptions for family firms lock in capital, harming reallocation. Exemptions are also regressive: the average effective tax burden on those paying tax on inheritance of less than EUR 500,000 exceeds 10%, but is just 1.8% on those inheriting EUR 20 million or more (DIW, 2016[51]).

Pricing of carbon dioxide emissions under the Climate Action Programme 2030 is a big step in the right direction but needs to become more ambitious. An efficient emissions price would increase over time in line with global costs, providing an incentive for firms and households to shift to lower emission fuels or reduce energy consumption. Emissions pricing can have a disproportionately large effect on low-income households, who spend a relatively higher share of disposable income on energy. This should be remedied directly through complementary distributional measures as discussed below. Economic costs of moderate emissions pricing have turned out to be small so far: evidence exploiting jurisdictional variation in Europe and Canada typically finds no significant effect of carbon pricing on employment or GDP growth (Metcalf and Stock, 2020[52]); empirical assessments typically find no statistically significant effects on competitiveness in the electricity and industrial sectors (Ellis, Nachtigall and Venmans, 2019[53]); and experience with carbon pricing in France shows that this can cut manufacturing emissions without a net loss of employment (Dussaux, 2020[54]).

In Germany, less than one fifth of emissions have historically been subject to a price at or above a low-end estimate of external carbon costs in 2015 (Figure 1.17, Panel B). Planned emission prices until 2025 remain below EUR 60/tonne, which is a midpoint estimate of carbon costs in 2020 and a low-end estimate for 2030 (OECD, 2018[55]). The planned carbon price schedule in the transport and buildings sectors is unlikely to be sufficient to meet emission reduction targets (Bach et al., 2020[56]; Umweltbundesamt, 2020[6]; Prognos, 2020[7]), a situation that would be exacerbated if 2030 targets are revised in line with new EU targets. An auction reserve price, or a carbon price support, could incentivise clean investment and additional abatement in the electricity and industry sectors, which are part of the EU Emissions Trading Scheme (Box 1.6).

Box 1.5. Simulation of the potential effect of structural reforms

The estimated impact of some key structural reforms proposed in this Survey are calculated using historical relationships between reforms and growth in OECD countries (Table 1.7). As these simulations abstract from detail in the policy recommendations and do not reflect Germany's particular institutional settings, the estimates should be seen as purely illustrative.

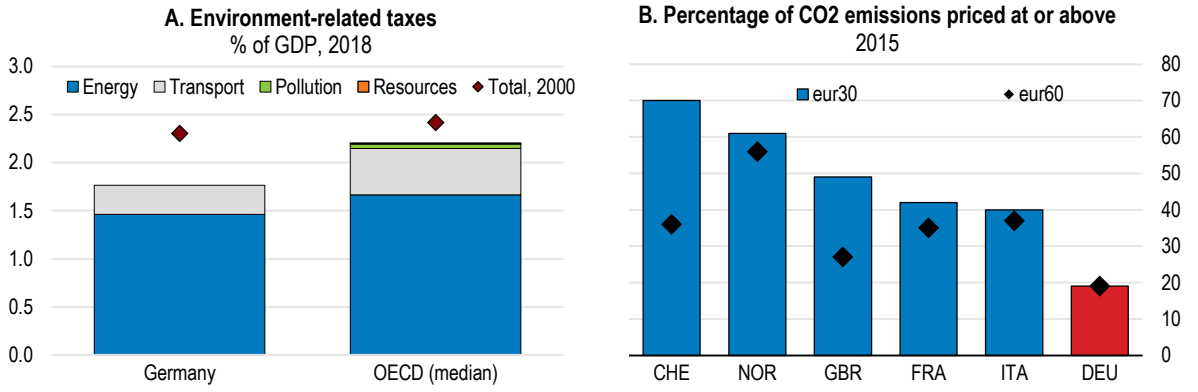
Table 1.7. Illustrative economic impact of some reforms proposed in this survey, after 10 years

	GDP per capita (%)	Through employment (percentage points)	Through productivity (percentage points)
Further increase debt-financed public investment	1.1		1.1
Increase parental leave for fathers[1]	0.5	0.3	0.2
Reduce taxation of labour income, while removing inheritance tax exemptions, raising reduced VAT tax rates to the standard rate, and strengthening environmental, property and capital income taxation	0.5	0.5	
Reduce rent control to close half the gap to the lowest level (Finland)[2]	0.9		0.9
Reduce occupational entry regulation to close half the gap to the lowest level (Sweden)	0.8		0.8
Boost fundamental skills, by improving teacher quality, postponing tracking and increasing general education in vocational education[3]	0.1[3]		0.1
Increase eligibility cap for R&D tax incentives to EUR 10 million	0.1		0.1
Total	**4.0**	**0.8**	**3.2**

1. Based on a temporary increase in women's employment and productivity for the first three years after birth of a child from a five week increase in paternity leave entitlement drawing on Patnaik (2019[57]), with offsetting reduction in fathers' employment. 2. Long-term gain in productivity from reducing skills mismatch. 3. Benefits of improving fundamental skills (increase mean PISA score by 10 points in 20 years) accrue slowly, increasing to 5% of GDP after 50 years.

Source: OECD calculations based on the framework in Égert and Gal (2017), "The Quantification of Structural Reforms in OECD Countries: A New Framework", *OECD Economics Department Working Papers*, No. 1354; Adalet McGowan and Andrews (2017), "Skills mismatch, productivity and policies: Evidence from the second wave of PIAAC", *OECD Economics Department Working Papers*, No. 1403; Bambalaite, Nicoletti and von Rueden (2020), "Occupational entry regulations and their effects on productivity in services: Firm-level evidence", *OECD Economics Department Working Papers,* No. 1605; Hanushek and Woessman (2010), *The High Cost of Low Educational Performance: The Long-run Economic Impact of Improving PISA Outcomes*, OECD Publishing.

Figure 1.17. Environment-related taxes are low and less than one fifth of emissions were subject to substantive carbon pricing in 2015



Note: EUR 30 per tonne of CO2 is a low-end estimate of the social cost of carbon today. EUR 60 per tonne is a midpoint estimate of carbon costs in 2020, as well as a forward-looking low-end estimate of carbon costs in 2030.

Source: OECD (2018), Effective Carbon Rates 2018.

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Box 1.6. The EU Emissions Trading Scheme and Market Stability Reserve

The EU Emissions Trading Scheme has operated since 2005, covering CO_2, N_2O and PFC emissions from electricity generation, industry and intra-EEA flights in 23 European countries. Large emitters are required to hold permits equal to the quantity of their emissions. Around half of German greenhouse gas emissions are covered due a high share of emissions from coal-fired generation, compared with 40% on average in the EU. The Market Stability Reserve, introduced in 2019, withdraws permits from the market if thresholds for the number of permits in circulation are exceeded and, from 2023 onwards, can trigger cancellation of permits. This aims to stabilise permit prices and can reduce the "waterbed" effect whereby additional abatement in one country allows an increase in emissions elsewhere.

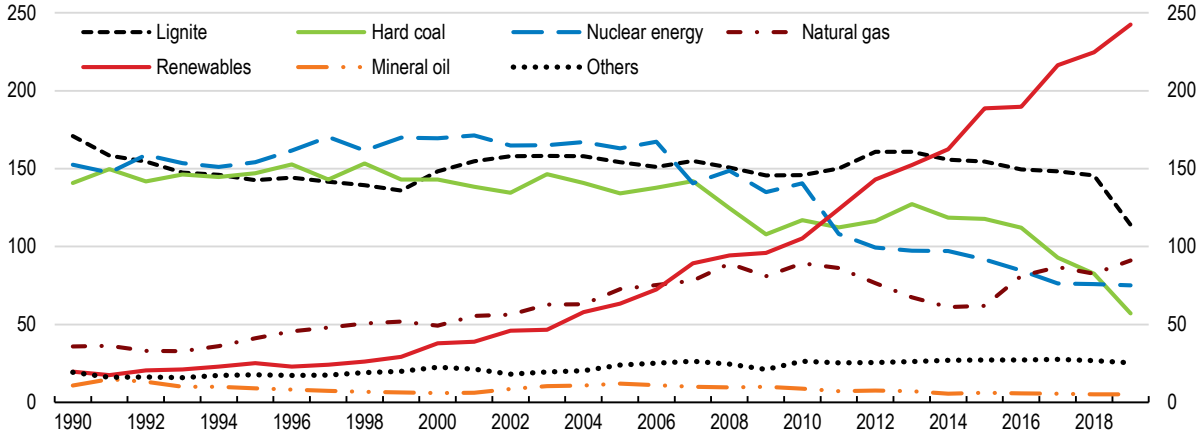
Sources: OECD (2018[55]); Flues and van Dender (2020[58]); European Environmental Agency (2019[59]).

Support for renewable electricity has been successful in achieving considerable expansion in renewable generation over the past two decades (Figure 1.18). This has been funded by household and industry consumers, who on average pay among the highest prices in OECD countries (IEA, 2019[60]). The burden on some users is pushed even higher because over 40% of electricity use by industry is at least partially exempt from the surcharge. The extent of exemptions is not justified by the small impact of energy sector emissions pricing on competitiveness (Ellis, Nachtigall and Venmans, 2019[53]; Dechezleprêtre, Nachtigall and Venmans, 2018[61]). Government plans to reduce the renewables surcharge are therefore welcome, not only for distributional reasons (discussed below) but to make abatement more efficient by removing a barrier to electrification.

Incentives should be better aligned with environmental objectives through a comprehensive review of the tax system, as foreshadowed under the long-term Climate Action Plan 2050. Diesel is taxed at a lower rate than gasoline on a per litre basis, even though burning diesel emits more CO_2 and is more harmful to human health. Coal and heating oil are taxed at lower rates than natural gas. Kerosene used in commercial aviation benefited from more than EUR 7.5 billion in tax relief in 2017 (Zerzawy, Fiedler and Mahler, 2017[62]).

Figure 1.18. Renewable power generation has expanded substantially

Gross electricity generation by energy source, TWh



Source: AGEB, https://ag-energiebilanzen.de/28-0-Zusatzinformationen.html.

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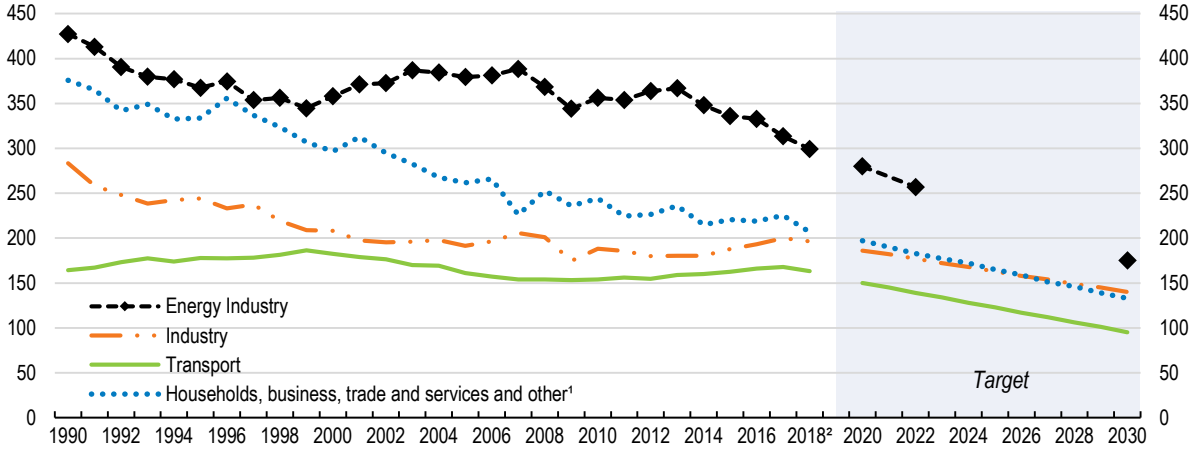
Little progress has been made in reducing greenhouse gas emissions from transport (Figure 1.19). Car ownership is high and progress in the deployment of electric cars is lagging most western European

countries (Figure 1.20). Legal obstacles have held back the expansion of charging infrastructure (Mattes, 2019[63]). Recent steps to expand public transport, support deployment of electric vehicles (in particular, through developing the charging network and strengthening rights to install charging facilities in apartment buildings) and tax carbon emission in transport move in the right direction, but achieving the 2030 target will still be challenging.

Better reflecting external effects through price signals in vehicle purchase and road use offers potential to reduce pollution, signal more accurately where new capacity is needed and shift demand towards more sustainable transport modes. For example, Israel reformed vehicle purchase taxation based on five key pollutants, resulting in around 83% of all new cars being in the lowest pollution grades in 2014, compared with 19% in 2009 (OECD, 2016[64]). Introducing road user charging scaled in proportion to pollution, congestion and damage to road surfaces would better reflect the costs of car use while helping to replace fuel taxes in funding infrastructure as electric vehicles replace conventional ones. Policy should seek to ensure accessibility to jobs, services and amenities through giving priority to sustainable transport modes, such as walking, cycling and public transport, while using urban planning systems to create proximity between people and places they go to for work and leisure (OECD, 2019[65]). Promoting teleworking would also help, which requires policies to help diffuse managerial best practices, self-management and ICT skills, investments in home offices, and fast and reliable broadband (OECD, 2020[66]). As argued in the 2018 *Survey*, policies to deploy ICT-based ride sharing would facilitate the low-carbon transport transition if this partly replaces individual car use (Table 1.8). The automotive manufacturing industry has an important role to play in reducing emissions, but also faces risks from associated structural changes (Box 1.2 above).

Figure 1.19. Transport emissions have not fallen as much as those from other sectors

Greenhouse gas emissions by sector, million tonnes of carbon dioxide equivalents



1. Emissions from households, commerce, trade & services, agriculture, waste and waste water and other emissions.
2. Short-term forecast for 2018.

Source: German Federal Environmental Agency; Federal Law Gazette, December 2019.

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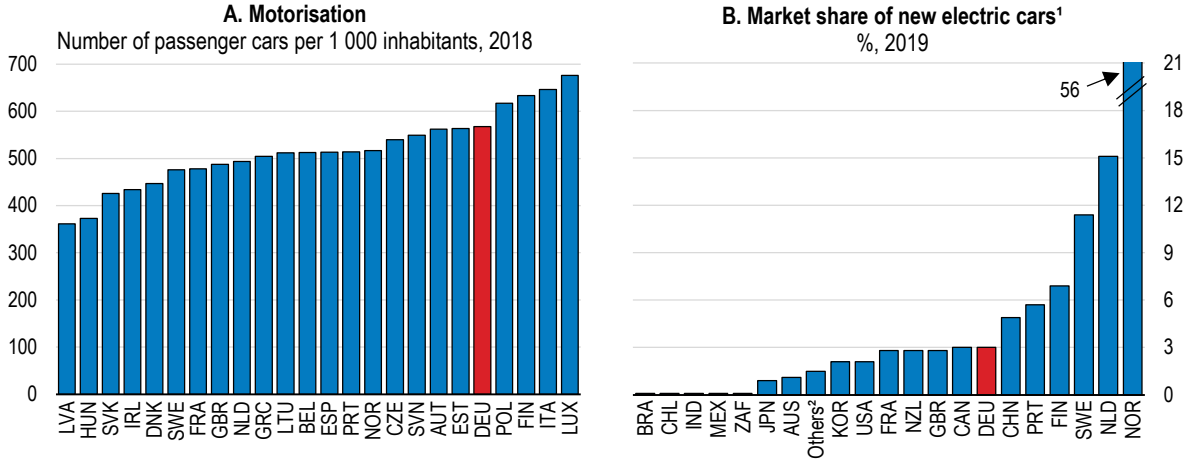
Figure 1.20. Passenger cars



1. This includes Battery Electric Vehicles (BEV) and Plug-in hybrid electric vehicles (PHEV).
2. The category "others" includes Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malaysia, Malta, Poland, Romania, Slovakia, Slovenia, Spain, Switzerland and Turkey.
Source: European Commission, Transport in figures, Statistical pocketbook 2020; IEA (2020), Global EV Outlook 2020.

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Table 1.8. Past recommendations and actions taken on fostering green growth

Recommendations	Action taken
Eliminate exemptions and reduced energy tax rates, except if they are designed to avoid double taxation, notably in sectors covered by the EU Emissions Trading Scheme.	No action taken.
Extend charging station infrastructure to promote electrification of road transport.	The Climate Action Programme 2030 expanded federal funding programmes for charging station infrastructure on a large scale and additional funding was announced in the June 2020 recovery package. The Federal Government also published a "Masterplan Charging Infrastructure" to ensure a coordinated effort.
Develop congestion pricing.	No action taken.
Remove regulatory hurdles to ride sharing services and allow them to serve public transport.	The Transport Ministry is reviewing the Passenger Transportation Act with a view to strengthen on-demand services and ensure a fair balance between different transport modes, after a December 2019 court ruling banned Uber from offering ride-hailing services.
Introduce taxation of NOx emissions of large emitters. Tax cars according to their NOx emissions.	No action taken.
Phase out tax expenditures for activities that damage the environment without harming international competitiveness, and better align environmental taxation with negative externalities. For example, raise taxes on diesel.	The Climate Action Programme 2030, agreed in late 2019, included a carbon pricing system in transport and heating. A new law is planned to increase prices before the start of the system in 2021. Prices are going to increase from EUR 25/tonne of CO2 in 2021 to EUR 55/tonne in 2025, followed by a transition to emissions trading.

Phasing out coal-fired power generation is important to reduce emissions

Coal-fired power generation is a major source of greenhouse gas emissions in Germany and the main reason its per capita emissions exceed those in most other European OECD countries. The parliament passed legislation in July 2020 to end coal-fired power generation by 2038, potentially brought forward to 2035.

Stronger price signals have the potential to curtail emissions from coal-fired power stations even while they remain operational. Renewable power generation is becoming increasingly competitive and a shift away from coal generation in 2019 occurred under an EU Emissions Trading Scheme price that remained below

EUR 30/tonne, demonstrating the relatively low cost of curtailing emissions from coal as documented in the previous *Survey*. Coal generation should be replaced primarily by renewables, but there is also a complementary transitional role for gas to play as a lower-emissions fuel that can be ramped up quickly when intermittent renewables are not operating. Reducing coal-fired power generation would have well-being benefits through ending mandatory resettlements in lignite (brown coal) mining regions, protecting forests and reducing air pollution. Mining and burning of lignite is responsible for around half of Germany's mercury, one third of its sulphur dioxide and one tenth of its nitrogen oxide emissions (Agora Energiewende, 2017[67]). Priority should be given to removing barriers to the continued rollout of renewables (see below) and strengthening the EU Emissions Trading Scheme, including through a floor price, which would give greater certainty to renewable investment.

The coal exit will have only a small effect on the German economy as a whole, but negative effects will be concentrated in relatively poor regions (Table 1.9). These regions will be affected by the discontinuation of mining and energy industry jobs that pay significantly above-average wages, with further indirect effects on service providers and suppliers. Historically, lignite mining regions have struggled to create new industries as mining has declined.

Compensation for affected households and regions requires careful design

The federal government has announced EUR 40 billion in support for coal mining regions until 2038, in addition to financial support of up to EUR 5 billion for related early retirement. The government's effort to support regions and workers to achieve a just transition is commendable, as regional effects can otherwise derail action to cut emissions. Funding focuses on supporting infrastructure, innovation and job markets. Such an approach, incorporating interventions tailored to specific regions, accords with best practice, and the support aims to improve regional economies and inequalities beyond just the affected employees. The quantum of support is substantial, however, amounting to about EUR 580 000 per directly and indirectly affected employee based on estimates of black coal, lignite and related employment from the Commission on Growth, Structural Change and Employment (2019[68]). While in this case some spending may have occurred anyway as it counters regional inequality and aligns with the recommendations of the Commission on Equal Living Standards, applying a similar approach more broadly could significantly increase the fiscal costs of greenhouse gas abatement.

Also positive are the government's efforts to actively manage distributional consequences of carbon pricing via reduced electricity prices, which can cushion vulnerable households and increase citizen support. However, reduced electricity prices will only partly offset the increase in energy costs due to the carbon price and, overall, the biggest burden will still fall on low-income households (Bach et al., 2020[56]). This could be avoided by small transfers to low-income households, for example through existing social support systems. Another measure in the Climate Action Programme 2030 is an increase in the tax credit for long distance travel to work. The entire tax credit should be abolished instead, as it encourages car use and therefore emissions, with the biggest benefits going to high-income earners who commute over long distances (Edenhofer et al., 2019[69]).

The German government has agreed to pay EUR 4.35 billion to the owners of lignite-fired power plants. On the one hand, these payments are in contradiction to the "polluter pays" principle and increase the fiscal cost of reducing emissions. On the other hand, potential future costs from legal remedies are prevented. Payments to coal-fired generators aim to address concerns of investor risk from government policy change by compensating for lost profits and the waiver of legal remedies. However, governments do not guarantee that regulation will remain unchanged or asset prices unaffected, and market participants have long anticipated policy action to reduce emissions. Setting a precedent that heavy emitters will be compensated encourages investment in other polluting industries. As demonstrated by Carbon Price Support in the UK, a sufficiently high carbon price could have reduced coal emissions at lower cost. In this case there was no compensation of generators that were no longer economic.

Table 1.9. Lignite mining is concentrated in regions with relatively weak economies

	Lignite share of gross value added, 2016	Lignite employment, 2018	GDP/capita, EUR 2015	Unemploy-ment rate, 2018	Business start-up rate	Population density	Broadband supply, 2016
	per cent	*per cent*					
Germany	0.1	0.05	37 128	5.2			75
Lausitz mining area	4.3	2.0	28 434	6.7	Low	Sparse	52
Rhineland mining area	2.4	1.2	32 769	6.4	Just below average	Part of a densely populated *Land*	87

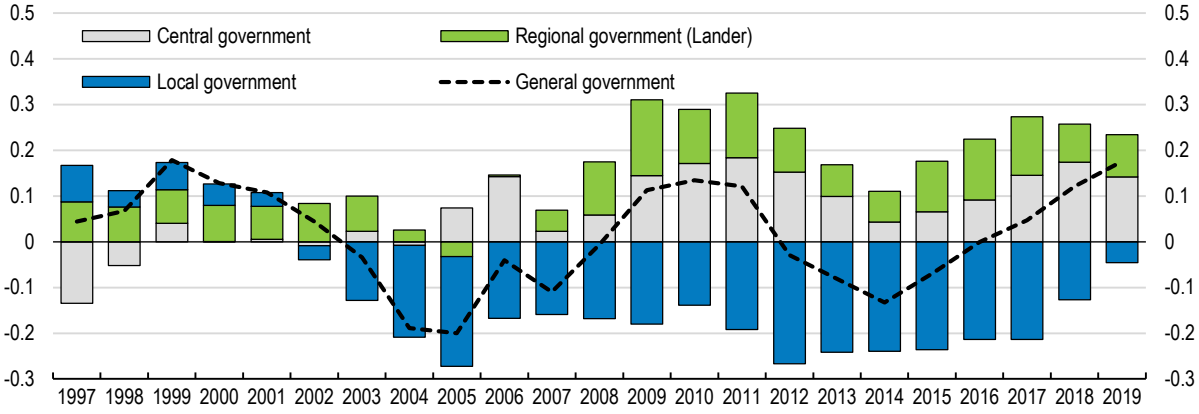
Note: Lignite mining also occurs in the Central German and Helmstedt mining areas, but accounts for less than 0.3% of jobs there.
Source: Commission on Growth, Structural Change and Employment (2019), *Final Report*; Stognief et al. (2019) *Economic Resilience of German Lignite Regions in Transition*; Agora Energiewende (2017), *Die Deutsche Braunkohlenwirtschaft*.

1.4. Further progress is needed to overcome the investment backlog

Stimulus spending should continue to be used to improve infrastructure, delivering long-term benefits through capital expansion. Green investments in particular, including in clean physical infrastructure, present high economic multipliers as well as strong climate change mitigation potential (Hepburn et al., 2020[70]). In many cases green investments will be private, incentivised by climate policy, but there is also a need to expand public network infrastructure, in particular public transport. While public investment has picked up since 2014, municipal investment remains insufficient to cover depreciation. The net municipal capital stock has declined by some EUR 80 billion since 2003 (Figure 1.21), contributing to a backlog estimated at EUR 147 billion, concentrated in transport and schools (KfW Research, 2020[71]). Investment is often low in municipalities with relatively weak local economies, with many having insufficient financial leeway to boost investment (Fratzscher, 2015[72]). Bardt et al. (2019[73]) estimate that EUR 450 billion in public investment will be needed over the next 10 years to overcome the backlog, expand early childhood education and all-day schooling, decarbonise, improve communication networks and adapt to demographic change (Table 1.10). As a share of GDP, public investment has been among the weakest in OECD countries (Figure 1.22) since the mid-1990s.

Figure 1.21. Public investment has picked up, but net municipal investment is still negative

Net public investment[1] by level of government, % of GDP



1. Public gross fixed capital formation less depreciation.
Source: OECD National Accounts database.

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Table 1.10. Estimated public investment requirement[1]

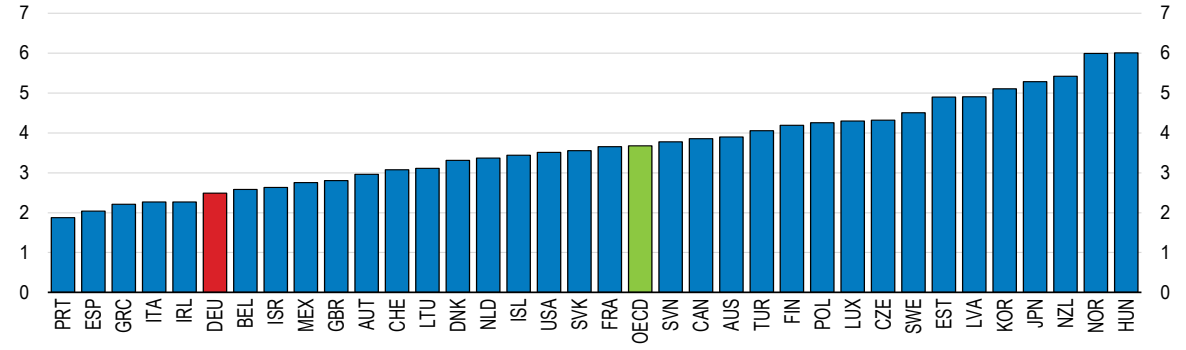
Over the next 10 years

	EUR Billion
Infrastructure at municipal level	
Municipal backlog[2]	147
Expansion of public transportation	20
Education	
Early childhood education	50
Expansion of all-day schools	9
Operation of all-day schools	25
Increase expenditure for universities and research funding	25
House construction	
Government share	15
Supraregional infrastructure	
Expansion of broadband/5G	20
Railways (federal government share)	60
Extension of highways	20
Decarbonisation	
Government share	75
Total sum	**466**

1. Independent estimates by the German Economic Institute (IW) and Institute for Macroeconomics and Business Cycle Research (IMK) of the Hans Böckler Foundation. Includes some government spending not classified as public investment in the national accounts, such as spending to promote private investment (for example, subsidies for energy efficient renovations) and investment in human capital. 2. Predominantly roads and transport infrastructure, schools, public administration buildings, and sports and culture. Updated for 2020 data (KfW Research, 2020[71]).
Source: Bardt et al. (2020), For a Sound Fiscal Policy: Enabling Public Investment, IW Policy Paper 6/2020.

Figure 1.22. Public investment is low

General government investment, % of GDP, 2019 or latest available year



Source: OECD Economic Outlook database.

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Funding for public investment has stepped up, but more needs to go to municipalities

The recent pickup in public investment is set to continue under the recovery package (Box 1.1 above) and with delivery of funding increases for public transport infrastructure. Over a longer period, reform of the debt brake (see above) could help to avoid excessively tight fiscal policy becoming a barrier to efficient infrastructure funding once the current exception expires.

Financially weak municipalities need more federal support to finance infrastructure. Survey data indicate that 95% of municipalities expect decreasing revenues due to the COVID-19 crisis and most expect increases in expenditure, except capital expenditure (KfW Research, 2020[71]). The federal government

has stepped in to finance part of the temporary loss in revenue and increase in social transfers via a permanent increase in the share of accommodation costs for jobseekers paid federally (to up to 75%). Also, compulsory contributions by municipalities can now be paid by the *Länder*. The government should further increase transfers to municipalities, as EUR 7 billion available under the Municipal Investment Promotion Fund falls short of what is needed to substantially reduce the investment backlog. However, any debt relief for municipalities should come from the *Länder*, as they are responsible for budgetary oversight, and federal debt relief would raise moral hazard problems.

Policy should actively seek to resolve capacity constraints

Resolution of capacity constraints is essential to allow expansion of investment spending to translate into new infrastructure. The COVID-19 crisis may create spare capacity in some parts of the economy, but a reduction in migrant flows could exacerbate shortages of construction workers. The government should investigate opportunities to increase flexibility through reducing the stringency of occupational licensing (see above) and facilitating use of foreign labour in key construction occupations.

Capacity constraints also exist in local planning agencies, resolution of which requires active support from central government, clear allocation of responsibility for technical assistance and long-term commitment. Between 1991 and 2011, the number of municipal staff employed in areas of construction, housing, and infrastructure planning declined by one-third, and between 2011 and 2015 by another 9%. (Gornig and Michelsen, 2017[74]). Among European municipalities reporting under-provision of infrastructure, Germany has the highest proportion citing technical capacity as a major obstacle (European Investment Bank, 2017[75]). Major projects, including broadband rollouts, are infrequent, meaning it is efficient to expand expertise in Partnerschaft Deutschland (Table 1.11). Development of planning capacity locally could be supported by centralised courses, as by the Ministry of Social Development in Chile and the UK Infrastructure and Projects Authority in cooperation with Oxford Saïd Business School (Global Infrastructure Hub, 2019[76]). Cooperation between local governments, as for example in local government clusters in New Zealand and multi-jurisdictional projects in Switzerland, help to pool capacity, develop specialisation, increase consistency and efficiency, and share learnings (Allain-Dupré, Hulbert and Vincent, 2017[77]; NZ Productivity Commission, 2013[78]). Attracting staff to local planning roles will require flexibility on remuneration and other benefits to make these positions more attractive – civil engineers are in high demand and there is a large difference in earnings between public building authorities and the construction industry (Grömling and Puls, 2018[79]).

Table 1.11. Past recommendations and actions taken on infrastructure investment

Recommendations	Action taken
Provide more support for good municipal investment projects, including by strengthening administrative capacity, especially in municipalities burdened with high spending mandates (such as cash transfers).	Commitment of most funds under the EUR 7 billion Municipal Investment Promotion Fund, though actual payment has lagged as it only occurs after work is completed. The federal government will reimburse municipalities for losses in revenue and permanently increase the federal share for some social benefits as part of the recovery package. Ongoing expansion of the capacity of Partnerschaft Deutschland to provide advice to local authorities on conceptual planning and strategic development, large scale project management and procurement options.
Improve assessment and disclosure of long-term financial risks of public-private partnerships (PPPs) of subnational governments. Share experience across levels of government and national borders and harmonise procedures.	Prevalence of PPPs remains low, meaning that one way to reduce the infrastructure backlog is underdeveloped.

Infrastructure governance reforms would yield productivity benefits

Sound governance of infrastructure investment is associated with a significant boost in productivity growth of firms in infrastructure industries and in industries that use infrastructure intensively (Demmou and Franco, 2020[80]). Overall, infrastructure governance in Germany is good, reflected in relatively high quality

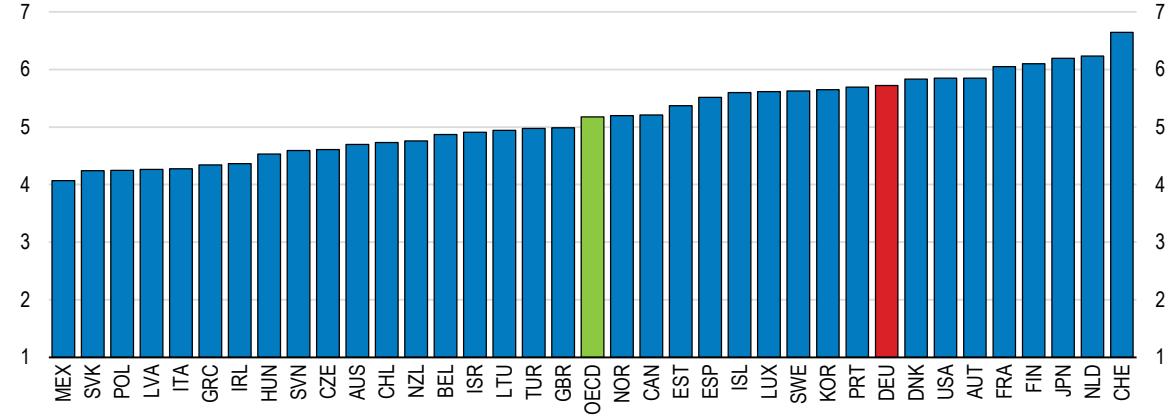
infrastructure despite low public investment (Figure 1.23). Nonetheless, there are areas for improvement, which are even more critical as investment spending increases.

First, strategic planning could be used more systematically to choose the highest quality projects. The OECD Recommendation on the Governance of Infrastructure, adopted in July 2020, emphasises the importance of a long-term strategic vision for infrastructure that takes into account synergies across sectors. Germany should assign periodic development of a long-term infrastructure plan and review of cost-benefit analysis to an institution that is independent of government and reports directly to parliament, a model successfully applied in the United Kingdom and Australia. Considering all infrastructure sectors within a single plan encourages greater alignment across sectors and investments (ITF, 2017[81]). Such an approach would build on the successful long-term analysis in the Federal Transport Infrastructure Plan 2030 by broadening the sectoral scope and involving an independent advisory but not decision-making body, potentially improving confidence for construction sector companies outside the transport sector to expand their production capacities. An independent institution could prioritise projects according to cost-benefit analysis – addressing the incentive for *Länder* to pursue local benefits (Bardt et al., 2014[82]) – and improve data on municipal infrastructure and its quality. Key to the effectiveness of such a body would be for its analyses to inform the parliamentary project selection process, as well as developing the expertise and reputation to influence decision-making.

Second, streamlining planning processes is crucial. Overly onerous and regionally-specific planning processes can delay investment and are sometimes used by local authorities to block investment projects committed at the national level. For example, changes to the design of the Fehmarn Belt Fixed Link were incorporated in Denmark through the parliamentary process within 6 months, while Schleswig-Holstein required three years for further consultation and regulatory approval (National Infrastructure Commission, 2017[83]). Expert opinion places Germany among the OECD countries with the greatest regulatory/administrative obstacles to infrastructure planning (Oprisor, Hammerschmid and Löffler, 2015[84]). A 2018 Act seeks to streamline transport-planning procedures, as does the *Measures Act* for specific listed projects and the draft 2020 *Investment Acceleration Act*. Consideration should be given to further steps proposed by the Commission on Growth, Structural Change and Employment (2019[68]), including linking the right to pursue legal action to the obligation to co-operate in planning, limiting the impacts of individual planning errors, increasing legal certainty, and shortening court proceedings and time limits.

Figure 1.23. The quality of infrastructure is fairly high

Quality of overall infrastructure score, from 1 (lowest score) to 7 (highest score), 2017



Note: The score is based on the assessment of business leaders operating in the country in response to the question: how do you assess the general state of infrastructure (e.g. transport, communications and energy) in your country? [1 = extremely underdeveloped – among the worst in the world; 7 = extensive and efficient – among the best in the world].

Source: World Economic Forum, The Global Competitiveness Index dataset 2007-2017.

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Third, Germany can better leverage data to improve value for money in procurement. Governments should systematically collect, analyse and integrate procurement data with other information systems (Chapter 2), consistent with the OECD recommendation to promote evidence-informed decision making for infrastructure (OECD, 2020[85]). As documented in the 2016 *Economic Survey*, a lack of federal coordination undermines the potential for learning across municipalities. Germany has several centralised procurement initiatives and greater use of these could increase efficiency and effectiveness of public procurement (OECD, 2019[86]). Independent observatories, as for transport projects in France, are one way to better monitor outcomes across different delivery models.

Enabling the energy transition through network reforms

Delays to grid expansion due to public opposition threaten the delivery of new north-south connections needed to accommodate further renewable generation. Most wind capacity is located in northern Germany, whereas most demand comes from metropolitan and industrial areas in the south and west. Grid stabilisation measures were required on 329 days in 2017, costing consumers hundreds of millions of euros (IEA, 2019[60]). Recent reforms to planning and consultation processes move in the right direction by reaching agreement around priority lines upfront and better coordinating the role of the *Länder*. Measures to decrease permitting procedure times, solve grid constraints and improve the business case for repowering old wind sites (which currently requires new planning approval) could result in over 40% more onshore wind growth by 2024 (IEA, 2019[60]).

Improved price signals would reduce system-wide costs and help prioritise the most important transmission investments. Currently, new generation projects do not face any locational price signals for accessing transmission. Further, action should be taken on extending temporal price signals to incentivise demand-side solutions such as distributed generation, storage and timing of flexible energy use such as electric vehicle charging. A necessary pre-condition is accelerating and expanding the smart meter rollout to all households.

1.5. Germany leads the OECD in recycling, but also generates much waste

As Germany progresses on climate policy and green investment, moving towards a more circular economy would reduce materials use and environmental impacts by avoiding wasteful use, and encouraging reuse, recycling and shared use. Overuse of primary materials causes high energy use, pollution from landfill and incineration, marine litter, and ecosystems toxicity from uncontrolled disposal (OECD, 2018[87]). The transition could take place with potentially significant positive, or at least without negative, consequences for economic growth and overall employment (Mccarthy, 2017[88]).

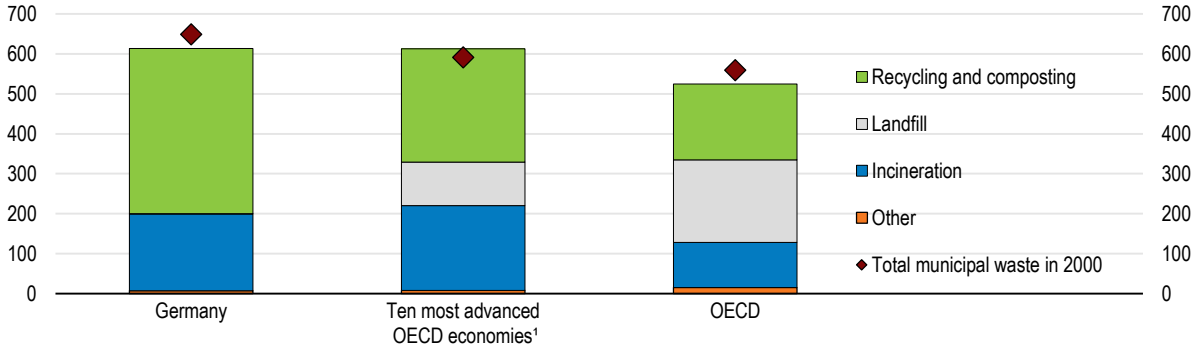
Thanks to aware citizens, a well-established waste management system and a long tradition of environmental regulation, Germany leads the OECD in recycling. Recycling standards are high and landfilling of untreated waste is practically non-existent after measures were taken in 2005 to ban landfilling of waste with a high calorific value. Using the Polluter Pays Principle ensures financing of the necessary infrastructure. A high environmentally-related public research and development budget, reflected by many patents in the field, help to improve waste management and minimise the pollution burden, in Germany and worldwide. A new Packaging Act in 2019 set ambitious recycling targets and required registering to a new national authority before putting packaging on the market. The Act should increase transparency and ensure a fair distribution of related costs among producers. In 2020, an amendment to the Circular Economy Act prioritised recycled products in public procurement, created a legal basis to extend producer responsibilities to littering in public spaces and limited the ability of retailers to destroy unused products.

Nevertheless, waste generation has not decreased. On the contrary, between 2010 and 2016, total waste generation increased by 10% mainly due to construction and demolition, which accounts for nearly 60% of total waste. Municipal waste generation is also above most OECD countries (Figure 1.24), and has

remained stable in recent years. Germany recycles two thirds of its municipal solid waste, and under the current measuring system has already reached the 2035 EU target of 65%. However, recycling levels have stabilised recently, which may reflect diminishing returns on additional investments. In order to move up the 'waste hierarchy', Germany should put more effort into preventing waste, and making reuse more economically attractive.

Figure 1.24. A lot of recycling, but also much waste

Municipal waste treatment, kg per capita, 2018 or latest available



1. Excluding Germany, Ireland and Luxembourg. Based on 2019 GDP per capita at current PPPs.
Source: OECD (2020), Municipal waste, OECD Environment Statistics (database).

StatLink https://doi.org/10.1787/888934200774

Pricing instruments and fiscal measures, as applied in Germany according to the polluter pays principle, are effective and efficient ways to internalise environmental costs and provide incentives for circular economic activities. Such measures encourage technology and business model innovation (Aghion et al., 2016[89]), and may speed up digitalisation in waste management systems. The agreement with the retail sector to charge for plastic bags in 2016 is one example of how even a low price can help prevent overconsumption. Consumption of plastic bags fell by a third in 2017 (European Commission, 2019[90]). The administrative costs of such measures are often low. In Ireland, for example, the introduction of a 15 Euro cent tax on plastic bags reduced use by about 90%, while the administration costs amounted to only 3% of revenues (Convery, McDonnell and Ferreira, 2007[91]). Effluent charges, first introduced in Germany in 1981, are another example of a pricing instrument that plays a role in improving wastewater treatment and reducing discharges (Rademaekers et al., 2011[92]).

As the largest waste stream, the construction industry is a major target for circular approaches. Although about 90% of construction and demolition waste is recycled, the building sector hardly uses any secondary materials. Therefore, recycling of construction and demolition waste is mostly converting valuable products into low-value raw materials. Taxes or levies on virgin raw materials used in construction, such as gravel and sand, could increase demand for recovered waste (European Environment Agency, 2020[93]). Economic instruments have reduced the use of these resources in Denmark, Sweden and the UK (Söderholm, 2011[94]). To mitigate the effect on housing construction costs, revenues could be invested in reducing waste processing costs. For example, by subsidising digital solutions for tracing the origins and qualities of building products and materials, governments can reduce market failures caused by imperfect information (Börkey and Barteková, 2020 forthcoming[95]).

Taxes and fees could help better manage household waste. The government recently set a target of halving food waste by 2030, as 55 kilograms of food per person is thrown away each year. The VAT on most foodstuffs is at a reduced rate of 7%. Phasing out this tax expenditure, mitigating the effect on poor families by using the social benefits system, could be one way to encourage prevention. It would also help to reduce greenhouse gas emissions from the livestock sector and reduce administrative costs and economic distortions, as pointed out in the 2014 survey (OECD, 2014[96]).

Relying even more heavily on pay-as-you-throw systems than already done in Germany would be more ambitious, but would provide stronger incentives to prevent waste. In 2013, the government of South Korea introduced compulsory food waste recycling using special biodegradable bags, which helped to increase the amount of food waste recycled to 95%. Fees for the bags help encourage home composting and meet 60% of the cost of running the scheme (World Economic Forum, 2019[97]). In San Francisco, the city charges residents and businesses for collection of their bins based on bin size, frequency of collection and the type of waste. Fees for collection of the trash bin are about ten times higher than for recycling and compostable containers. Additionally, the city uses incentives to avoid contamination of recycling and compostable bins. Businesses, for example, can obtain a credit if they protect the bin from being contaminated (Heinrich, 2017[98]).

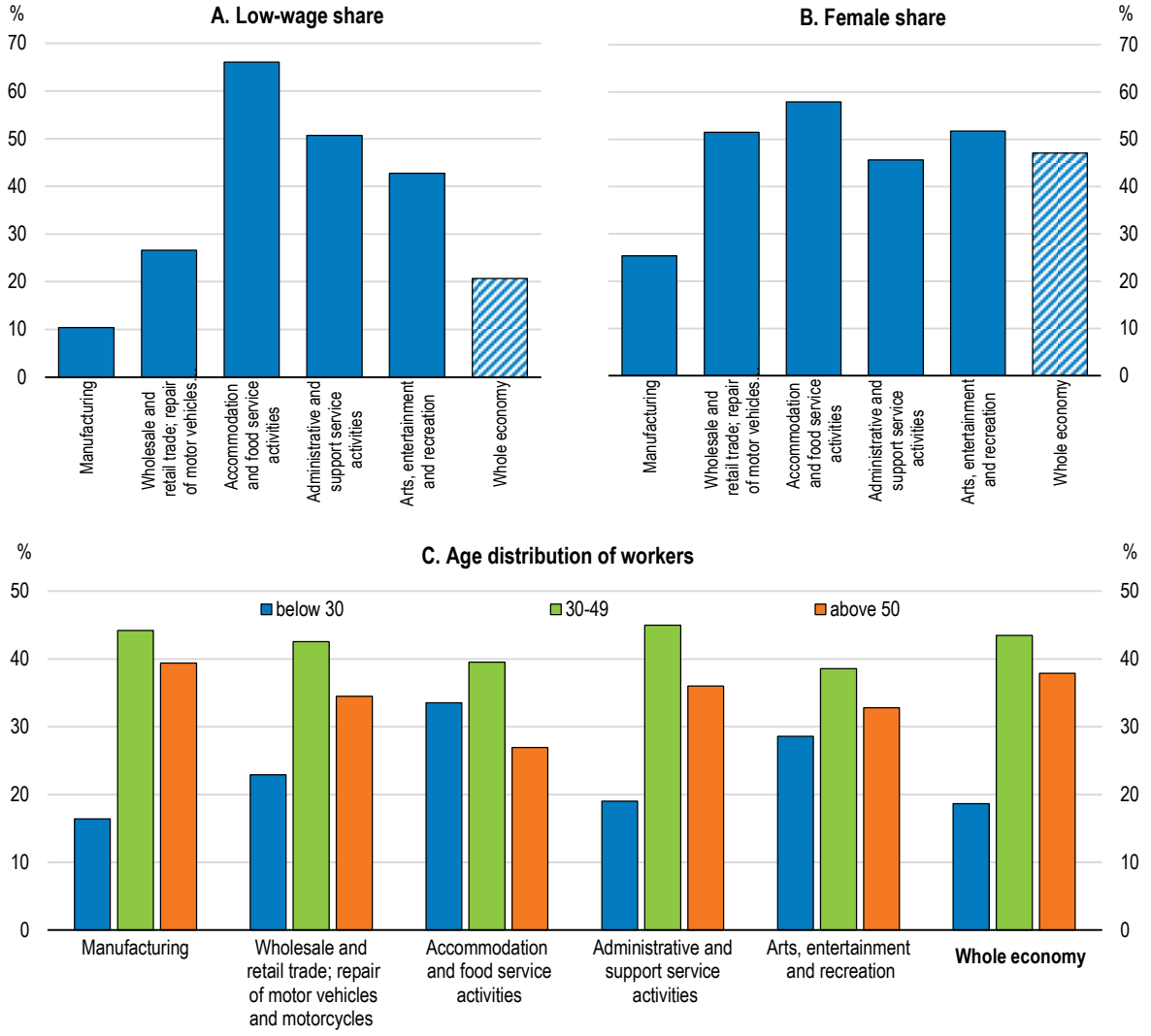
1.6. An inclusive and flexible labour market is crucial during the recovery

The crisis risks exacerbating existing labour market inequalities. Low-wage earners and women are particularly vulnerable to rising unemployment, as their share in some heavily hit industries is comparatively large (Figure 1.25) and they are more often in marginal employment, thus ineligible for short-time work (Kalina and Weinkopf, 2018[99]; Hammerschmid, Schmieder and Wrohlich, 2020[100]). Similarly, young workers are at risk as hiring might be subdued for some time and graduating during a recession can lead to long-lasting scarring effects. Lower skilled VET graduates particularly suffer from adverse starting conditions as they face lower future employment stability and persistent wage loss (Umkehrer, 2019[101]).

During the downturn, the government should exercise caution in proceeding with proposals to substantially increase minimum wages and strengthen collective bargaining extensions. While the introduction of a minimum wage in 2015 and incremental increases to EUR 9.35 per hour have increased wages at the bottom of the distribution without adverse employment effects (Caliendo, Schröder and Wittbrodt, 2019[102]), there is greater risk of negative effects during a downturn (Boeri, Cahuc and Zylberberg, 2015[103]). The designated minimum-wage commission is well-structured and took these risks into account in recommending slow and stepwise increases in the minimum wage, starting with EUR 9.50 on 1 January 2021 and reaching EUR 10.45 by mid-2022. Plans by the Labour Ministry to increase voluntary participation in collective bargaining have potential to boost employment, consistent with OECD experience of collective bargaining that is “organised decentralised” and characterised by a high degree of wage co-ordination across different bargaining units (OECD, 2019[104]). The proposal of strengthening agreement extension further, however, requires careful design in terms of representation of workers and employers, public interest and flexibility, as it may hurt both firms and workers not associated with social partners (OECD, 2018[105]).

Figure 1.25. Share of low-wage earners, women and youth is high in some affected sectors

Demographic and work characteristics in different industries, 2018



Source: Eurostat, Structure of Earnings Survey.

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The tax and benefit system should be better designed to encourage moving to jobs with higher earnings

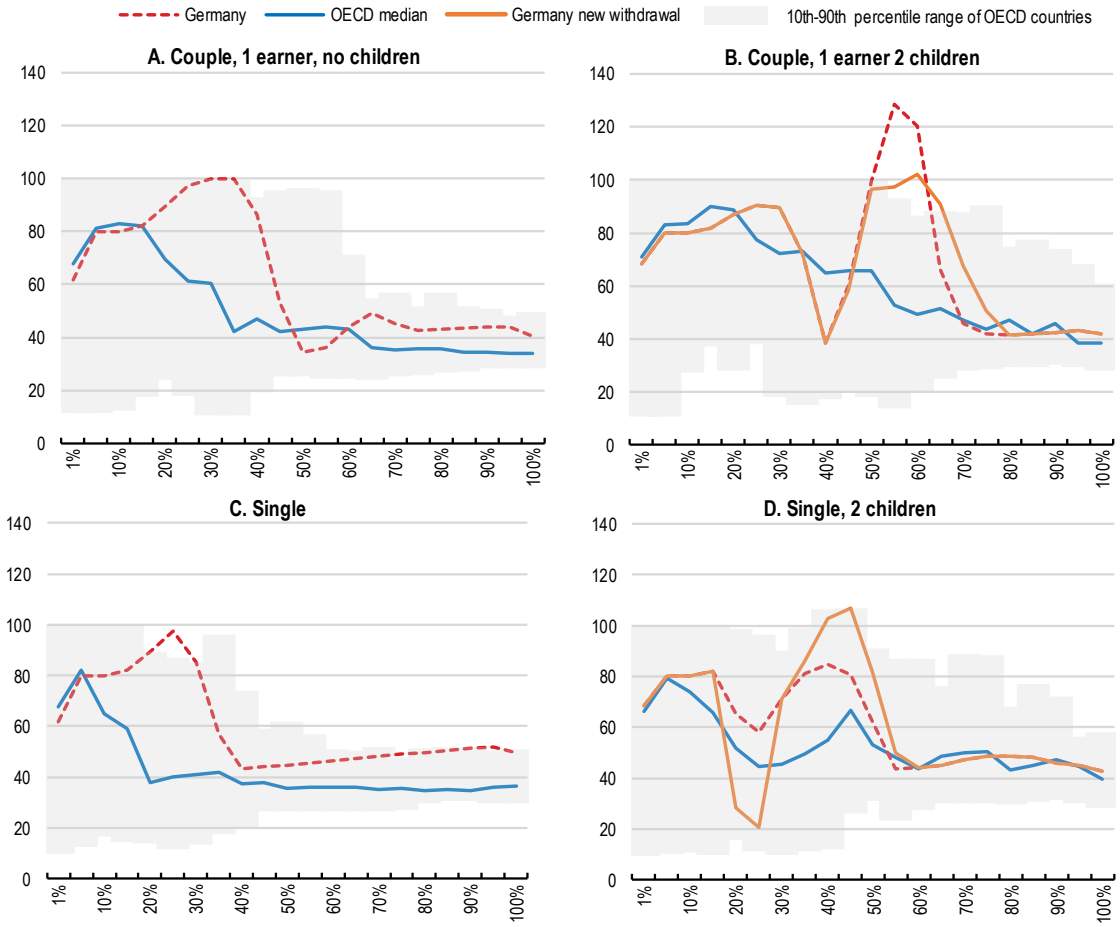
Upward earnings mobility for low-wage earners, who are often in part-time or marginal employment (Kalina and Weinkopf, 2018[99]), is weak (Grabka and Schröder, 2019[106]). As around half of all low-skilled workers earn low wages, upskilling would increase their earnings potential (Chapter 2). Promoting training and facilitating the job matching process will be critical if the current downturn persists or consumer preferences change and reallocation of workers between firms or sectors becomes necessary. Active labour market policies tend to be more effective during times of economic slowdown, and particularly benefit females and the long-term unemployed (Card, Kluve and Weber, 2018[107]).

The design and withdrawal of different transfers causes high marginal effective tax rates (METRs) at low earnings and disincentivises working more and moving to better-paying jobs (Bertelsmann Stiftung, 2017[48]). For households without children this is driven by high withdrawal rates of subsistence benefits for earnings of more than EUR 100 per month, while for households with children child supplements could

be phased out more slowly (OECD, 2014[96]). Despite recent reforms of child allowances, METRs continue to be high (Figure 1.26). Slower and more coordinated withdrawal of social assistance, child supplement and housing benefits could smooth and lower METRs and increase overall labour supply (SVR, 2019[108]). This would extend the income range that would qualify for benefit payments, though higher tax receipts due to increased employment may offset some of the extra spending. It might, however, reduce the number of hours worked, especially among second earners, typically women (Bruckmeier, Mühlhan and Wiemers, 2018[109]), which is a problem associated with household-income based transfers in general (Immervoll and Pearson, 2009[110]). Reducing the tax burden on the income of second earners remains important to raise employment among women, as recommended in previous surveys (Table 1.12; OECD (2018[111])). This can be achieved, for example, by introducing a separate tax-free allowance and relating health insurance premiums to the number of adults in a household.

Figure 1.26. The transfer and benefit system creates weak incentives to expand working hours

Effective marginal tax rate at % of average wage, 2019



Note: The vertical axis shows the effective marginal tax rate in % for a 10 percentage point increase in earnings at various gross employment income levels. Scenarios with children are based on two children at the ages of 4 and 6. Annual housing costs are assumed to be 20% of average wage. Median and percentile values for OECD are based on OECD countries except Germany. Results are based on rules as of 1 January 2019. The orange line adjusts the Germany 2019 model to include reforms implemented in July 2019 and 2020 concerning withdrawal rates of child allowances: parental income is withdrawn at a rate of 45% instead of previously 50% and the cliff edge is abolished. For single parents, alimony payments, which count as child income, are only withdrawn at 45% instead of 100%. Increased levels of child allowance from July 2019 are not taken into account. Source: OECD calculations from OECD Tax-benefit model, http://oe.cd/taxBEN.

StatLink https://doi.org/10.1787/888934200812

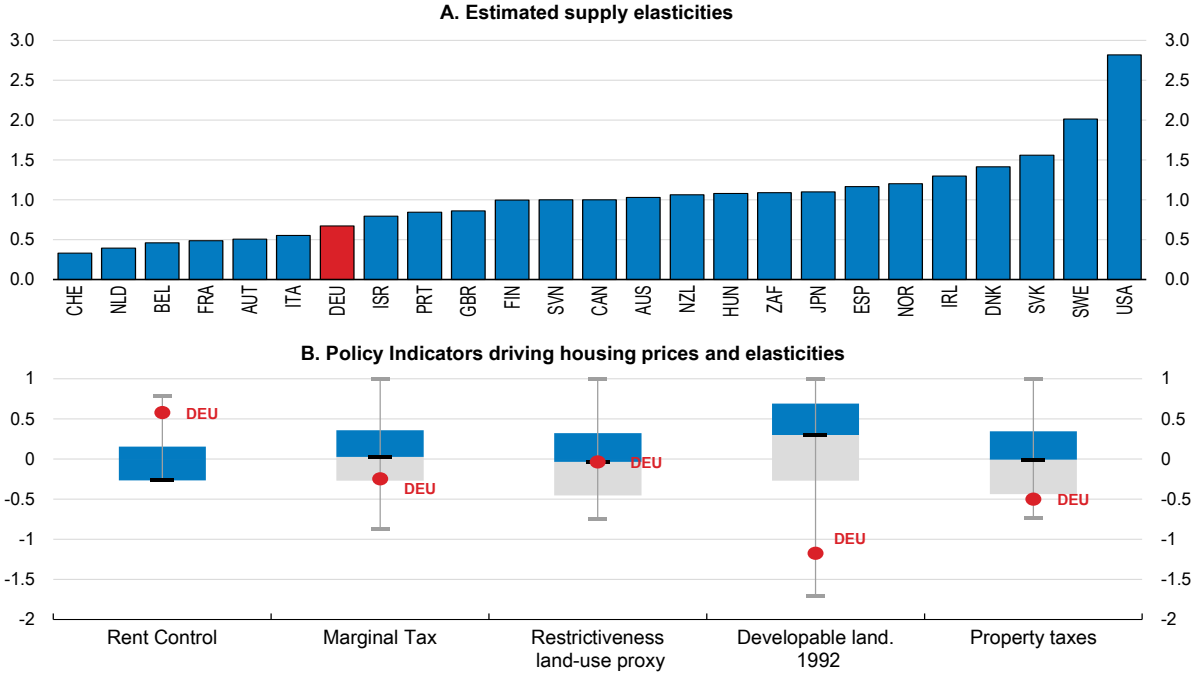
Table 1.12. Past recommendations and actions taken on labour market inclusion and education

Recommendations	Action Taken
Strengthen support for unskilled adults to obtain professional qualifications. Provide financial incentives for employers to provide workplace learning for the low-skilled.	The Act on Opportunities to Gain Qualifications, in effect since 2019, has expanded training opportunities for individuals independent of age, qualification and firm size whose jobs are affected by structural change, or who wish to pursue continuing vocational training in a profession affected by skilled labour shortages. Employers can receive a wage subsidy for the time their workers spend in skill development programmes. The act also strengthened the counselling of the Federal Employment Agency. In 2020, the "*Arbeit-von-morgen-Gesetz*" was implemented to strengthen training further in view of ongoing structural change related to digitalisation and climate change. The law includes measures to increase the support rate to firms for training subsidies if a large share of employees requires training, to ease the application process for subsidies and to grant workers without a vocational degree the legal right for subsidies to obtain qualifications.
Offer more training programmes for the modular acquisition of qualifications in lifelong learning and foster the recognition of skills acquired on the job. Ensure modular training contributes towards full qualifications.	The pilot project ValiKom has developed a joint procedure to assess and validate occupational skills and competences acquired outside the formal education system. It applies self-assessment and external assessment to document prior learning and examine the equivalence of the competences compared to formal regulated professions. At the end of 2018 BMBF started ValiKom-Transfer, involving up to 30 chambers and opening the validating process to more occupations. In June 2019 the partners of the National Skills Strategy agreed to check the possibility of anchoring the ValiKom approach within the legal or regulatory framework.
Improve transparency in the adult education market and facilitate access to guidance on adult training. Carefully monitor the outcome of financial support programmes for adult learning and education.	The National Skills Strategy (Nationale Weiterbildungsstrategie) aims to facilitate career advancement for broad sections of the population, to strengthen skilled labour development, and to foster long-term employability in a changing world of work.
Phase out child benefit supplement (*Kinderzuschlag*) paid to parents receiving a housing allowance more slowly.	A reform in 2019 increased the monthly maximum benefit from EUR 170 to EUR 185 per child. For single parents, the withdrawal rate based on alimony payments has been lowered from 100% to 45%. In January 2020, the abrupt phase-out of the benefit was replaced by a smooth phase-out and the withdrawal rate for parental income decreased from 50% to 45%.
Reduce the gap in employment protection between permanent and temporary workers. Ease employment protection for regular job contracts, for example by reducing notice periods. Limit use of multiple successive fixed term contracts and strengthen enforcement of workplace regulation for workers on non-standard contracts.	Since 2017, the duration of employment on jobs filled by temporary agency workers is limited to 18 months.
Target preferential tax treatment of minijobs towards low-wage workers. Tax subsidies should not be provided for combining jobs.	No action taken.
Improve access of immigrants to public sector jobs.	No action taken.
Improve training and the recognition of immigrants' skills.	As part of the new immigration law for skilled migrants in effect since 2020, recognition and administrative procedures have been improved and accelerated. A central point of contact for individuals abroad seeking information on recognition was established within the labour agency. Access to language classes and training support has increased from 2019.
Increase the minimum amount of time the second parent has to take parental leave, from the current two months, for the couple to receive the maximum leave entitlement.	No action taken.
Lower the tax burden on wage income of second earners. Link health insurance premiums to the number of adults in a household.	No action taken.
Raise quality standards in childcare and early childhood education. Expand primary education to high-quality full-day education programmes.	The "Gute-Kita-Gesetz" was implemented in 2019 through individual agreements with all 16 states providing funding of EUR 5.5 billion until 2022 for measures to improve childcare quality, reduce fees, and adapt childcare to local needs. As part of the 2020 recovery package, additional funds for expansion of full-time schooling will be granted for states that start deploying funds in 2020/2021. For early childhood education expansions carried out in 2020/2021, additional support of EUR 1 billion will be granted.
Provide more financial resources to schools with a comparatively high share of pupils with weak socio-economic background in particular at lower secondary level.	A 2019 joint federal–*Länder* programme to support primary and lower-secondary schools in socio-economically disadvantaged areas ("Schule macht stark") will provide EUR 250 million over 10 years from school year 2021-22.
Strengthen general education within vocational schools, and maintain the strong labour market orientation of vocational education and training. Improve access to university education for upper secondary vocational graduates.	An amendment to the vocational training act in 2020 introduces internationally comparable degree designations, facilitates part-time vocational education programmes and transfer of credit for sequential programmes.

Housing policy reforms can support labour mobility, inclusion and decarbonisation

Driven by favourable financing conditions, sustained economic growth, increased immigration, growing urban populations and a weak supply response (Figure 1.27), house and rental prices started to rise faster than the OECD average in 2011 and accelerated from 2016. Though housing is still comparatively affordable, costs including fees and energy costs put a large burden on low-income households (OECD, 2020[112]). Rent and house price increases have adverse distributional effects, particularly in Germany where the share of renters is high (Causa, Woloszko and Leite, 2019[113]; Baldenius, Kohl and Schularick, 2019[114]). The number of building permits has risen steadily since 2009, suggesting some increase in the capacity of building supply to respond to demand, though less permits were issued in 2019 than in the mid- to late-1990s. Increasing the supply response, building on the comprehensive housing strategy from 2018 (Table 1.13), remains important.

Figure 1.27. Housing supply is not very responsive to prices



Note: Panel A shows estimates of the long-run supply elasticity from 1980Q1 to 2017Q4. For Panel B, a thick solid black line shows the median. The high/low values of the whiskers are either 1.5 times the interquartile range or the extreme value for the sample, whichever diverges further from the median. Each indicator is cross-sectionally de-meaned and expressed relative to its maximum value. Data refer to 2017 or the latest available date except for developable land and the change in built-up area per capita that refer to 1992 and 1990, respectively. The cross-sectional sample consists of 25 countries, except for the land-use restrictiveness proxy (covering 24 countries) and rent control indicator (19 countries). The marginal tax is the average marginal effective tax rate for home-owners who buy without credit. The index of rent control is sourced from Kholodilin (2018[25]). Developable land is the share of non-built-up, non-water land in each country in 1992. The land-use restrictiveness proxy captures the presence and importance of land-use regulations at lower levels of government. The higher the indicator, the more land-use planning decisions are decentralised, which has been found to result in tighter restrictions (Ahrend, Gamper and Schumann, 2014[115])). Property taxes is the share of property taxes over total tax revenues.
Source: (Cavalleri, Cournède and Özsöğüt, 2019[116]).

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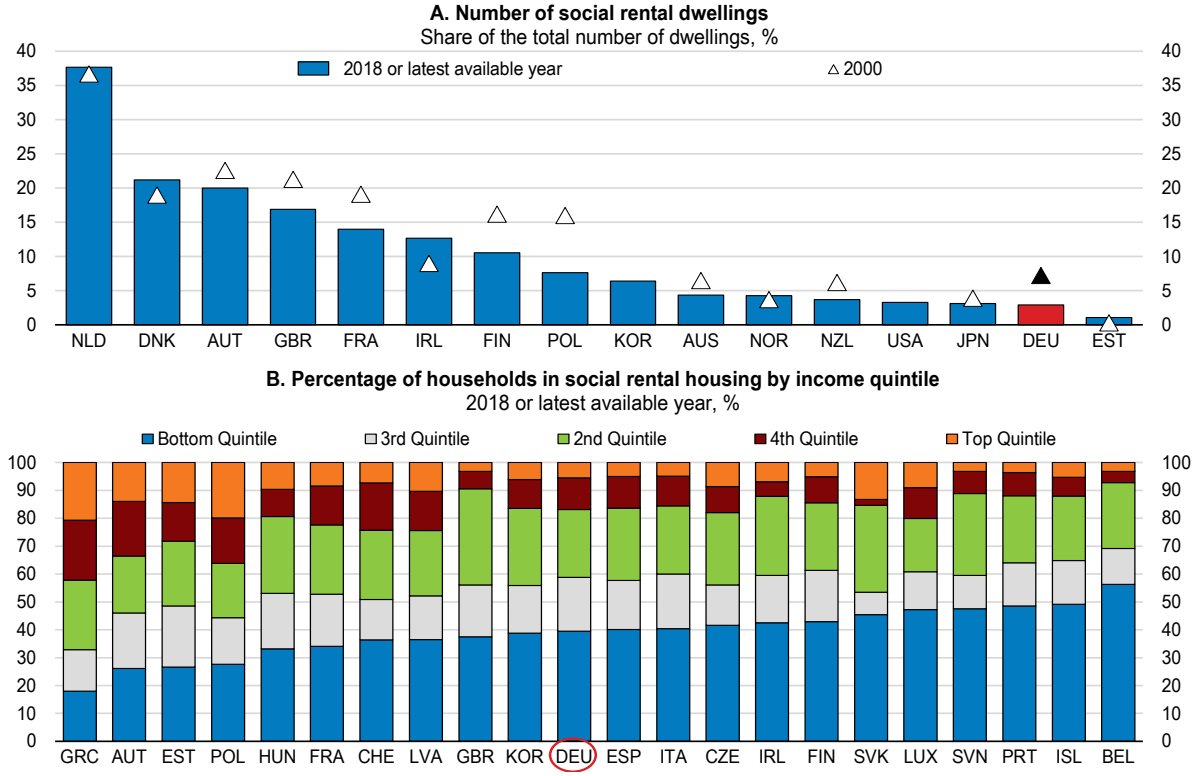
While Germany is among the OECD countries spending the most on housing allowances, social housing is limited (Figure 1.28, Panel A). Portable housing allowances are generally preferable with respect to mobility, but do not guarantee good housing and may raise rental prices (Kangasharju, 2010[117]). Federal support of EUR 5 billion for social housing over the period 2018 – 2021 and an additional EUR 1 billion per year for the years 2022 – 2024 are welcome, but improved targeting towards low-income households will

be crucial (Panel B). Strengthening the currently low application of misallocation fees might not be enough (Wissenschaftlicher Beirat beim Bundesministerium für Wirtschaft und Energie, 2018[118]), if the social-housing stock is limited. The introduction of regular means testing and transition to market-based rents as incomes increase would provide revenue to further expand social housing while also encouraging tenants whose circumstances have improved to move to other forms of housing. Potential disincentives for economic advancement and effects on social mixing in social housing would need to be carefully managed.

Figure 1.28. The social housing stock is low and targeting could be improved



Note: Subsidised rental housing covers all housing rented at below-market-rate, including social rental housing, employer-provided housing and housing where rent levels are fixed by law.
Source: OECD calculations based on OECD Affordable Housing Database.

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Tighter rent controls, such as the recent rent freeze in Berlin, should be avoided. With the introduction of the rental brake in 2015, which slows the growth of rent prices in tight markets, Germany ranks at the higher end in terms of strictness (Figure 1.27 above, Panel B). While rent control helps equalise the power balance between tenants and landlords, potential drawbacks include reduced construction, fewer upgrades or misallocation of housing (OECD, 2020[119]). New dwellings have been exempt from the rental brake, and negative effects on construction have not been found so far (Mense et al., 2018[120]). Nevertheless, uncertainty about future expansion could reduce supply in the longer term. Furthermore, limiting the return on rental units – especially through a rent freeze – can lead to increased conversion of rental to owner-occupied units (Kholodilin and Kohl, 2019[121]) and strict tenant-landlord regulation might pose obstacles to residential and labour mobility (Causa and Pichelmann, 2020[122]).

Since 2008, primary energy consumption in buildings has declined by 16% in large part due to high efficiency standards for new buildings (IEA, 2020[123]). In recent deliberations to merge different regulations into a single law, however, the government has abstained from raising standards further partly to keep rising construction costs in check. Similar to other standards, energy efficiency requirements have contributed to increasing construction costs in the past (Holm and Sprengard, 2015[124]; Walberg,

Gniechwitz and Halstenberg, 2015[125]). However, they also help to reduce energy bills. The government will assess current standards in 2023, taking into account construction and living costs. Existing standards, such as requirements for parking in cities, should also be re-assessed with climate objectives in mind (BMUB, 2015[126]).

Annual energy-efficient building renovation rates need to increase from currently 1% to at least 1.5% to achieve Germany's 2050 goal of a near climate-neutral building stock (dena, 2019[127]). While financial subsidies for renovation exist and have been increased in the government's Climate Action Programme 2030 and recovery package, the split-incentives problem whereby landlords pay for retrofits while tenants benefit from lower energy bills needs to be addressed better. Rent increases following retrofits should be based on energy savings rather than renovation costs, as in the Dutch social housing sector (Müller et al., 2016[128]), so as to increase transparency and avoid higher gross rents (Weber and Wolff, 2018[129]). Introducing minimum standards for existing buildings combined with targeted support for lower-income owners could also boost renovation. In the UK, dwellings with an energy-performance standard of F or below are no longer allowed to be rented out (Economidou and Bertoldi, 2015[130]).

Table 1.13. Past recommendations and actions taken on housing policy

Recommendations	Action Taken
Improve housing supply in dynamic cities fostering densification in urban areas, for example, with incentives for compact development on brownfield sides.	In 2018, a comprehensive housing strategy was formulated aimed at creating 1.5 million new dwellings by 2021. Measures directly targeted at an increased housing supply are earmarked federal funding for social housing of EUR 5 billion from 2018 to 2021, the adoption of a model type approval in the federal building code, a temporary tax deduction for the construction of new rental dwellings until 2021, measures to speed up approval processes, and an evaluation of the costs of new standards for construction. The real estate tax reform allows municipalities to levy an additional tax on vacant construction land from 2025 onwards. From 2020 onwards, support for urban development has a larger focus on sustainable development including brownfield sites for housing.
Update real estate valuations while protecting low-income households.	In 2019, reform of the property tax has been decided on, which will take effect in 2025. Real estate valuations will be updated and continue to be based on both land and buildings. Reform has been designed to be fiscally neutral. An opening clause for states to design their own property tax was introduced as well as an option to levy extra tax on vacant construction land.
Extend capital gains taxes on residential real estate except for owner-occupied housing.	No action taken.

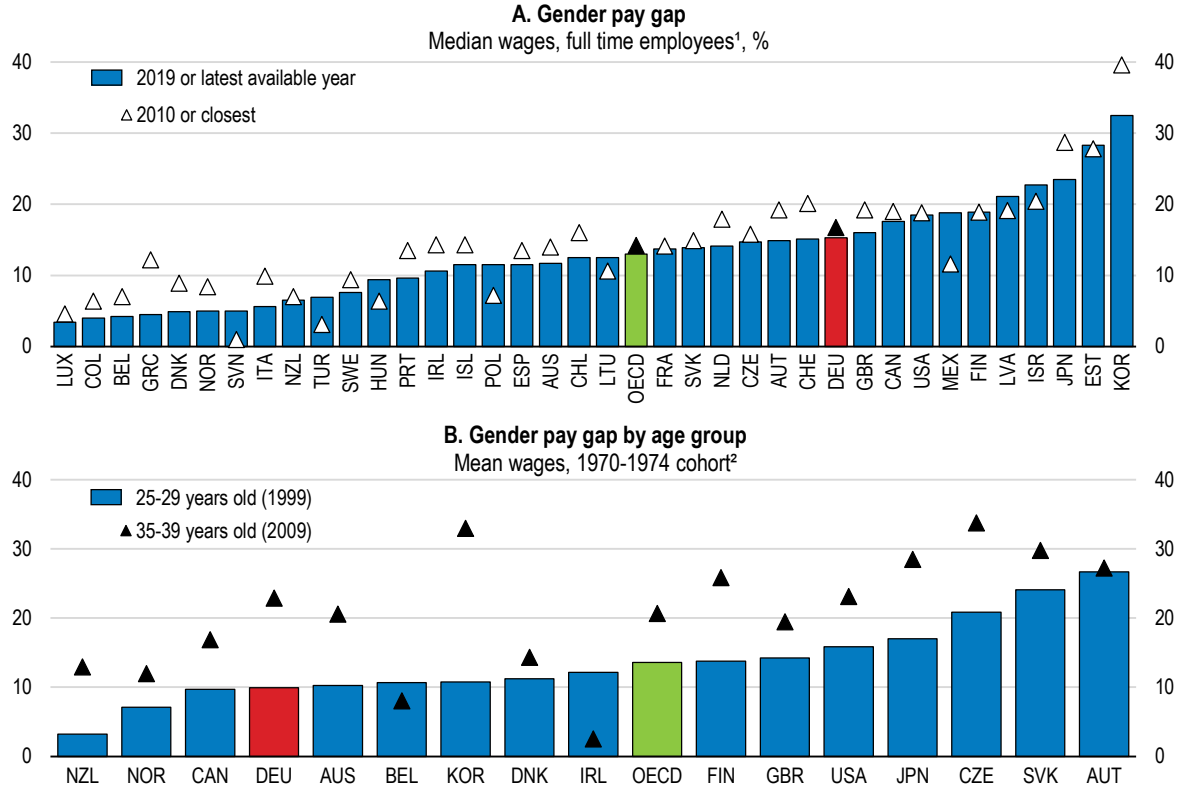
The high share of part-time work among women contributes to a large gender wage gap

The unadjusted gender wage gap (20% in 2019) has changed little over the past twenty years (Statistisches Bundesamt, 2020[131]). At 16.2%, the gap among full-time employees is lower, indicating differences in working hours as one factor (Figure 1.29, Panel A). Sector and occupational segregation explains about 30% of the wage gap, as women are overrepresented in jobs with low pay (Boll and Lagemann, 2018[132]). The wage gap is smallest for young women (Schrenker and Zucco, 2020[133]), and increases as women reach childbearing age (Panel B). Reflecting this labour-market experience, the gender pension gap is among the highest in the EU and lifetime earnings of women and especially mothers are well below male earnings (Bönke et al., 2020[134]). While the employment rate is comparatively high, one factor driving the earnings gap is the high female part-time share (Figure 1.30, Panel A). Having children increases the incidence of part-time work (Panel B), as women spend more time on childcare (OECD, 2017[135]).

In 2019, a right to return to full-time hours after a period of part-time employment was introduced, but it is still too early to observe outcomes. Flexitime and teleworking have been shown to reduce part-time work among mothers (Chung and van der Horst, 2018[136]). Increased telework during the pandemic has shown

that much potential working from home had been left untapped and could make firms and workers use this arrangement more frequently in the future (Grunau, Steffes and Stefanie, 2020[137]; Alipour, Falck and Schüller, 2020[138]). Policy could strengthen those working arrangements further by granting, where applicable, *all* employees a legal right to flexible arrangements including teleworking or encouraging social partners to cover flexibility in collective bargaining (OECD, 2017[139]). In the Netherlands, employees are entitled to ask their employer for flexible working hours. The employer should honour such a request unless there is a significant reason for not doing so. Encouraging flexible work arrangements may increase the well-being of both women and men and reduce large gender wage gaps, especially within occupations that reward long hours disproportionally (Zucco, 2019[140]). Similarly, promoting higher female employment in STEM and ICT fields could reduce the gender gap as these occupations generally provide high earnings and a high capacity to work from home (Chapter 2).

Figure 1.29. The gender pay gap for full-time employees has changed little in the last decade



Note: The gender wage gap is defined as the difference between male and female wages divided by male wages.
1. Full-time employees are defined as those individuals with usual weekly working hours equal to or greater than 30 hours per week.
2. Data for 25-29 years old refers to 1998 (instead of 1999) for Denmark, Korea, Norway and the Slovak Republic; to 1997 for Ireland. Data for 35-39 years old refers to 2008 (instead of 2009) for Australia, Austria, Denmark, Finland, Germany, Norway, Korea, and the Slovak Republic; to 2007 for Belgium, the Czech Republic and Ireland. For Austria, 25-29 refers to 20-29, 35-39 refers to 30-39.
Source: OECD (2020), Gender wage gap (indicator); OECD (2012), Closing the Gender Gap: Act Now.

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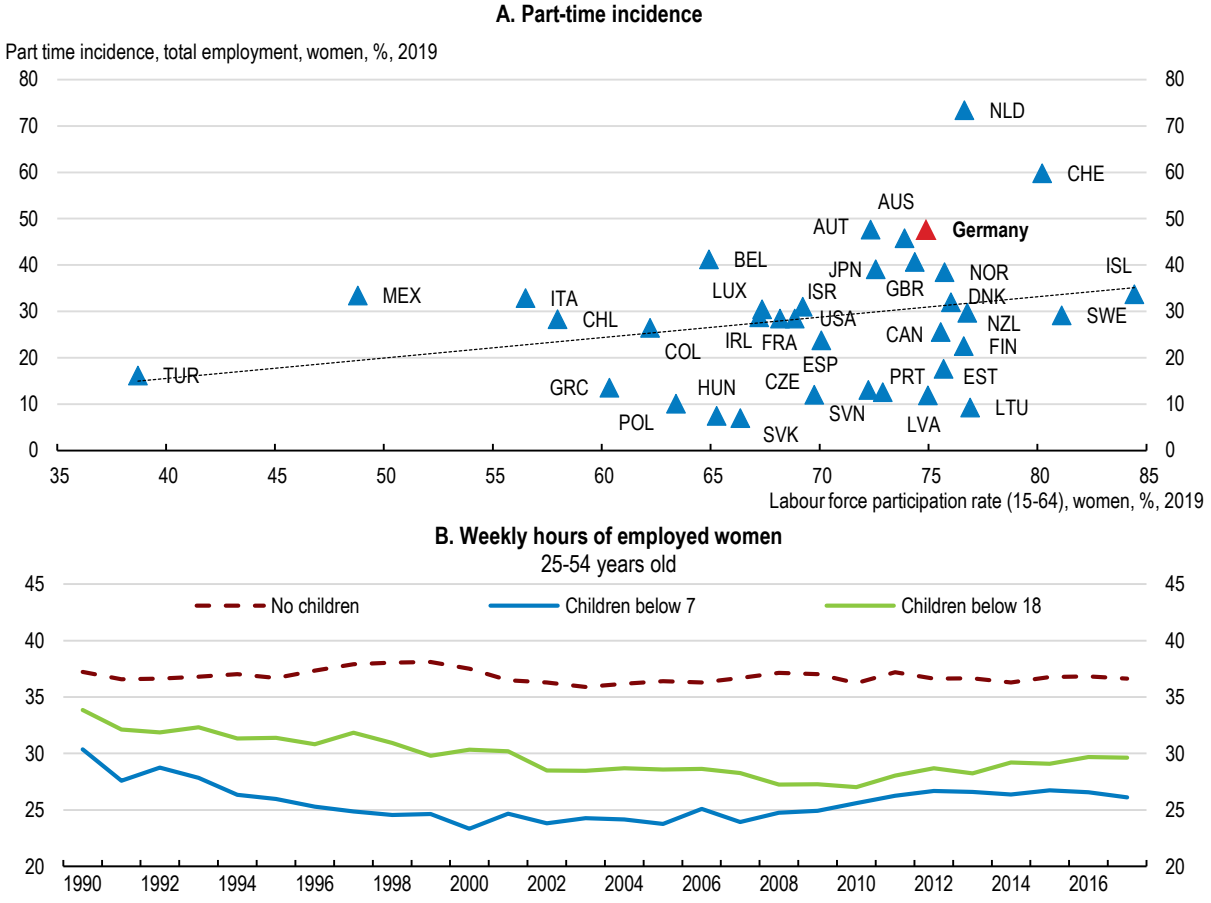
Figure 1.30. Women, particularly mothers, often work part-time



Source: OECD Labour Force Statistics; OECD calculations based on GSOEP v34.

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Family and care policies are on the right track but equal sharing still has some way to go

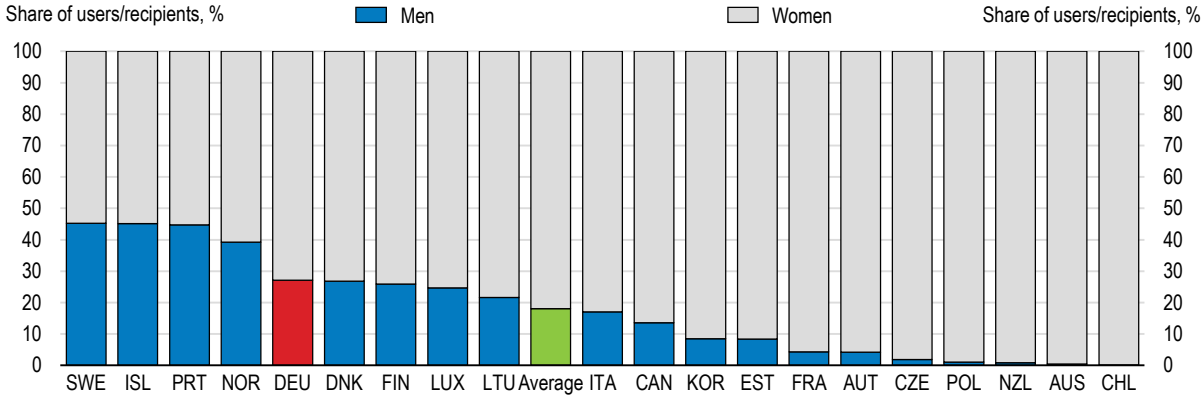
As the COVID-19 pandemic has shown, flexible work arrangements are not a substitute for institutional childcare. Previous expansions of early childhood education and full-day schooling have lifted participation to or above the OECD average and increased maternal labour-market engagement (Gambaro, Marcus and Peter, 2019[141]; Zimmert, 2019[142]). Still, the demand of 12% of parents with children below age three was not met in 2018 (Alt et al., 2018[143]), and shortfalls are increasing (IW Köln, 2020[144]). Additionally, six per cent of parents with children in preschool or primary school required longer hours. Planned expansions are, therefore, welcome, but more remains to be done. Going forward, flexibility in care hours will be important. As part of agreements with the federal government, some states plan to adapt opening hours to parents' needs or to encourage the engagement of childminders, who can provide tailored and flexible care due to smaller groups.

Without steps to increase supply, rapid expansion of the early childhood education system could result in staff shortages. Germany may need close to half a million new early childhood education staff by 2030, which far exceeds the expected number of appropriately qualified graduates over the same period (OECD, 2019[145]). Salaries for workers in the field are relatively low (Oberhuemer and Schreyer, 2017[146]) and the vast majority of workers in the profession are women. Increasing wages and opportunities for career progression may help attract more teachers and reduce the overall gender pay gap.

Increased paternity leave can strengthen care sharing and increase female employment (Huerta et al., 2013[147]; Tamm, 2019[148]; Patnaik, 2019[57]). The introduction of two minimum "daddy-months" in 2007 has boosted paternity leave (Figure 1.31), and *ElterngeldPlus*, which allows combining parental leave and part-time employment, seems to have lengthened paternity leave slightly (Samtleben, Schäper and Wrohlich, 2019[149]). Still, women take the vast majority of leave (Statistisches Bundesamt, 2018[150]). As previously recommended, leave reserved for the second parent could be extended (OECD, 2018[111]). As fathers often report financial motives as reasons for not taking longer leaves (Samtleben, Schäper and Wrohlich, 2019[149]), financial incentives could be extended, especially as Germany is only around the OECD average for both overall spending on parental leave and replacement rates for fathers (OECD, 2020[151]; OECD, 2020[152]).

Figure 1.31. The paternal share of parental leave exceeds the OECD average

Recipients of publicly administered parental leave benefits or publicly-administered paid parental leave, 2016



Note: Data refer to recipients/users of publicly-administered parental leave benefits or publicly-administered paid parental leave, and do not include users of maternity or paternity leave unless the country in question does not make a distinction between the different leaves (e.g. Iceland, Portugal). Data refer only to those using statutory schemes and do not include individuals using only employer-provided parental leave or parental leave pay. Data for Germany refer to 2015.
Source: OECD Family Database.

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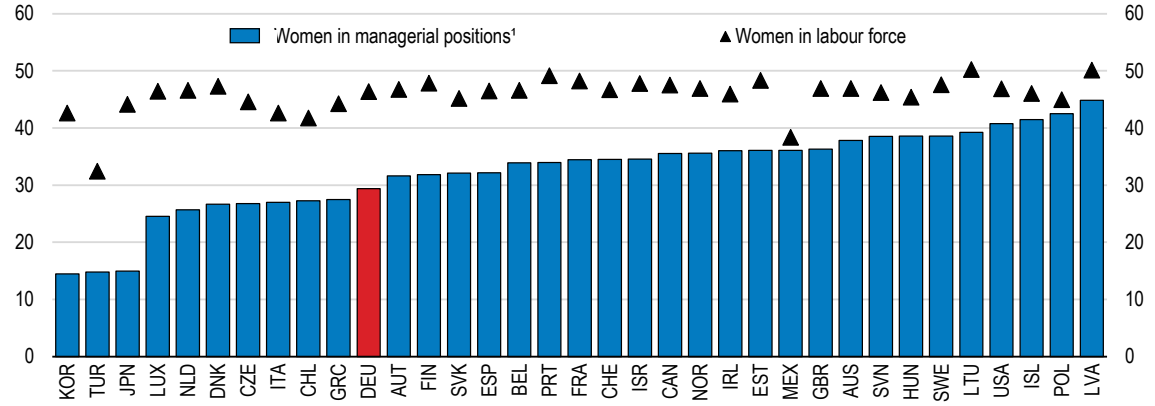
Women are still a minority in management positions

The low share of women in managerial positions also contributes to the gender wage gap (Figure 1.32). While a quota for supervisory boards in 2015 has been successful in raising the share to about 35%, female managers are still rare even in firms covered by supervisory board quotas (Kirsch and Wrohlich, 2020[153]). The national gender equality strategy, adopted in July 2020, introduced nine goals, including promoting more women to management positions and supervisory boards. The government is discussing a proposal to expand the quota for supervisory boards. Pay-transparency laws are a key lever to promote gender equality. Early evidence on the 2017 German law suggests room for improvement, as few employees use their right to inquire about colleagues' wages and many firms neglect their reporting requirements (Federal Ministry for Family Affairs, 2019[154]). Moving beyond individual entitlements and requiring more general reporting on gender pay gaps as in France and the UK may be necessary. Such instruments are relatively new and studies on their effects are still scarce, but reporting of gender-disaggregated statistics in Denmark has reduced pay gaps.

Figure 1.32. Women are under-represented in managerial positions

Female share of management employment and female share of labour force, all ages, 2018 or latest available year



1. Employment in management is based on the International Standard Classification of Occupations (ISCO) and refers to total management (category 1 of ISCO-08 or ISCO-88).

Note: For Colombia, the female share of managerial employment is the female share of the employed that hold jobs classified in International Standard Classification of Occupations 1968 (ISCO 68) major group 2 (administrative and managerial workers); for Canada, Chile and the United States, the female share of managerial employment is the female share of the employed that hold jobs classified in International Standard Classification of Occupations (ISCO) 88 category one (as legislators, senior officials and managers). For all other countries, the female share of managerial employment is the female share of the employed that hold jobs classified in International Standard Classification of Occupations (ISCO) 08 category one (as managers).

Source: OECD Labour Force Statistics; ILOSTAT.

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MAIN FINDINGS, key policy insights chapter	RECOMMENDATIONS (key recommendations in bold)
Macroeconomic policies to support the recovery	
Fiscal policy is highly expansionary and an immediate return to a tight deficit limit under the debt brake could derail the recovery.	**Stand ready to give further support if the recovery is weak.** **Gradually remove fiscal support once the recovery is well underway.** **Pursue planned fiscal consolidation while addressing long-term challenges.**
Boosting public investment	
Public investment has picked up since 2014, but not enough to resolve the infrastructure backlog. Future needs will increase with the energy transition, digital transformation and ageing.	**Further increase spending on high-quality public investment, including through funding to municipalities.** Continue to prioritise green investments in stimulus policies.
Capacity constraints in the construction industry and local planning offices hold back the delivery of new infrastructure.	**Bolster local planning capacity through inter-municipal cooperation, training and expanding staffing in key technical roles.**
Infrastructure governance is generally good, but there are weaknesses that restrict productivity benefits from public investment.	Assign an independent advisory body with responsibility for preparing a long-term strategic infrastructure plan. Streamline planning processes and improve public procurement through better data collection and compilation.
Structural reforms for a sustainable recovery	
The tax burden on low labour income is high, due to high social security contributions, while environmental and property taxation is low and exemptions to inheritance and capital income taxes contribute to high wealth inequality.	**Reduce taxation of labour income, while removing inheritance tax exemptions, raising reduced VAT tax rates to the standard rate, and strengthening environmental, property and capital income taxation.**
Progress in reducing greenhouse gas emissions has been concentrated in electricity generation, with the transport sector in particular facing considerable challenges to meet its 2030 goal.	**Provide low-emissions alternatives through expanding public transport and charging networks, urban planning that creates proximity between people and places they visit for work or leisure, and facilitating telework.**
Substantive emissions pricing is being introduced for transport and heating, but inconsistencies in energy taxation remain.	**Make emissions pricing more consistent across sectors and fuels.** Eliminate harmful subsidies such as the tax credit for long distance commuting.
While energy-efficient standards are high for newly constructed buildings, renovation rates for existing buildings need to increase.	Increase minimum energy efficiency standards for existing housing and tie allowable rent increases to energy savings.
Germany leads the OECD in recycling, but as a high income country also generates much more waste than most OECD countries.	Make more use of pricing mechanisms to promote waste prevention and make reuse and recycling more attractive.
Increasing labour market inclusion	
Occupational entry regulations affect a high share of the workforce, which leads to higher prices, slows labour market dynamism and hurts the ability of immigrants to use their skills.	**Liberalise entry conditions, prioritising sectors subject to supply constraints (such as construction) and preserving the strengths of the vocational education and training system.**
High marginal effective tax rates at the bottom of the income distribution create disincentives to expand labour market participation and can trap individuals in low-wage employment.	**Reduce marginal effective tax rates for low income earners through slower and more coordinated withdrawal of social assistance, child supplement and housing benefits.**
Germany has relatively strict rent control, which is associated with lower housing supply elasticities and reduced labour mobility.	**Reduce strictness of rent controls in markets where more supply is needed, such as Berlin.**
More fathers are taking parental leave but often limited to the minimum two months. Financial motives are often cited as reasons for not taking leave or not taking longer leaves.	Encourage longer leave periods by fathers by, for example, increasing the number of months dedicated to the second parent or increasing replacement rates.
The gender pay gap exceeds the OECD average.	Advance the law on pay transparency to require more broadly applicable reporting on gender-disaggregated wage and pay statistics by firms.
Quotas have boosted women's representation on supervisory boards, but advancement into top management positions remains limited.	Extend the quota for supervisory boards to more firms and management boards.
Mothers, even those with older children, often work part time. Flexible work arrangements can reduce part-time work.	**Strengthen legal rights to flexible working arrangements for all employees, including teleworking where possible.**

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2 Unleashing the benefits of digital transformation

Digital transformation holds important potential for productivity, growth and well-being. The German government has made good progress in addressing some key issues, but much potential remains for unleashing the full benefits of digital transformation and data. Low penetration of high-speed broadband due to few fibre connections and an urban-rural divide in connection speeds, as well as below average mobile broadband data consumption and speeds weaken the foundations for digital transformation. Sluggish adoption of key ICT tools and activities, combined with low investment in knowledge-based capital and digital security concerns, further limits firms' potential to innovate and create value with data. In particular SMEs require support to catch up. Addressing connectivity bottlenecks, incentivising investment and supporting business dynamism during the recovery by reducing administrative burden, facilitating access to financing, and accelerating progress towards digital government can boost technology diffusion and productivity growth. To empower everyone to thrive in digital environments, high demand for numeracy and literacy skills and shortages of ICT specialists, notably among women, need to be addressed. Making the most of digital transformation also requires a national digital transformation strategy and governance that ensures effective policy co-ordination.

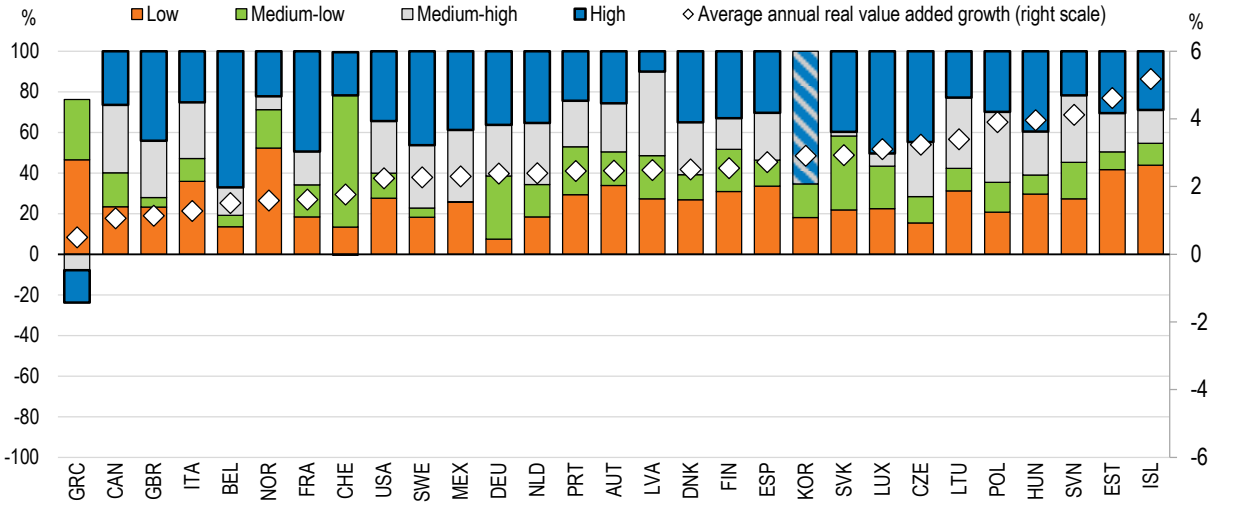
2.1. Boosting productivity and improving policy coherence

Digital transformation holds important potential for productivity, growth and well-being. The German government has made good progress in addressing some key issues, but much potential remains for unleashing the full benefits of digital transformation and data. Digital transformation is underpinned by connectivity, the adoption of ICT tools and activities and effective use of data by firms, governments and individuals, and refers to the economic and societal effects of digitisation[1] and digitalisation[2] (OECD, 2019[1]). Benefitting from digital transformation while addressing challenges across the many areas it affects requires an integrated approach to policy making. Building on core insights from the OECD's Going Digital project, this chapter identifies key priorities for action and recommendations across several policy areas on making the most of digital transformation for Germany. The COVID-19 crisis has illustrated many opportunities of digital transformation for the economy and society, amplifying the importance of several of these recommendations.

In Germany, digital-intensive sectors (high and medium-high) have contributed 62% of growth in value added, compared to 54% on average across OECD countries, between 2015 and 2018 (Figure 2.1). A sector's digital intensity depends on a range of factors, including the adoption of advanced ICT tools, the human capital required for their effective use, purchases of intermediate ICT goods and services, and turnover from online sales, among others (Calvino et al., 2018[2]). Between 2009 and 2018, digital-intensive sectors also contributed 40% of new jobs in Germany, a net creation of 1.6 million jobs.

Figure 2.1. Digital-intensive sectors contributed significantly to recent growth in value added

As a percentage of average annual growth in real value added 2015-18, chain-linked volumes (reference year 2015)



Note: 2015-17 data for Germany, Greece, Latvia, Lithuania, Norway, Poland and Portugal, Switzerland. 2015-16 data for Canada. Digital intensity is defined according to the taxonomy described in: Calvino, F., C. Criscuolo, L. Marcolin and M. Squicciarini (2018), "A taxonomy of digital-intensive sectors", OECD Science, Technology and Industry Working Papers, No. 2018/14, OECD Publishing, Paris, https://doi.org/10.1787/f404736a-en. Factors that define digital intensity of sectors include: ICT tools; human capital needed for their effective use; ICT tangible and intangible (i.e. software) investment; purchases of intermediate ICT goods and services; stock of robots; and turnover from online sales.

Source: Going Digital Toolkit. https://goingdigital.oecd.org/en/indicator/08/.

StatLink https://doi.org/10.1787/888934200945

Better connectivity, wider diffusion of ICT tools and effective use of data by firms hold important potential for innovation and productivity. Such potential lies, for example, in business processes innovation, automation of routine tasks, more efficient interactions with suppliers and customers, and the use of data in innovation. Labour productivity is high in Germany but is held back by weak capital deepening and slow diffusion of ICT tools and activities to less productive firms (OECD, 2018[3]). In addition to more investment

in ICTs, firms also need to invest in complementary assets: the greatest benefits from digital transformation are often found in firms that also invest in knowledge-based capital and skills (Gal et al., 2019[4]).

Unleashing the full benefits of digital transformation requires coherent policies and co-ordination across all areas affected by digital transformation. This can be achieved through a comprehensive national digital transformation strategy and a governance approach that ensures effective co-ordination. Germany's efforts in this respect are evident. Multiple digital-related strategies and policies exist and the key measures are summarised in the implementation roadmap Digitalisierung Gestalten (Shaping Digitalisation) (Bundesregierung, 2019[5]). This document is co-ordinated by a dedicated unit in the federal Chancellery and serves as a tool to monitor the implementation of existing measures (Box 2.1). The government also allocates significant funding to different aspects of digital transformation (Bundesregierung, 2019[5]), with additional funds being released via the COVID-19 recovery package.

Box 2.1. Towards a national digital transformation strategy

The implementation roadmap Digitalisierung Gestalten presents an important step towards a comprehensive national digital transformation strategy. The document brings together existing and planned digital-related policies across the government in five priority areas: digital skills, infrastructure and facilities, innovation and digital transformation, digital transition of society, and modern state. The document is updated periodically to monitor the implementation of digital-related policies. It will be enhanced with an interactive online dashboard with indicators developed by the federal ministries that are implementing respective policies, designed to measure and provide public information on implementation progress.

Source: (Bundesregierung, 2019[6]; OECD, 2020[7]).

A next step should be to develop a national digital transformation strategy. A comprehensive set of policy areas to consider and key steps for developing a national digital transformation strategy are provided by the OECD's Going Digital Integrated Policy Framework that is designed to help governments improve policy coherence and co-ordination (OECD, 2020[7]). Key steps to develop such a strategy include to: i) identify Germany's overarching vision and priorities for digital transformation; ii) involve all relevant stakeholders into strategy development; iii) integrate and/or co-ordinate (with) all other digital-related strategies and policies and responsible actors; iv) provide clear objectives for each priority area; v) and ensure coherence among the policies designed to achieve these objectives.

A successful strategy requires leadership and governance that ensures effective co-ordination. Currently, most responsibilities for digital-related policies reside in different line ministries. In some cases, ad hoc co-operation across these ministries exist. The federal Chancellery provides light co-ordination in the context of its implementation roadmap, organises digital ministerial cabinet meetings, and has set up a digital council of external experts; it also has a dedicated unit to co-ordinate and develop digital cross-sectional topics such as the forthcoming national Data Strategy. These are useful elements of a governance approach, which however may need to evolve to effectively co-ordinate the development and implementation of a national digital transformation strategy. This may also involve a deeper integration of such a strategy with public funding allocated to digital transformation.

This chapter identifies priority areas and key policy levers to unleash the benefits of digital transformation in Germany. These include: addressing connectivity bottlenecks and increasing quality of service (Section 2.2); strengthening foundations for firms' digital transformation (Section 2.3); overcoming key barriers to firms' successful digital transformation (Section 2.4); supporting business dynamism during the recovery to boost technology diffusion (Section 2.5); and improving skills to thrive in the digital age (Section 2.6). Main findings and recommendations are summarised in a table at the end of the chapter.

2.2. Addressing connectivity bottlenecks and increasing quality of service

Access to fixed and mobile high-quality broadband at competitive prices is a key foundation for people, firms and the government to tap into digital opportunities. The COVID-19 pandemic has shown the essential role of broadband networks as work and education have shifted to homes. For example, 35% of German employees report to have worked partially or completely from home during the enforcement of mobility restrictions in early April of 2020 (SOEP, 2020[8]). As a consequence, demand for broadband communication services has soared, with over 9.1 terabits per second (Tbps) in data transmitted (which equals the simultaneous transmission of up to 2 million high-definition videos), a 120% increase in videoconferencing traffic and a 30% increase in online and cloud gaming at one of the biggest Internet Exchange Points in Frankfurt (DE-CIX, 2020[9]).

Increasingly data-intensive applications are driving demand for more bandwidth, a trend that is set to continue (Cisco, 2018[10]). As for other OECD countries, networks have proven to be resilient during the mobility restrictions of the COVID-19 pandemic (OECD, 2020[11]). However, lacking the fundamental infrastructure for an increasingly data-driven economy and society would restrain Germany's potential to unleash the benefits of digital transformation and to cope with health emergencies, such as pandemics. Proposals in Germany to establish a right to work from home for those workplaces allowing for it, as a response to the COVID-19 pandemic, also depend on the availability of high-quality broadband.

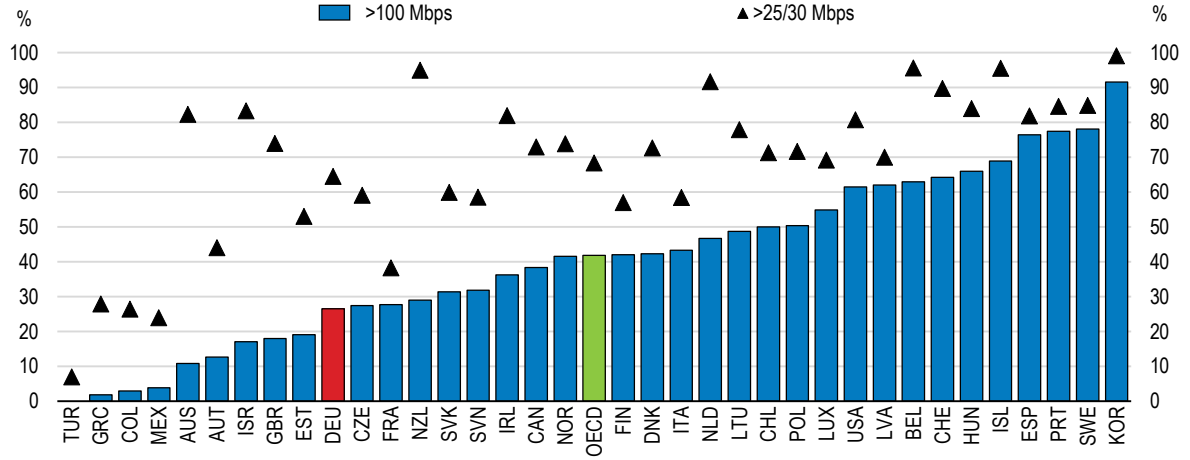
Expand fixed networks and increase their quality

Germany lags behind on broadband subscriptions in higher speed tiers

In 2019, Germany had 42.2 fixed broadband subscriptions per 100 inhabitants, compared to an OECD average of 31.8. However, the share of such subscriptions in the higher speed tiers is low (Figure 2.2). Higher network speeds are important for the use of key ICT tools, such as cloud computing (Section 2.3) and many other data-intensive activities and demanding applications across sectors as for example industry automation, services relying on augmented reality or medical imaging. In addition, high and symmetrical download and upload speeds are necessary to support work from home and use.

Figure 2.2. Germany has a low share of Internet subscriptions in higher speed tiers

Fixed broadband subscriptions with contracted speed faster than 25/30 Mbps and 100 Mbps, December 2019.



Notes: Australia: Data reported for December 2018 and onwards is being collected by a new entity using a different methodology. Figures reported from December 2018 comprise a series break and are incomparable with previous data for any broadband measures Australia reports to the OECD. Speed tier data are only for services purchased over the National Broadband Network (NBN), which comprise the majority of fixed broadband services in operation. There is no public data available for the speed of non-NBN services. Data for Canada, Switzerland and United States are preliminary. New Zealand: Speed tiers are for 2018 instead of 2019.

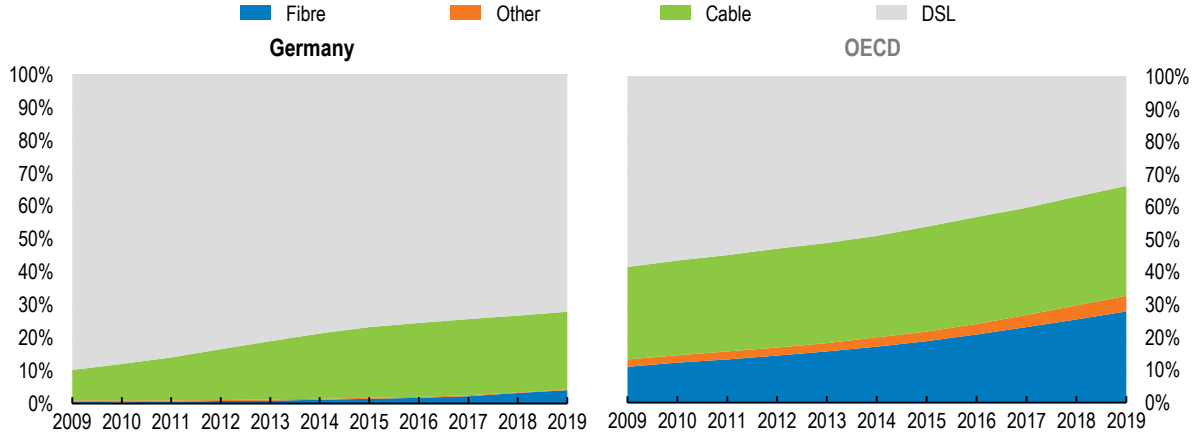
Source: OECD Broadband Portal, https://www.oecd.org/sti/broadband/broadband-statistics.

StatLink https://doi.org/10.1787/888934200964

The low share of faster Internet subscriptions correlates with the infrastructure technology mix in Germany. Digital subscriber line technology (DSL) constitutes the large majority of total fixed broadband subscriptions. The share of fibre-to-the-Home connections is particularly low in Germany at only 4.1%, compared to an OECD average that now reaches 28% (Figure 2.3). DSL connections suffer from an inherent asymmetrical capacity as they use telephone infrastructure that was primarily built for low-speed analogue voice service. Most are characterised by low upload speeds, making them poorly suited to support the increase in telework during the COVID-19 pandemic (OECD, 2020[12]). As data for a large number of fixed broadband operators show, the demand for fibre subscriptions is rising, with a 42% take-up rate for homes connected by these companies (BREKO, 2020[13]). While transitioning from DSL to fibre takes long-term and proper network planning, broadband providers could be encouraged in the medium term to deploy fibre deeper into their networks, gradually phasing out DSL and replacing it with fibre-to-the-home.

Figure 2.3. The share of fibre is low and has increased only slowly in Germany

Technology mix of fixed broadband subscriptions in Germany and the OECD, 2009 – 2019

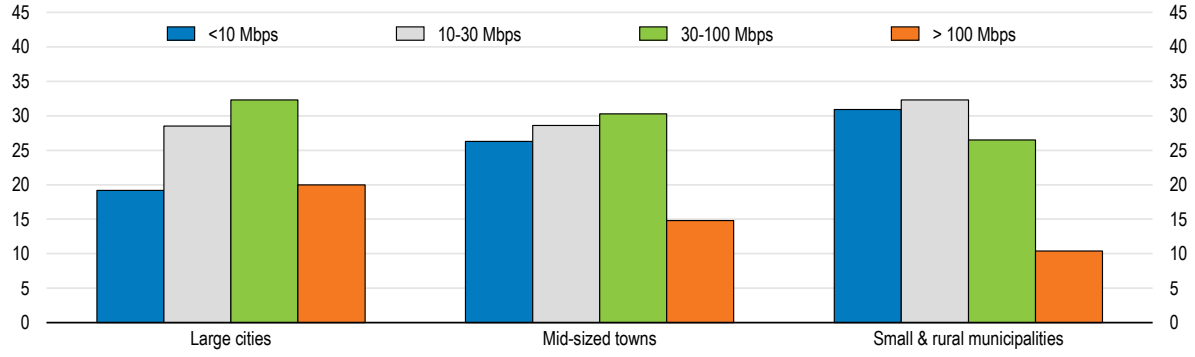


Source: OECD Broadband Portal, https://www.oecd.org/sti/broadband/broadband-statistics.

StatLink https://doi.org/10.1787/888934200983

Figure 2.4. Germany faces an urban-rural divide for Internet subscriptions above 30 Mbps

Broadband subscriptions in firms, 10+ employees, without financial sector, by speed tiers and locations, 2017



Note: Excludes firms without any broadband subscription (around 5% of surveyed firms).
Source: (Alipour, forthcoming[14]).

StatLink https://doi.org/10.1787/888934201002

At the subnational level, larger cities have typically been connected first with higher speed broadband. In 2019, 94% of households in large cities had access to fixed broadband with download speeds of over 100 Megabits per second (Mbps) compared to only 53% across rural municipalities (BMVI, 2020[15]). Regional gaps in coverage rates tend to narrow over time. However, Germany's urban-rural divide translates into

regional disparities with respect to higher speed broadband subscription rates among firms (Figure 2.4 above). Small and rural municipalities lagged behind large cities by a factor of two regarding local firms' subscription rates to broadband of at least 100 Mbps in 2017 (Alipour, forthcoming[14]).

Only a small amount of public funds for broadband deployment has been disbursed

The German government has recognised this gap and has set an ambitious goal for high-speed connectivity in its coalition agreement: nationwide gigabit Internet coverage by 2025 (CDU, CSU and SPD, 2018[16]). To achieve this goal, the federal government has put in place a number of public broadband subsidies. Between 2016 and 2030, around EUR 11 billion has been or will be made available by the Federal Government's state aid programme for broadband deployment. This includes 70% of special assets ("Sondervermögen Digitale Infrastruktur"), financed mostly by the EUR 6.6 billion in revenue generated by the 2019 spectrum auction (to be paid in instalments until 2030), which are channelled into Gigabit network deployment. Additional funds of approximately EUR 11 billion are provided by the *Länder*.

However, only a small amount of the disposable funds of the Federal Government's state aid programme has been paid out so far. As of September 2020, only EUR 750 million had been paid out. One of the reasons for delays in the disbursement of funds is the German two-stage system of granting subsidies and drawing on funds. In this system, a preliminary grant approval decision has to be issued by the competent authority and the disbursement of funds is triggered only when the construction process reaches certain pre-agreed milestones, which often take a long time to be achieved. Germany has taken measures to improve this process, such as the establishment of a focus team for project acceleration and a federal project management agency. However, the two-stage system should be further simplified. This includes reducing administrative procedures to ease the participation of smaller providers. In addition, funds are only paid out very late in the process, which might act as an additional barrier given that network deployment is capital intensive. The government could review this practice to ensure that the programme is taken up more widely.

Streamline administrative processes and rights of ways to spur fixed infrastructure deployment

Another reason for insufficient infrastructure deployment may be the long administrative processes, including for rights of way. The German Law for the Facilitation of the Expansion of Digital High-Speed Networks ("Gesetz zur Erleichterung des Ausbaus digitaler Hochgeschwindigkeitsnetze", DigiNetz Act) implemented the European Union's Cost Reduction Directive 2014/61/EU and is aimed at speeding up network deployment and reducing respective costs. However, processing times for applications submitted to municipalities ("Wegebaulastträger") still take three to four months, which adds to the total length of rights of way approvals, delaying network expansion.

In addition, approval procedures are not streamlined and often require approval from several different public authorities. While Germany plans to take measures to accelerate approval procedures in the context of the upcoming amendment of the Telecommunication Act, additional steps should be taken to shorten administrative approval times and streamline rights of way processes, respecting the responsibilities of relevant entities at different levels of government. In Spain for example, the Ministry of Energy, Tourism and Digital Agenda examines whether a municipality's management instruments comply with the Spanish Telecommunication Law through periodic reports.

Construction bottlenecks as described in the Key Policy Insights also play a key role as private companies as well as municipalities have struggled to commission construction works in a timely manner. At times, this even hinders applications for public subsidies as deployment timelines cannot be met. Another reason for slow fibre deployment may be the reluctance to use alternative deployment methods such as microtrenching, i.e. laying fibre less deep. While the DigiNetz Act allows for microtrenching, this option has

been little used. Measures that ease the use of alternative deployment methods are foreseen in the upcoming amendment of the Telecommunication Act.

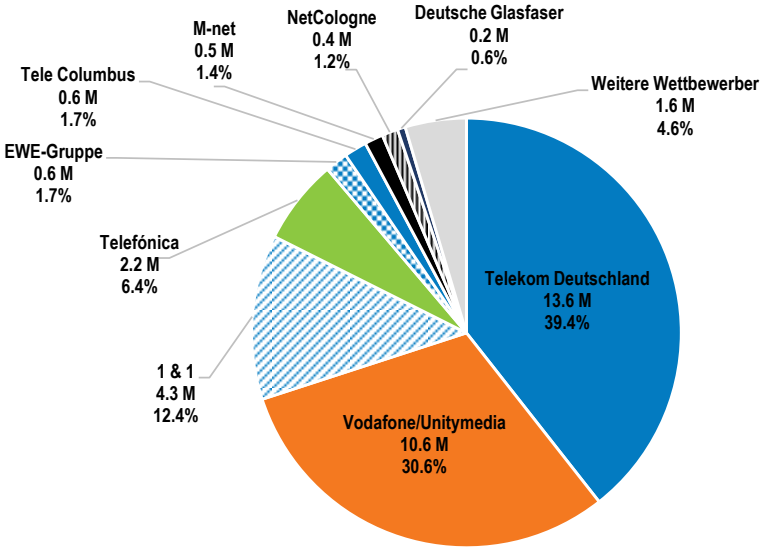
More competition in the fixed broadband market could boost high-quality broadband

Another factor in low penetration of high-speed subscriptions may be that costs lower uptake rates: fixed broadband connections are relatively expensive in Germany compared to peer countries. In June 2020, German consumers paid USD PPP 43 for a connection of 100 Mbps and above (360 GB per month), compared to USD PPP 36 in France, USD PPP 38 in Italy, USD PPP 40 in Sweden (Strategy Analytics, 2020[17]).

Comparatively higher prices often reflect the state of competition in a country. With Vodafone's acquisition of Liberty Global's (Unitymedia) business in Germany in 2019, the competitive landscape is currently undergoing significant changes. On the one hand, the merger might lead to an increase in network speeds as Vodafone might upgrade existing cable lines, which, in turn, might incentivise more fibre deployment. Moreover, the merger remedy of granting Telefonica access to Vodafone's cable network might enable Telefonica to compete with bundled services containing high-speed Internet access. On the other hand, Deutsche Telekom and Vodafone now own more than 70% of fixed broadband connections, while Deutsche Telekom alone owns almost 40% of connections (Figure 2.5). It will be important for the relevant authorities to continue to monitor competitive dynamics in the market for fixed broadband services in Germany. In addition, competition in connectivity of multi-dwelling buildings can be fostered.

Figure 2.5. Germany has a concentrated fixed broadband market

Fixed broadband market shares by number of customers, July 2019



Source: (VATM, 2019[18]).

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Current legislation in Germany allows for housing cooperatives and property management companies to sign bilateral contracts with network operators, which require all tenants to pay a monthly fee for the connection. Historically, these operators have mainly been cable companies. Consequently, this makes existing cable connections relatively more attractive, as accessing a different service would require a tenant to pay for both connections. This may represent an entry barrier for communication operators other than cable network operators (Monopolkommission, 2011[19]). While the legislation has been extended to allow a similar approach for non-cable TV services, it still favours existing connections. Eliminating this legislation would lower switching costs for consumers to other providers and increase competition between different network operators.

To further promote competition while at the same time reducing deployment costs, Germany could promote in-building infrastructure (and cost) sharing for fibre wiring in multi-dwelling buildings. For example, current legislation in France imposes symmetrical obligations for the party deploying in-building fibre wiring and requires operators that have deployed a fibre optic network in a building to comply with reasonable requests for access from other operators.[3] An agreement determines the technical and financial conditions of access between the concerned parties and any refusal of access has to be justified (Gouvernement de la République française, 2019[20]).

To further foster competition, Germany should also facilitate passive infrastructure sharing, i.e. the sharing of network elements such as ducts and cabinets, and increase the transparency of existing passive infrastructure such as ducts. While the German infrastructure information system "Infrastrukturatlas" aims at providing this transparency, the tool could benefit from being fully digitalised, from being easily accessible and publicly available, as well as from additional features such as geo-referencing and displaying prices of usable assets directly to the user. The upcoming amendment of the Telecommunication Act, which foresees the creation of a central information system, presents an opportunity to revise the current infrastructure information system and address its shortcomings. Mexico has set up such an information system to foster infrastructure sharing and deployment (Box 2.2). Increased access to ducts has had positive fibre-to-the-home deployment effects in countries such as France, Spain and Portugal. In addition, communication operators could be encouraged to jointly invest with other infrastructure providers, such as local electricity providers. Measures such as dig-once policies or the joint use of ducts can increase efficiency and lower the costs of infrastructure deployment.

Box 2.2. Increasing the transparency for infrastructure deployment in Mexico

In Mexico, the Secretariat of Communications and Transportation (SCT) issued an interagency agreement that allows for close to 110 000 state-owned structures to be used and shared, by concessionaires (licensees), permission-holders and infrastructure developers, as passive infrastructure for telecommunication networks under non-discriminatory, equal-access and non-exclusive conditions. Information pertaining to the relevant properties, including geo-referenced location, as well as physical, economic, technical, safety and operational conditions and the market value are published on an on-line platform called ARES operated and managed by Institute for National Assets (Instituto de Administración y Avalúos de Bienes Nacionales, INDAABIN). Interested parties can use the platform as a search engine and indicate their interest in a particular building and INDAABIN will serve as a one-stop portal for all the requests. Apart from the 110 000 federal buildings, other interested public institutions, for instance at the municipal level can become a member of the portal and present their properties that fulfil the necessary technical conditions.

Increase mobile network coverage and quality

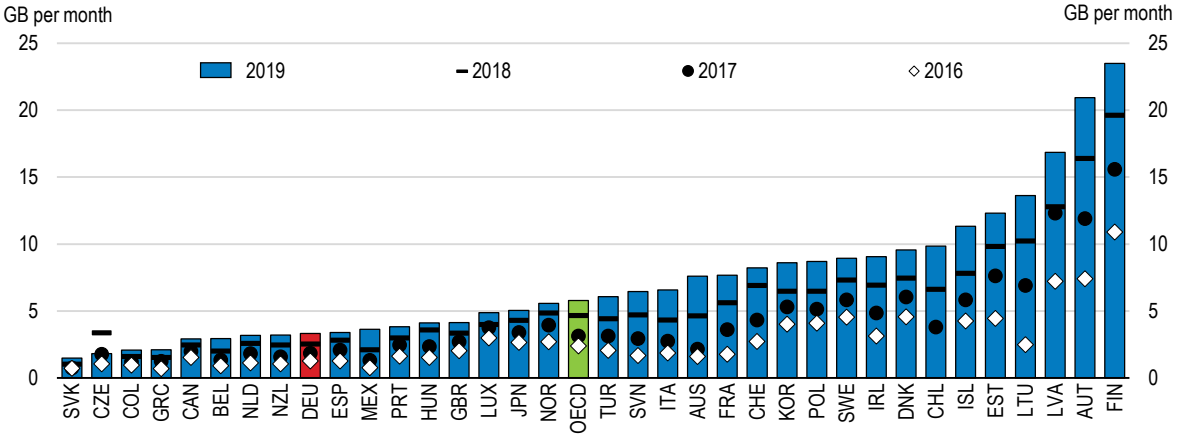
Germany has fallen behind on mobile broadband subscriptions, speeds and data usage

Although mobile broadband services have been a major driver of increasing connectivity in Germany over recent years, subscriptions are well below the OECD average. While there are 87 mobile broadband subscriptions per 100 inhabitants in Germany, the OECD average is 114.5. Germany has also fallen behind the OECD average on mobile data usage (Figure 2.6). Low data consumption may be linked to comparatively higher prices among peers for larger mobile data packages as well as differences in prices between third generation (3G) and fourth generation (4G) mobile data packages. In May 2020, German consumers paid around USD PPP 34 for a 10 GB data plan (including 900 calls), while consumers paid USD PPP 22 in Spain, USD PPP 24 in France, USD PPP 27 in Italy, and USD PPP 29 in Sweden (Strategy Analytics, 2020[17]).

Germany is also falling behind on mobile network performance. The average download speed on Long Term Evolution (LTE) networks in Germany is below the OECD average according to two different providers of speed tests, which provide different perspectives on and measurement of the mobile Internet (Figure 2.7). Moreover, download speeds on LTE networks are not even available in all parts of Germany, as white spots with no or only second generation (2G) connections are still common in Germany (zafaco GmbH, 2020[21]).

Figure 2.6. German mobile broadband subscribers consume less data than the OECD average

Mobile data usage per mobile broadband subscription, 2019

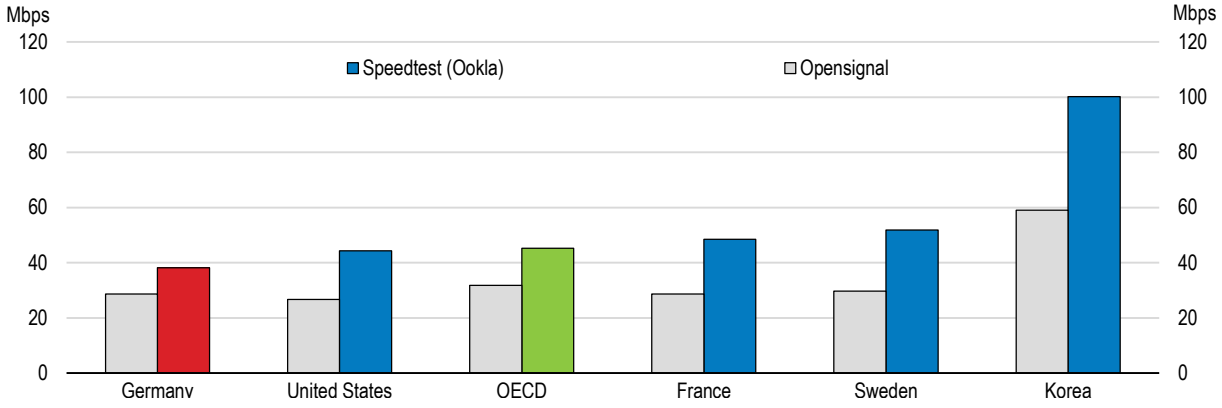


Note: The multiplier 1024 is used to convert TB into GB; the total amount of GB is divided by the yearly average number of Mobile broadband subscriptions. Australia: Data reported for December 2018 and onwards is being collected by a new entity using a different methodology. Figures reported from December 2018 comprise a series break and are incomparable with previous data for any broadband measures Australia reports to the OECD. Data for Canada and Switzerland are preliminary. OECD average includes estimates.
Source: OECD Broadband Portal, https://www.oecd.org/sti/broadband/broadband-statistics.

StatLink https://doi.org/10.1787/888934201040

Figure 2.7. Germany has fallen behind peer countries on mobile download connection speeds

Average download speed on LTE networks for selected countries and the OECD, 2020



Note: Speedtest (Ookla) data are for May 2020, Opensignal data are for the average download connection speed on Long-Term Evolution networks, collected between 1 January and 30 March 2020.
Source: Speedtest (Ookla), www.speedtest.net/global-index, Opensignal, https://www.opensignal.com/reports/2020/05/global-state-of-the-mobile-network.

StatLink https://doi.org/10.1787/888934201059

Ensure fast implementation of the national mobile strategy and streamline rights of ways for mobile infrastructure

Germany has also set itself ambitious targets for mobile access. Contracts signed between the federal Ministry of Transport and Digital Infrastructure (BMVI) and mobile network operators at the 2018 mobile telecommunication summit aim for an LTE coverage of 99% of all households throughout Germany by the end of 2020, and a 99% LTE coverage of all households in each federal state by 2021 (BMVI, 2019[22]). The German mobile strategy ("Mobilfunkstrategie"), published at the end of 2019, aims at closing gaps in the LTE network and making Germany a leading country in fifth generation cellular networks (5G) (BMVI, 2019[23]). Following the COVID-19 pandemic, the German Government is planning to direct an additional EUR 5 billion towards 5G infrastructure development (BMF, 2020[24]).

While these initiatives are welcome, a timely and effective implementation of measures to improve access to public properties, to speed up approval procedures, and to facilitate access to information on infrastructure deployment will be crucial to achieve the strategy's objectives. Measures such as the amendment of the Federal Highway Law that eliminates minimum distance rules for cell towers close to highways are welcome. Nevertheless, the overall procedure to construct a cell tower currently takes two to two and a half years as most of the time is spent on the determination and acquisition of locations to build the towers (OECD, 2019[25]). As mentioned above, Germany could improve its information system "Infrastrukturatlas" to facilitate the identification of available public assets.

Successful entry of a fourth operator will depend on a national roaming agreement

The 2019 auction of spectrum in the 2 Gigahertz (GHz) and 3.6 GHz bands paved the way for 5G deployment in the country. While Deutsche Telekom received most of the spectrum, the auction allowed for the entrance of a new player with 1&1 Drillisch, which has the potential to significantly spur competition in the German mobile market. The auction was linked to coverage obligations, which could considerably improve coverage and increase network speeds. Obligations included each operator's commitment to a minimum data rate of 100 Mbps available by the end of 2022 for 98% of households in each state, all federal highways, all main roads and along the major railway routes. Also, each carrier must install 1 000 5G base stations and 500 other base stations in defined areas by the end of 2022. At the end of 2024, 5G coverage should be extended to seaports, main waterways and all other road and rail routes (RCR, 2019[26]).

The entrance of a fourth operator can significantly spur innovation and competition in the German mobile market, as observed in other OECD countries (such as Chile and France) when a fourth operator entered the market. Currently, the market is characterised by less innovation in terms of contracts offered compared to other European markets such as France and Finland, where for example more "roam like at home" contracts, more unlimited data offers or more flexible contract durations can be found. In addition, none of the three mobile network operators provides a mobile post-paid contract with a minimum contract period below 24 months.

For the fourth operator to substantially increase competition in the mobile market, it will be important for it to close a domestic roaming agreement with one of the three existing mobile network operators, as has been the case for the entrance of Iliad Free to the French market. In addition, the fourth operator needs to be considered when current spectrum licences expire, especially the band below 1 GHz. Existing spectrum licenses should not be extended automatically as this would undermine the improvements in competition stemming from the entry of a fourth player. In addition, it is important to ease and promote passive infrastructure sharing due to positive effective cost reductions especially in rural and remote areas. If Germany also envisages active infrastructure sharing, consideration should be given to safeguarding an adequate level of mobile communications infrastructure competition.

Operators need to upgrade and extend fibre backhaul for 5G network deployment

An important prerequisite for a wide 5G deployment is to deploy fibre deeper into mobile backbone networks and to lay fibre to mobile cells in order to offload mobile traffic into fixed networks. Not all mobile cells and towers are currently connected to fibre networks. It is expected that all German network operators need to significantly deploy more fibre in their networks to achieve the goals in the mobile strategy and to enable 5G.

Since November 2019, the German regulator has made spectrum available for corporate licences for local 5G industry campus networks, enabling major industry players to run their own private networks in the frequency range of 3.7 to 3.8 GHz. Industry players interested in these frequencies indicated that they may want to use these frequencies for automation processes as well as for agriculture. While this may help German companies to increase efficiency in production, it is important to award all frequencies to users as soon as possible. This will allow for an assessment of the amount of spectrum that may be unused and the development of a plan for its efficient use. As of September 2020, 74 of the reserved frequencies have been awarded out of 78 applications (Bundesnetzagentur, 2020[27]).

2.3. Strengthening foundations for firms' digital transformation

High-speed and affordable broadband is an essential but not a sufficient foundation for firms' successful digital transformation. It can be considered a general-purpose technology (Bresnahan and Trajtenberg, 1995[28]) that underpins productivity and economic growth (Czernich et al., 2011[29]; Rohman and Bohlin, 2012[30]). High-speed broadband has become crucial for many firms, in particular in knowledge-intensive sectors, as illustrated by its fundamental role for increased teleworking during the COVID-19 crisis (OECD, 2020[12]). However, reaping the gains from broadband requires firms of all sizes, across sectors and territories to adopt a wider set of ICT tools and activities, which together can boost competitiveness, spur innovation and increase productivity (Draca, Sadun and Van Reenen, 2009[31]; Gal et al., 2019[32]).

Table 2.1. Firms with higher speed broadband are more likely to adopt other ICT tools and activities

Estimated percentage point change in the likelihood of adopting ICT tools and activities for German firms by speed tiers of broadband subscription

	ERP	CRM	e-purchase	e-sales	Social media	Cloud computing	BDA
100+ Mbps subscription	3.32***	3.07***	1.12	4.321***	9.75***	6.85***	3.07**
30-100 Mbps subscription	1.60*	2.06**	2.57***	2.87***	6.61***	6.96***	-1.20
Observations/Firms	24685/22316	24593/22241	24857/22467	30126/26511	26330/22724	9488/8546	5821/5821
Survey years	2012-2015, 2017	2012, 2014, 2015, 2017	2012-2015, 2017	2012-2017	2013-2017	2014, 2016	2016

Note: Firms with 10 or more employees, excluding financial sector. ERP stands for enterprise resource planning, CRM for customer relationship management, BDA for big data analysis. This table reports OLS regression results based on representative repeated cross-section survey data of German firms for the period 2012-2017. Dependent variables equal 100 if a given ICT tool or activity is adopted and 0 otherwise. Coefficients reflect the percentage point change in the likelihood of a firm adopting a given ICT tool or activity associated with broadband speed tiers of 100+ Mbps and 30-100 Mbps, respectively compared to a baseline speed of <10 Mbps. In addition to a broad set of control variables, regressions (except big data) control for year, municipality and industry (4 digit) fixed effects. Big data uses fixed effects at the county level instead of the municipality level. Standard errors are clustered at the municipality level (not reported); ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. Table A1 in the Annex provides additional detail.
Source: (Alipour, forthcoming[14]).

Firms' adoption of high-speed broadband tends to correlate with the adoption of other ICT tools and activities. Table 2.1 (above) reports estimates on the complementarity between firms' broadband

subscriptions by speed tiers (30-100 Mbps or 100+ Mbps) and their adoption of other ICT tools and activities in Germany. These tools and activities enable firms to perform in increasingly knowledge-intensive economies, optimise processes and integrate into digital markets, and collect, store, exchange and analyse big data. The complementarity between the speed of Internet subscriptions and other ICTs are strongest for key tools that enable firms to create value with data such as cloud computing and social media as well as with tools that enable digital market integration and process optimisation such as e-sales, customer relationship management (CRM) and enterprise resource planning (ERP).

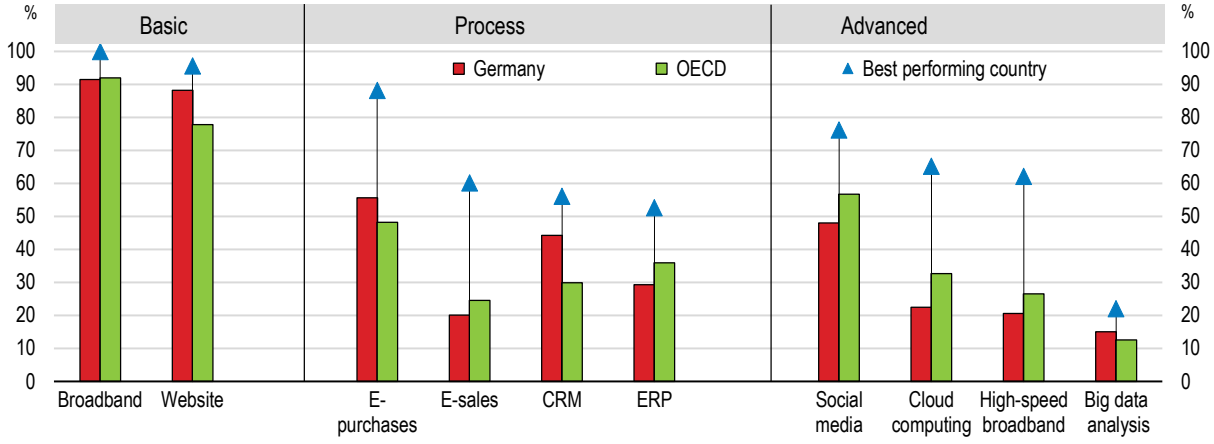
Foster firms' adoption of ICT tools and activities needed to create value with data

Basic ICT tools such as broadband and websites, which enable firms to digitise information and establish a presence online, are widely diffused in Germany. ICT tools and activities that enable firms to digitalise and optimise processes, such as CRM are fairly well diffused too, as are 3D printing and robots, notable industrial robots in large firms (OECD, 2019[33]; Eurostat, 2018[34]). However, Germany is not among the best performing countries in the OECD for most process-related ICT tools and activities and remains even below the OECD average for ERP and e-sales (Figure 2.8), including for e-commerce intensity (e-commerce in total turnover) (OECD, 2019[35]).

For more comprehensive digital transformation and data-driven innovation, firms will need to adopt newer and more advanced ICT tools and activities notably those that enable them to collect, store, exchange and process (big) data. Firms in Germany significantly lag behind in the adoption of most of these tools and activities, including high-speed broadband (100+ Mbps), cloud computing and social media. Shares of firms with a high-speed broadband subscription or that purchase cloud computing are less than half of those in the best performing countries (Figure 2.8). On big data analysis (BDA), German firms have caught up between 2016 and 2018. Some more general catch-up is evident in above average growth rates in firms' adoption of other advanced ICT tools (except for high-speed broadband) over recent years. An important sector in which Germany has fallen behind in digital transformation is health (Box 2.3).

Figure 2.8. German firms lag in the adoption of advanced ICT tools and activities

% of firms, 2019 or latest year available



Note: Firms with 10 or more employees, excluding financial sector. ERP stands for enterprise resource planning, CRM for customer relationship management; high-speed broadband are subscriptions with 100+ Mbps.

Source: OECD ICT Access and Usage by Businesses database, http://oe.cd/bus.

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Firms notably lag in the adoption of cloud computing. Cloud computing can be used for advanced process optimisation and for many data-intensive applications in firms. The share of firms in Germany that purchase cloud computing is over 40 percentage points (pp) below the best performing country (Finland) and 8pp

below OECD average. In particular medium-sized firms lag far behind (-14pp) the OECD average. This is striking, given that smaller and younger firms tend to be key beneficiaries from cloud computing in other countries, leveraging the cost-efficiency and flexibility of scaling up and/or down digital operations as compared to legacy information technology (IT) infrastructure (Bloom and Pierri, 2018[36]). Firms in Germany lag behind for all types of cloud computing and across all sectors, with the largest gaps (all firms) occurring in manufacturing (-11pp to average) and transportation and storage (-10pp to average).

Box 2.3. Digital transformation of Germany's health care system

Digital transformation of the health care system holds important potential for Germany. For example, electronic health records (EHR), telemedicine, electronic prescriptions and automated reimbursements could bring important efficiency and monetary gains, estimated at EUR 34 billion (about 12% of health spending) in 2018. Around 70% of these gains would come from digital transformation in health care delivery, i.e. notably physicians and hospitals, compared to 30% from effects in sickness funds (McKinsey, 2018[37]).

Germany's health care system showed strength in successfully managing the COVID-19 pandemic. This should not divert attention from the fact that Germany has fallen behind many other countries in the digital transformation of health care. Germany lags important digital health fundamentals, including digital services, ranking 16th out of 17 countries analysed in the Bertelsmann Digital-Health-Index, which covers 13 EU member states, the UK and 3 other OECD countries. Contrary to Germany, in Estonia and Denmark citizens can already consult diagnostic results and vaccination data online, and telemedicine practices are commonplace in Canada and Israel (Bertelsmann Stiftung, 2018[38]).

Telemedicine turned out particularly beneficial in the context of the COVID-19 pandemic by allowing continuity of certain health care in times of social distancing while reducing infectious exposure (CDC, 2020[39]). More generally, telemedicine can improve safety and cost-effectiveness, and can in some cases lead to better health outcomes than conventional face-to-face care (Oliveira Hashiguchi, 2020[40]). Despite evident benefits, telemedicine still represents a small fraction of all health care activity and spending in Germany. In 2017, less than 10% of Germans used telemedicine, compared with 18% in the EU and almost 50% in Estonia and Finland. The share of general practitioners who use electronic networks to exchange medical data with other providers is low too, and so is the use of electronic prescriptions (European Commission, 2019[41]).

Evolutions in the legal framework over recent years have significantly improved the conditions for digital transformation of Germany's health care system. For example: the 2015 E-Health Act introduced a basic statutory electronic patient record and a roadmap for building a telematic infrastructure; the 2019 Drug Safety and Supply Act expanded the possibilities of tele-medicine through new rules for electronic prescriptions (BMG, 2019[42]); the Appointment-service and Care Act mandates sickness funds to introduce an electronic patient record by 2021 at the latest (BMG, 2019[43]); and the 2019 Digital Healthcare Act brings additional improvements, e.g. with regards to online video consultations and access to a secure healthcare data (BMG, 2019[44]).

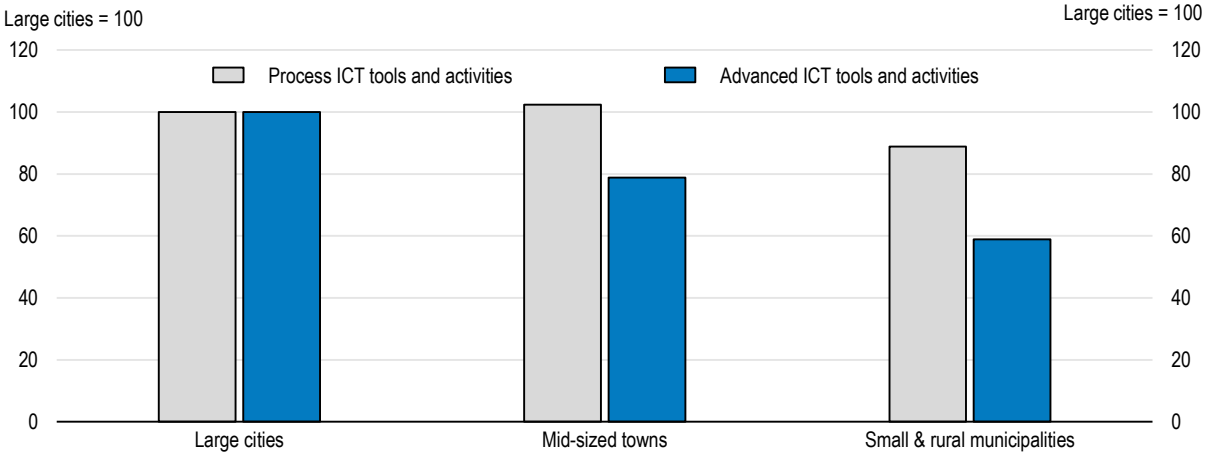
Source: (Bertelsmann Stiftung, 2018[38]; BMG, 2019[42]; BMG, 2019[43]; BMG, 2019[44]; CDC, 2020[39]; European Commission, 2019[41]; McKinsey, 2018[37]; Oliveira Hashiguchi, 2020[40]).

Firms' backlog on newer and more advanced ICT tools and activities is most visible outside of large cities. As a federal and quite decentralised country, Germany has many important firms outside large cities, including "Mittelstand" firms, many of which are small and medium-sized (SMEs, 10-249 employees) or mid-range (250-3000 employees) enterprises. The use of newer and more advanced ICT tools and activities in small and rural municipalities is almost a third lower than in large cities (Figure 2.9). In contrast,

firms in smaller towns and rural municipalities are almost as likely as in large cities to use process-related ICT tools and activities. This is in line with the finding that the share of firms with lower Internet speed subscriptions (below 30 Mbps) does not decrease in smaller towns and rural areas (Section 2.2, Figure 2.4). It might also indicate that process-related ICT tools and activities require less bandwidth than newer and more advanced ones that enable firms to create value with data.

Figure 2.9. Firms in small and remote places lag furthest on advanced ICT tools and activities

User rates (index) across settlement types in Germany, by types of ICT tools and activities, 2017 or latest available



Note: The index of user rates is set to 100 for large cities. Process ICT tools and activities include e-purchases, e-sales, customer relationship management and enterprise resource planning; data for these are for 2017. Advanced ICT tools and activities include cloud computing, big data analysis and social media; data for these are for 2016.
Source: (Alipour, forthcoming[14]).

StatLink https://doi.org/10.1787/888934201097

Creating value with data, for example through data-driven innovation, often requires big data analysis (OECD, 2015[45]; Niebel, Rasel and Viete, 2019[46]). Germany has caught up fast over recent years with the OECD average on the share of firms performing big data analysis, from 6% in 2016 (-5pp to average) to 15% in 2018 (+2pp to average), and also reduced the distance to the best performing country from 13pp to 7pp over the same period. However, a closer look at firms' performance of big data analysis by sector and data source provides a mixed picture. While key sectors such as manufacturing and transport are above average, the gaps to the best performing country remain important across all sectors (Figure 2.10, Panel A).

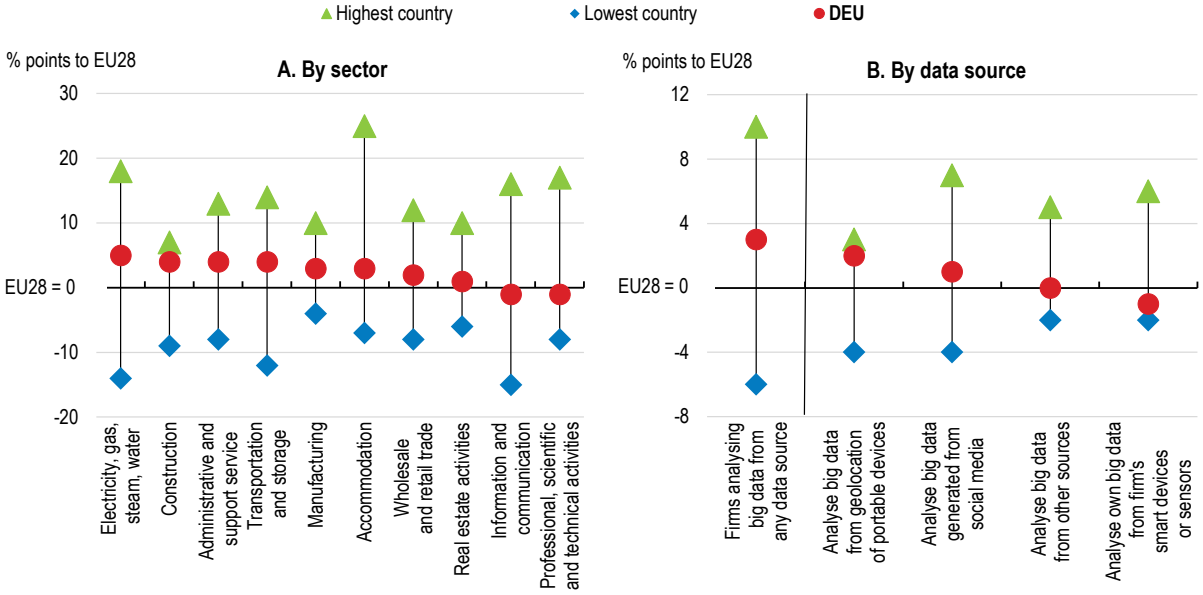
Much of firms' potential to create value with data in Germany and Europe is considered to reside in the use of firm-related and machine generated data in the context of industry 4.0, which is of strategic importance for factory automation in German industries (BMWi, 2019[47]). Generally, firms that invest for the first time in digital technologies tend to focus more strongly on the potential of data, notably data from their own operations and machines (Bitkom, 2018[48]). Strikingly, only 3% of firms in Germany use data from their own sensors or devices to perform big data analysis, which is below the European Union (EU) average of 4% (Figure 2.10, Panel B) and far less than in leading countries, such as the Netherlands (10%), Finland (8%) and Belgium (7%). Data on the geolocation of portable devices and from social media, which are more likely customer-related data, are the most widely used data sources for firms' big data analysis in Germany.

The government has recognised the urgent need to boost firms' collection, sharing and effective use of data, notably with project GAIA-X that establishes key building blocks for a federated European data infrastructure to strengthen Europe's competitiveness in global digital and data-driven markets (Box 2.4). The government is also developing a Data Strategy, which has been announced as covering four main areas: 1) improving data sharing and securing access to data, 2) promoting responsible data usage and

increasing the potential for innovation, 3) improving data competencies and establishing a data culture, 4) Making the state lead by example (Bundesregierung, 2019[49]). It is crucial that this strategy provides an effective data governance framework, including for a data-driven public sector, to enhance access to and sharing of data, and includes ambitious objectives and measures to help firms boost their collection and use of data, for example measures concerning open data, data portability, and contractual agreements (OECD, 2019[50]). Australia and Finland are considered to be advanced among OECD countries that have or are developing a national or sector-specific data strategy.

Figure 2.10. Data from firms' sensors and devices remains underused for big data analysis

% firms performing big data analysis, differences in percentage points to EU28 average, 2018 or 2016



Note: Firms with 10 or more employees, excluding financial sector.
Source: (Eurostat, 2018[34]).

StatLink https://doi.org/10.1787/888934201116

The more data firms collect and use, the more relevant AI becomes to create value with data. Fast growing investments in AI over recent years reflect high expectations of its potential. Globally, the United States attracts the largest share of equity investments in AI start-ups, although China is rising fast, while Europe attracts only a small share. Within the European share, Germany accounts for only 14% of investment, after the UK with 55% (OECD, 2019[51]). Diffusion of AI in firms, such as for data analytics, natural language processing, image recognition, and automation (OECD, 2019[33]) is still poorly measured and probably at an early stage. The most advanced users of AI tend to be large firms that are already sophisticated users of ICT tools and activities, notably in the ICT, automotive and financial services sectors. However, important potential looms in many other sectors too, e.g. in retail, media and entertainment, health care, and education (MGI, 2017[52]; OECD, 2020[53]). AI's crosscutting applicability has become evident also for tackling the COVID-19 pandemic, for example in predicting the evolution of the virus or accelerating medical research on drugs and treatments (OECD, 2020[54]).

Box 2.4. GAIA-X: towards a federated data infrastructure for Europe

GAIA-X is an ambitious project to create a federated and trustworthy data infrastructure for Europe in a strengthened European Digital Single Market. The project aims to benefit data subjects and data controllers by fostering data sharing and innovation with the mission to strengthen digital sovereignty for business, science, government and society and to unleash digital and data-driven innovation. Initiated by the Federal Ministry for Economic Affairs and Energy (BMWi) and the French Ministry for Economy and Finance, GAIA-X involves industries from both countries, in particular cloud services providers and customers (BMWi and BMBF, 2019[55]; BMWi, 2020[56]). Representatives from several European countries are currently involved and other European partners from business, science and politics are invited to join.

GAIA-X is conceived as a European digital ecosystem that can be distinguished in three ways. 1) A data ecosystem that fosters ontologies for interoperability and application programming interfaces (APIs) within and across sector specific data spaces according to the EU data strategy. This should facilitate the emergence of smart services, artificial intelligence (AI), and big data market places and applications. 2) An infrastructure ecosystem that enables services based on common standards. This involves network and interconnection providers, cloud solution providers, high performance computing as well as sector specific clouds and edge systems. 3) Federation services to operate the GAIA-X ecosystem, following the principles of security by design and privacy by design in order to ensure highest security requirements and privacy protection, while supporting the free flow of data (BMWi, 2020[57]; BMWi, 2020[58]).

GAIA-X also relates to the European Data Space initiative that is part of the European Data Strategy (EC, 2018[59]) (EC, 2020[60]), which aims to create a genuine single market for data. For example, one initiative that could provide impetus for the implementation of the European Data Strategy in the mobility sector is the current expansion and optimisation of Germany's National Access Point for traffic and mobility data as part of the German Mobility Data Space, promoted in the framework of the German Presidency of the EU Council. This Data Space could contribute to the development a common European Mobility Data Space that connects the national access points of the participating member states (EC, 2020[61]).

Source: (BMWi and BMBF, 2019[55]; BMWi, 2020[56]; EC, 2018[59]; EC, 2020[60]; BMWi, 2020[57]; BMWi, 2020[58]; EC, 2020[61]).

Germany's AI Strategy recognises the important role of data and AI and bundles a range of (mostly existing) initiatives including on data infrastructure, data governance, and industrial data (BMWi, 2019[47]). An update of the strategy is currently underway. Investments of EUR 3 billion support the strategy's implementation. So far, EUR 1 billion was allocated in two tranches via the federal budgets for 2019 and 2020 to be spent until 2022 and 2023 respectively. An additional EUR 2 billion will be allocated via the COVID-19 recovery package. Important parts of Germany's AI funding is targeting scientific AI-related research, as put into practice in the Cyber Valley in Tübingen, Europe's largest AI research consortium with scientific and business partners. This should ultimately strengthen Germany's position among the top countries for AI-related publications and patents (OECD, 2019[33]; Baruffaldi, 2020[62]). Additional measures should be considered to boost the adoption of AI in firms alongside the range of policy instruments that can foster the adoption of ICT tools and activities more generally (Box 2.5; Sections 2.3. and 2.4).

Box 2.5. Fostering the adoption of ICT tools and activities by firms

Different types of policy instruments can be used to promote the adoption of ICT tools and activities by firms. Most common is direct financial support, followed by indirect financial support and other measures such as regulatory guidance or sandboxes.

Financial support includes direct financial support measures for firms' adoption of ICT tools, such as for cloud services (Korea), big data (Portugal), digital consultancy services and digital skills (Denmark, Slovenia). Indirect financial support includes tax credits or other relief for ICT investment (Brazil, Japan) and subsidies to credit institutions to enable lending at preferential rates to firms in priority sectors that invest in digital products (Russian Federation).

Non-financial measures often raise awareness of the opportunities and risks of ICT tools and activities, for example via tailored advice and counselling services (Australia, Lithuania, Sweden), including on regulations relevant to new business models (Turkey) or by sharing the experience of "digital champions" or offering mentoring schemes (Portugal, Slovenia). Other measures include guiding principles and assessments to ensure that regulation is fit for digital transformation. For example, Denmark introduced a mandatory assessment of regulation to ensure it facilitates new business models, is technology-neutral, and ensures user-friendly digitalisation.

Regulatory sandboxes are another non-financial measure that allows firms to test new ICT tools and activities in a real-world environment while providing the opportunity for advancing ICT-related regulation through regulatory learning. With its Regulatory Sandbox Strategy, Germany aims to systematically establish regulatory sandboxes as frameworks for testing innovation and regulation across technologies and policy areas (BMWi, 2020[63]).

Source: (OECD, 2020[64]); (OECD, 2020[65]); (BMWi, 2020[63]).

Firms' effective use of ICT tools and data underpins innovation across sectors (OECD, 2019[66]). While Germany has long been considered a world leader in technology, engineering and innovation (EC, 2012[67]) the innovative edge of many German firms cannot be taken for granted in the digital age. Germany still has a high share of innovative firms, as measured by the Eurostat Community Innovation Survey. However, this share decreased by over 16pp between 2008 and 2016, while it increased by almost 15pp in the Netherlands and by 10pp or more in Great Britain, Finland, and Belgium; the latter two now have a higher share of innovative firms than Germany (Duc and Ralle, 2019[68]). Germany's initiatives to boost firms' digital innovation potential, including in the context of industry 4.0 (BMWi, 2019[69]), such as via the High-tech Strategy and the Regulatory Sandbox Strategy (BMBF, 2018[70]; BMWi, 2020[63]), are crucial in this context. However, they need to be complemented with measures that overcome key barriers to firms' successful digital transformation (Section 2.4), including to boost investment in knowledge-based capital. This is paramount for firms of all seizes across all sectors and particularly urgent for firms operating at the digital frontier, such as those in the automotive industry.

Strengthen the automotive industry's capacity for data-driven innovation

Firms in the automotive industry need to innovate in business models to capture the increasing share of digital value in their core products and to remain competitive with new entrants, including players from outside the automotive industry. The automotive industry is Germany's largest industrial sector, accounting for around 20% of total German manufacturing industry revenues and 4.7% of gross domestic product (GTAI, 2018[71]). The COVID-19 crisis reduced demand for German cars, and with plant closures production over the first nine months of 2020 was down by one third compared with the same period in 2019 (VDA, 2020[72]). This adds to existing challenges resulting from global trade and the transition to

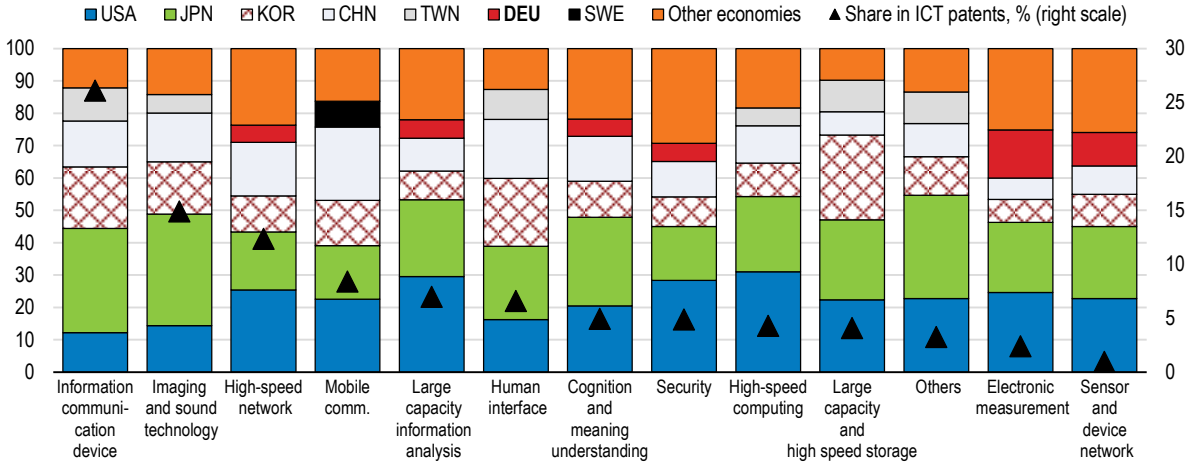
alternative power trains, electrification in particular. Against this background, automotive firms are facing digital transformation at several fronts: in production and innovation, in their core products, and in evolving (urban) mobility patterns that are shaping the role, use of, and demand for cars (ITF, 2019[73]).

The German automotive industry is a leader in industry 4.0, championing the digitalisation of business processes and supply chains and the automation of production systems (WEF, 2016[74]). Key benefits from industry 4.0 are improvements in cost, quality and delivery, including through closer co-operation with suppliers, transparent inventory management and just-in-time/sequence logistics, shorter material lead times, and improved in-plant material flows (Kern and Wolff, 2019[75]). While the industry in Germany has remained strongly focussed on the digitalisation of production and logistics (VDA, 2018[76]), its core products, cars in particular, have started transforming through fast-paced digital and data-driven innovation. A growing share of cars' value is moving from the mechanical, physical good to the car as a digital platform. This transformation has increased the importance of connected systems and autonomous driving for the industry (SAP, 2018[77]).

Compared to other industries in Germany, the automotive industry performs well on specific patents for the industry's digital transformation, but Germany is not an international leader in ICT-patents and related R&D spending. German automotive firms account for 43% of International Patent Classification patents in "Electric Digital Data Processing" (IW, 2018[78]). However, on a range of ICT-patents Germany lags behind the top players, featuring among the top five in less than half of the ICT-related patent categories shown in Figure 2.11. In contrast, the United States, Japan, Korea and China dominate across all of these categories. The same countries are also home to the top corporate research and development (R&D) investors contributing most to develop AI-related technologies (EC and OECD, 2019[79]). Overall, Germany's share of ICT-related patents in the total number of IP5 patents (patents from the world's five largest IP offices) is below the OECD and EU averages and R&D expenditures in ICT equipment and information services are low (OECD, 2017[80]).

Figure 2.11. Germany lags behind top economies in ICT-related patenting

Share of the top five economies' shares of patents in ICT-related technologies, 2014-17



Note: Data refer to IP5 families, by filing date, according to the applicants' residence using fractional counts. Patents in ICT are identified using the list of IPC codes in Inaba and Squicciarini (2017).

Source: OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, September 2020.

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A central development in the evolution of cars is autonomous driving technology, which requires ICT hardware and software that are not among the traditional German industrial strengths. Cars capable of level 4 automation (the highest level is 5) are on the road in test mode and sales of vehicles with this degree of automation could rise significantly by 2030 (McKinsey, 2016[81]). While German manufacturers

hold 55% of autonomous driving related patents worldwide, co-operations of suppliers with several manufacturers may lead to fast diffusion of autonomous driving innovation, which may undermine long-term advantages (Bardt, 2017[82]). Software is also often not patentable in Europe and can be supplied globally by few players. In addition, leading firms of key automated driving hardware, such as microprocessors, are not based in Germany (ifo, 2019[83]). These aspects could undermine the strength of Germany's automotive sector over time, if value creation in the industry increasingly relies on innovation in and production of ICTs.

On the one hand, autonomous driving could weaken German premium cars' core value propositions such as driving dynamics or precision steering, with implications for the margins that companies gain from selling premium cars that can be re-invested in R&D (ifo, 2019[83]). On the other hand, automation is an opportunity for German manufacturers to innovate in new functions and services to remain competitive. Autonomous driving may further underpin evolutions in mobility that affect the role of cars in the value chain. High and full autonomy may allow passengers to dedicate more time in mobility to other activities than driving, for example work and entertainment. This would shift even greater shares of value from cars as physical goods into services offered and data collected in mobility. This may benefit firms controlling more segments of the value chain, such as Tesla, which is involved in battery production, autonomous driving technology and software, direct retailing and insurance (Chen and Perez, 2018[84]).

The creation, delivery and capture of value that resides in digital components and services requires business models and competencies that are not common in the automotive industry, for example competencies related to networks, software and data. Today, these tend to be concentrated among established digital technology companies, many of which have entered the autonomous vehicle market already (CB, 2019[85]). Some of them have made important in-roads, for example, in autonomous driving (e.g. Waymo) and cars' digital operating (e.g. Android Automotive OS) and infotainment systems (e.g. Apple CarPlay). These entrants can leverage interoperability and synergies with other digital platforms they operate, including cloud computing. On key services, such as autonomous driving, German automotive firms may increasingly have to partner with foreign companies that have the talent, expertise, and networks needed to excel in data-driven value creation.

The government has advanced several initiatives over recent years in support of the automotive industry's digital transformation. Building on the 2015 Strategy for Automated and Connected Driving, the 2018 action plan Digitalisation and Artificial Intelligence in Mobility bundles several measures related to data usage, vehicle automation, connectivity, real world test beds, ethical rules, legal and regulatory reviews, and international standardisation (BMVI, 2015[86]; BMVI, 2018[87]). A large testbed was established on the A9 highway with a focus on automated and connected driving and related infrastructure implications. Urban testbeds in several major German cities are serving to trial interactions between vehicles, infrastructure and other road users and to gather experience for industry and research in real traffic and driving situations of varying complexity. These testbeds should also allow citizens to experience the potential of new technologies "hands-on" and provide insights for further policy decisions (BMVI, 2017[88]). Germany also participates in two Important Projects of Common European Interest, one on microelectronics (EUR 1 billion) and one on the battery value chain (EUR 1.25 billion), and runs a programme on ICTs in electro mobility (BMVI, 2019[89]; BMWi, 2018[90]; European Commission, 2019[91]). In the context of the COVID-19 crisis, the government provided demand stimuli by temporarily lowering VAT and increasing incentives for purchasing electric cars.

In addition to addressing the industry's need for skills (Section 2.5) more attention should be paid to standard-setting, in particular with regards to connected and automated driving, which is shaped by multiple technologies and industries with complex interoperability implications (VDA, 2018[76]; NPM, 2020[92]). Germany has not been a front-runner so far on ICT-related standard setting for connected and automated driving, where international standardisation bodies and consortia play an important role. The establishment of Working Group 6 of the National Platform on the future of Mobility and Germany's engagement at the European level as well as in the Working Party on Automated/Autonomous and

Connected Vehicles within the World Forum for Harmonization of Vehicle Regulations (WP29) of the United Nations Economic Commission for Europe are good steps. However, sustained efforts are needed to catch up with countries such as Japan and China that are considered to have taken a lead in using standardisation as a strategic instrument to shape the state of the art of technical solutions and regulatory guidelines (VDA, 2019[93]). Germany's automotive industry would benefit from the pursuit of a more strategic and co-ordinated approach to standard-setting related to autonomous driving technologies across standardisation bodies, consortia and industry domains (OECD, 2017[94]).

Digital transformation also underpins changes in mobility patterns that are likely to affect the role, use of, and demand for private cars, in particular in cities. Key trends that are likely to shape urban mobility include shared mobility services and autonomous driving, both of which rely heavily on ICTs. In the long-run, intra-urban travel may shift more to public transport and shared mobility (ITF, 2019[73]). While global demand for private cars is still on the rise, the International Transport Forum estimates that between 2015 and 2030, growth in urban transport demand (passenger-kilometres) in the OECD will be strongest in shared mobility (15%, including all modes), while demand for private cars may slightly decrease. In a scenario in which all private car use is replaced by the massive uptake of shared mobility in conjunction with existing public transport systems, vehicle-kilometres and CO_2 emissions could be reduced by 30-60%, compared to current mobility patterns (ITF, 2019[73]).

An important step underway to improve Germany's legal framework for evolving urban mobility is the current review of the Personenbeförderungsgesetz (Passenger Transport Act) that may improve the conditions for ride- pooling (BMVI, 2019[95]). Other initiatives include the government's mFund, which supports investment in data-driven innovation, research projects, SMEs and start-ups in mobility (EUR 200 million 2016-2020 and EUR 250 million starting 2021), and the German Association of the Automotive Industry's Urban Mobility Platform that involves major cities, automotive firms and suppliers and aims at launching pilot projects (VDA, 2018[76]). Looking ahead, strategic considerations should take into account the interrelated and increasingly converging trends of automated driving, shared mobility and alternative powertrains.

2.4. Overcoming key barriers to firms' successful digital transformation

Germany should address three key barriers to digital transformation: first, low investments in ICTs and knowledge-based capital that are crucial for the effective use of data and to drive innovation; second, specific hurdles faced by SMEs; third, concerns about digital security that discourage many firms from adopting key ICT tools, such as cloud computing.

Boost investment in knowledge-based capital

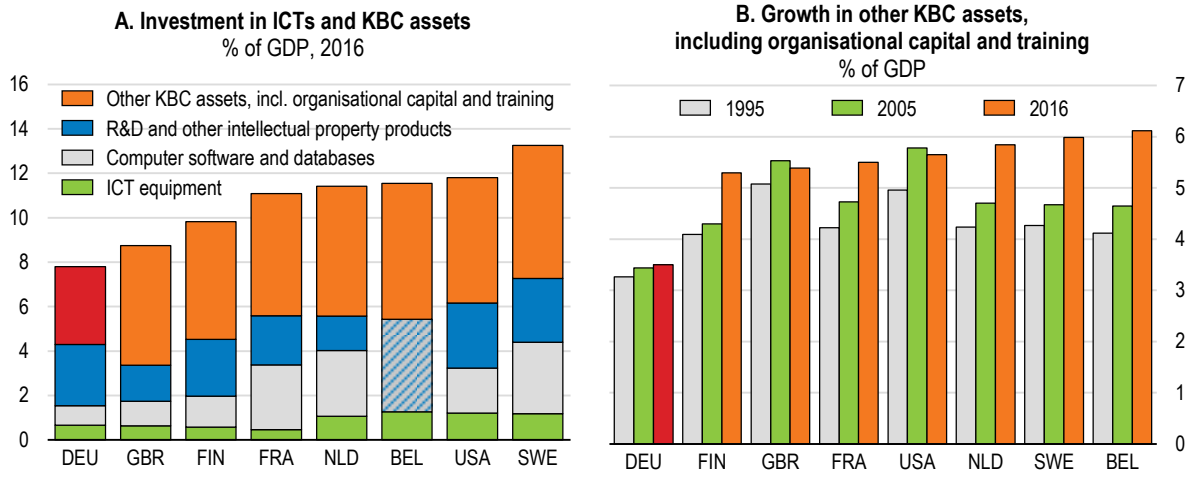
Unleashing the potential of digital transformation for innovation and productivity requires firms to invest not only in ICT equipment but also in knowledge-based capital, including R&D, intellectual property, software, data, organisational capital, design and training (OECD, 2013[96]). Investment in knowledge-based capital has significant effects on productivity in Germany, notably when combined with investments in tangible assets (DIW, 2017[97]). However, low levels and sluggish growth of investment in knowledge-based capital undermine the innovation potential of German firms (Bertelsmann, 2019[98]; BDI, 2020[99]) and the contribution of knowledge-based capital to productivity growth (OECD, 2018[3]; Demmou, 2019[100]). This may also relate to low growth of knowledge-intensive services in Germany, compared with other countries such as the United Kingdom and the United States (SVR, 2019[101]).

In Germany, investment in knowledge-based capital is low and tends to be concentrated in only a few sectors and firms. While investment in R&D is above and in ICT equipment is close to the respective OECD average, investments in software and databases are less than two thirds of the OECD average (OECD,

2019[33]). Investments in other knowledge-based assets, including organisational capital and training have remained low over the past three decades, compared to best performing countries (Figure 2.12). In addition, investment in R&D, software, licences, patents are concentrated in a small number of larger firms in a few sectors, in particular in the manufacturing sector for R&D (car manufacturing accounts for 30%) and the ICT sector for software (the ICT sector accounts for 40%). Investments in organisational capital and training are spread out more broadly across sectors (DIW, 2017[97]).

While Germany's gross domestic expenditure on R&D is at the higher end among OECD countries and has increased over the past decade, the share of business R&D in value added in industry (2.17%) is below OECD average (2.54%) and decreased between 2005 and 2015. However, the intensity of business R&D adjusted for industrial structure is above OECD average, which can be explained by the German economy's relative specialisation in R&D intensive industries. Strikingly, the SME share in business R&D is below 10%, compared to over 60% in the ten countries with the highest share (OECD, 2017[80]).

Figure 2.12. Investment in ICTs and knowledge-based capital is low



Note: KBC stands for knowledge-based capital. No breakdowns of intellectual property products available for Belgium. Other KBC assets are estimated based on INTAN-Invest data and cover all industries except real estate, public administration, education, health and households.
Source: OECD calculations based on OECD National Accounts database and INTAN-Invest data, http://www.intaninvest.net/.

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A key policy instrument to address R&D market failures are expenditure-based R&D tax incentives, which account for 55% of total government support for business R&D in the OECD area in 2017, up from 30% in 2000 (OECD, 2020[102]). Germany introduced R&D tax incentives in early 2020, subsidising 25% of maximum EUR 2 million R&D expenditures per year, limited to EUR 15 million in total (direct and tax) support per firm (BMF, 2019[103]). As part of the COVID-19 recovery package, this cap has been increased to EUR 4 million per firm until the end of 2025 (BMF, 2020[104]). While this measure is expected to benefit R&D in SMEs, the initial cap is likely to limit the effects for larger "Mittelstand" firms, so called mid-range companies, which are key players for innovation with important potential for R&D (ZEW, 2018[105]; ZEW, 2019[106]). Based on closely monitoring the instrument's uptake, further refinements should consider increasing the cap and account for the role of direct R&D support (Appelt et al., 2020[107]). Monitoring and potential refinements of the instrument should also consider interactions with related instruments such as the Central Innovation Programme for SMEs (Zentrales Innovationsprogramm Mittelstand) (BMWi, 2019[108]; ifo, 2019[109]) and the potentially complementary depreciation allowance for "digital goods" that is currently in planning.

Knowledge-based assets themselves can act as a barrier to accessing asset-based financing, in particular for SMEs. Lenders often face important challenges to recognise SMEs' knowledge-based assets as collateral, and may struggle to understand their role for firms' success, how to value these assets, and how

to realise value in case of a default (Brassel and Broschmans, 2019[110]). Where bank financing plays a dominant role, as in Germany, this can work against investment in knowledge-based assets (OECD, 2019[111]). This might partly explain or reinforce the technology bias in digital-related investments of SMEs' in Germany, 83% of which invest in technology, compared to only 64% that invest in related skills (European Commission, 2018[112]). Germany may consider other countries' approaches to address this issue. For example, the French public investment bank Bpifrance supports investments in knowledge-based capital through uncollateralized loans and bank loan guarantees, and the French Ministry of the Economy and Finance launched a website to help businesses and investors develop knowledge-based capital intensive business strategies (DGE, 2018[113]). The UK's Intellectual Property Office subsidises IP audits for SMEs, which helps strengthen SMEs' IP protection strategies and creates awareness of knowledge-based asset value (OECD, 2019[114]).

The need to reduce information and financing barriers to firms' investments in knowledge-based capital and ICTs should also be reflected when reviewing key digital related strategies and policies, such as the Digitale Strategie 2025 (Digital Strategy 2025) and the Mittelstand-Digital (SME Digital) strategy, which currently lack attention to this issue (BMWi, 2016[115]; BMWi, 2019[116]). Beyond WIPANO, a programme for knowledge and technology transfer via patents and standards that promotes the patenting and exploitation of inventions and funds research projects on standardisation, and the above-mentioned incentives to invest in R&D, policies should aim to boost firms' investments in software, databases, organisational capital and training, which remain particularly low compared to other countries (Figure 2.12 above). Existing programmes that provide investment incentives for some of these forms of knowledge-based capital, such as the ERP Digitalisierungs und Innovationskredit (KfW, 2020[117]), could be scaled up, including with more funding.

Step up support to accelerate the digital transformation of SMEs

SMEs are at the heart of the German economy, champions in some international niche markets, and key partners of larger multinationals as upstream suppliers. Germany's SMEs play a key role in automotive industry supply chains, and account for the bulk of the German international trade surplus (VDA, 2018[76]; OECD, 2019[118]). While in the context of the COVID-19 crisis SMEs suffered in many sectors, IT and telecommunication were among the few sectors that experienced increasing demand, for example to support telework (Meffert, Mohr and Richter, 2020[119]). To remain competitive in an increasingly digital and data-driven economy, including with less mobile staff and customers during containment, SMEs need to invest more in advanced ICTs, knowledge-based capital and the skills they need to succeed in digital transformation (Section 2.6).

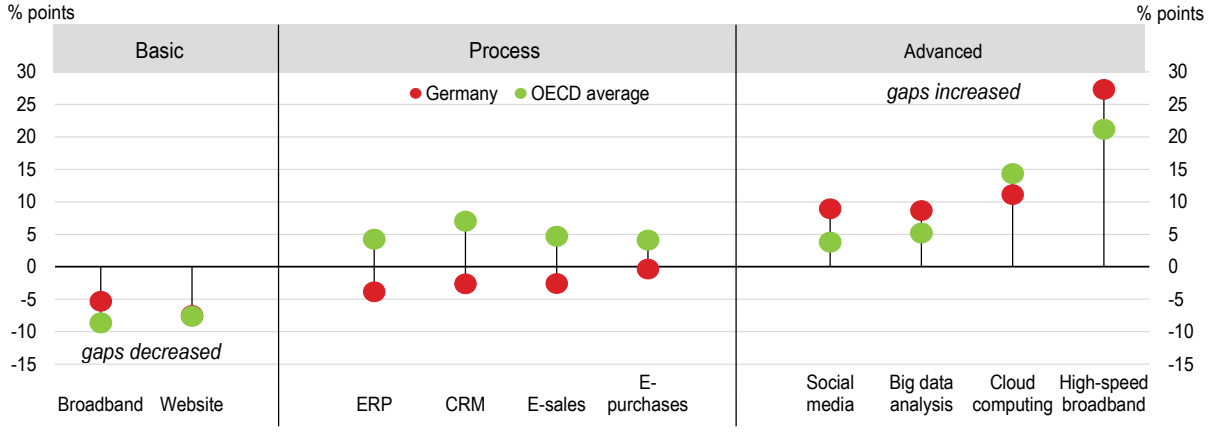
Over recent years, digital transformation trends of German SMEs have shown a positive dynamic, but gaps with larger firms remain. Between 2016 and 2018, 40% of SMEs completed digitalisation projects successfully, which corresponds to some 1.5 million SMEs, up from 26% between 2014 and 2016 (KfW, 2020[120]). However, large firms remain frontrunners in the adoption of newer and more advanced ICT tools and activities that enable firms to create value with data. Across OECD countries, the gap between large and small firms is closing for the adoption of basic ICT tools, and in Germany this is also the case for process-related ICT tools and activities (Figure 2.13). Large firms, however, still drive the adoption of newer and more advanced ICT tools and activities, in most cases, even more so in Germany than across OECD countries. This may also reflect Germany's general backlog in the adoption of such tools and activities (Section 2.2, Figure 2.4 above), in particular of high-speed broadband. Policies supporting their adoption should thus notably target smaller firms.

SMEs often face barriers to access external finance and many invest only little in their digital transformation. Key reasons include uncertainty about success, difficulties for lenders to assess digital transformation projects and a low share of investments that could account as collateral. In part as a result, SMEs tend to finance digital transformation projects mainly from their cash-flow (Saam, Viete and Schiel,

2016[121]). Currently, SMEs finance such projects by 87% with internal funds, while bank loans only account for 7%, a proportion that does not necessarily reflect firms' first choice. Indeed, firms conducting loan negotiations on digital transformation projects are more likely to report difficulties in accessing credit than enterprises negotiating loans for capital expenditure (KfW, 2020[122]). Over the past three years, average digitalisation expenditure stagnated at EUR 17 000 per firm. The EUR 19 billion SMEs invested in digitalisation in 2018 remains low compared to the EUR 34 billion spent on traditional innovation and the EUR 220 billion spent on material assets (KfW, 2020[120]).

Figure 2.13. Small firms are not yet catching up in the adoption of advanced ICT tools and activities

Percentage point change in the gap between small and large firms for the adoption of ICT tools and activities, 2010 to 2019 or latest available



Note: Firms with 10 or more employees, excluding financial sector. For Germany, data refer to 2013-2014 for using social media, purchasing cloud computing services and 2016 for having performing big data analysis. For OECD average, data refer to 2011-15 for using social media, 2009-14 for purchasing cloud computing services and 2016 for having performing big data analysis.
Source: OECD ICT Access and Usage by Businesses database, http://oe.cd/bus.

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Policies in support of SMEs' digital transformation include several well-targeted measures. The government's 2019 Mittelstand-Digital strategy raises awareness and provides guidance on digital transformation for SMEs (BMWi, 2019[123]), including through Mittelstand 4.0 Kompetenzzentren, which provide local contact points offering specific digital expertise to SMEs (BMWi, 2017[124]). The Go Digital programme subsidises authorised digital transformation consultants for SMEs (BMWi, 2018[125]), and the recently launched Digital Jetzt (Digital Now) programme subsidises investments in ICTs, including software and related training in firms with 3-499 employees (BMWi, 2019[126]). Several additional programmes exist at sub-national level. The largest programme, Digital Now, provides around EUR 50 million annually over four years (BMWi, 2020[127]). While in sum this is substantial, more may be needed to significantly accelerate the digital transformation of the over 2 million eligible firms.

Policies to foster the adoption of ICTs in SMEs should be carefully designed so as not to discourage firms' expenditures on digital services that are crucial for their digital transformation. Recent OECD analysis found that specific ICT capital incentive programmes in the UK and in Germany were associated with lower adoption of digital services that firms do not account for as capital but as operating expenditure, notably cloud computing (Andres et al., 2020[128]). It is thus important to design policies not only to incentivise investment in physical ICT capital but also to encourage firms to increase expenditures on digital services. For example, the depreciation allowance for "digital goods", which was suggested in the coalition agreement (CDU, CSU and SPD, 2018[16]) and is currently in planning, may benefit from considering SMEs' expenditures on digital services such as cloud computing, in addition to investments in digital goods such as computer hardware and software.

SMEs also often struggle finding the skills and building the organisational capital they need for using ICTs effectively. Through its Initiative New Quality of Work, the Federal Ministry of Labour and Social Affairs created several measures to support SMEs in this regard. This includes Innovation Spaces to experiment digital work arrangements and processes (BMAS, 2020[129]), Hubs for Tomorrow to test innovative in-house training approaches, with a focus on eastern German states (BMAS, 2020[130]), a Centre for Digital Work that supports these hubs with research findings on labour market evolutions induced by digital and demographic change, and Corporate value: Human, a programme that provides guidance and support, including subsidies for consulting, to help SMEs create or adapt their human resource strategy (BMAS and ESF, 2020[131]). Further development of these initiatives should be considered in the larger context of education and training policies (Section 2.6).

Promote digital security risk management more strategically

In the context of the COVID-19 pandemic, many firms have increased their digital activities, for example teleworking. More digital operations can create additional exposure and increase vulnerability to digital security threats, which have markedly increased since the COVID-19 outbreak (OECD, 2020[132]). A single digital security incident can disrupt operations, lead to loss of innovation assets, or destroy reputation, with potentially existential implications for the firm. In 2019, 11% of firms in Germany experienced digital security incidents with implications for the availability of digital services, the destruction or corruption of data, or the disclosure of confidential data. This is slightly below the EU average of 13% (Eurostat, 2019[133]) and may partly reflect lower exposure of firms in Germany to digital threats due to their sluggish adoption of advanced ICT tools and activities that are essential to collect, store, exchange and analyse data (Figure 2.8 above). Overall, cybercrime and related losses in Germany are estimated to exceed EUR 50 billion per year (BMWi, 2019[116]).

Digital security concerns are an important barrier to the adoption of key ICT tools and activities in Germany. The use of cloud computing, including for software and database hosting, is particularly affected by security concerns (Hentschel, Leyh and Petznick, 2018[134]). Such concerns are high in Germany both compared with other countries, and compared with other obstacles to cloud computing such as interoperability or skills (ZEW, 2015[135]). These concerns may help explain the low adoption of cloud computing in firms to date (Figure 2.8 above).

Many German firms are implementing practical and technical digital security measures but lack a strategic approach to digital security, based on risk management. Technical security measures are a widespread practice in German firms. However, only 34% of firms carry out a periodical digital security risk assessment considering the probabilities and consequences of security incidents (Figure 2.14), compared with 60% in Finland, the best performing country. The situation in SMEs is similar, with a vast majority implementing key technical measures, but only few carrying out more strategic activities, involving for example organisational measures and security related training (wik, 2017[136]).

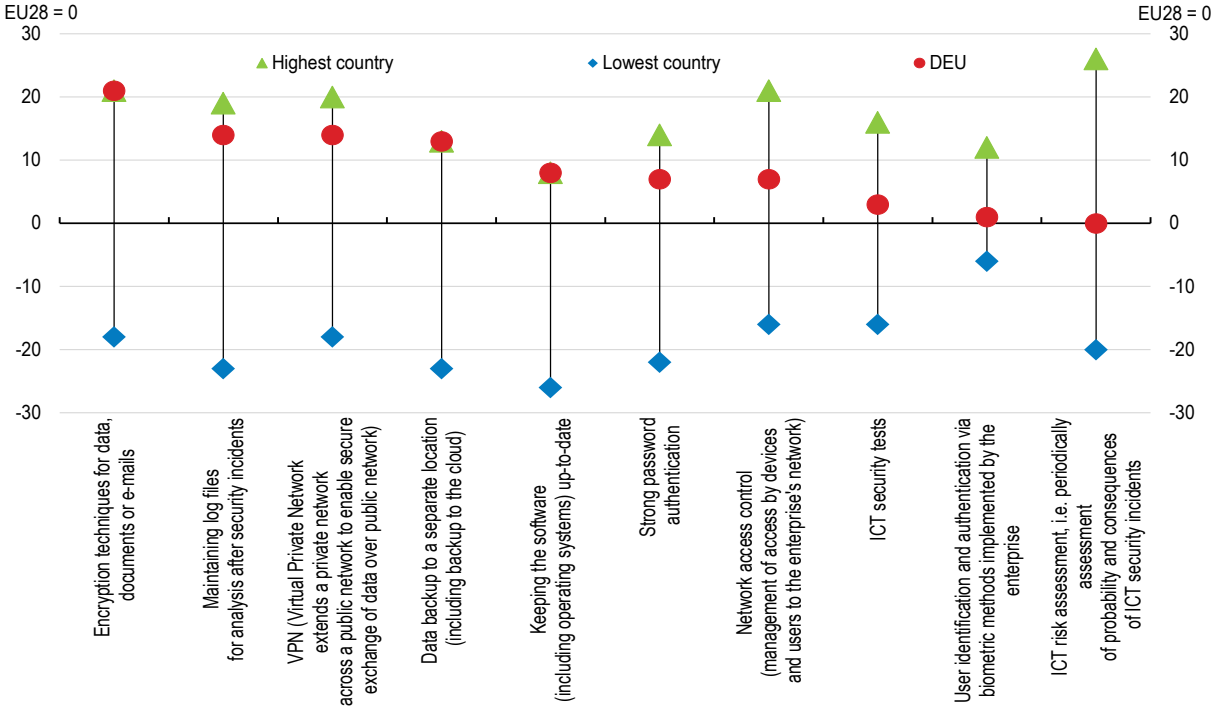
Risk assessment is an essential part of digital security risk management, which itself is the foundation for firms to approach digital security risk strategically and to increase resilience. Digital security risk management enables firms to prioritise resources not only to protect their information systems and networks from attacks, but also to reduce the effects of incidents on the business, for example, loss of reputation, theft of innovation assets, or disruption of operations (OECD, 2015[137]). Implementing digital security risk management in firms requires elevating digital security from being merely a technical issue to the top of business decision making. This involves raising awareness and empowering all stakeholders to understand and manage digital security risk, including via continuous risk assessment.

The government's current approach to digital security is focussed on legal, technical, and civilian aspects (Schallbruch and Skierka, 2018[138]) and lacks a strong business perspective and strategic promotion of digital security risk management in firms. While the 2016 Cyber-Sicherheitsstrategie für Deutschland (Cybersecurity Strategy for Germany) recognises the importance of protecting firms, it highlights in this

respect the role of the *Länder* police and the federal Verfassungsschutz (the domestic intelligence service of the Federal Republic of Germany) (BMI, 2016[139]). Both institutions are legitimately concerned with cybercrime and legal issues, but may not be well equipped to support firms in managing digital security risk for business success and resilience. A revision of the 2016 Cybersecrity Strategy for Germany should lead to a stronger focus on firms in general and on digital security risk management in particular, with the aim to foster economic and social prosperity (OECD, 2015[137]; BMI, 2016[139]). Such an approach can be found in the United Kingdom's National Cyber Security Strategy (HM Government, 2016[140]).

Figure 2.14. Despite strong technical measures, digital security risk assessment remains weak

% of the enterprises (10+ employees) implementing digital security measures 2019



Source: (Eurostat, 2018[34]).

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The Digital Strategy 2025 also addresses digital security in firms, however, it focuses mainly on legal and technical issues (BMWi, 2016[115]); the project GAIA-X too is primarily concerned with technical solutions (Box 2.5 above) (BMWi and BMBF, 2019[55]). While the programmes IT Sicherheit in der Wirtschaft (IT Security in the Economy) and Digital Now explicitly target firms and include measures to raise awareness, provide advice and offer other support related to digital security, in particular for SMEs (BMWi, 2020[141]; BMWi, 2020[142]; BMWi, 2020[127]), these practical measures seem largely independent from the 2016 Cybersecurity Strategy for Germany and insufficient for a more strategic promotion of digital security risk management in firms. In order to strengthen the business perspective and the digital security risk management approach in the Cybersecurity Strategy for Germany, closer co-operation may be required between the Federal Ministry of the Interior, Building and Community, which drafted the strategy, and the BMWi, which can provide relevant expertise and experience on digital security policies targeting firms.

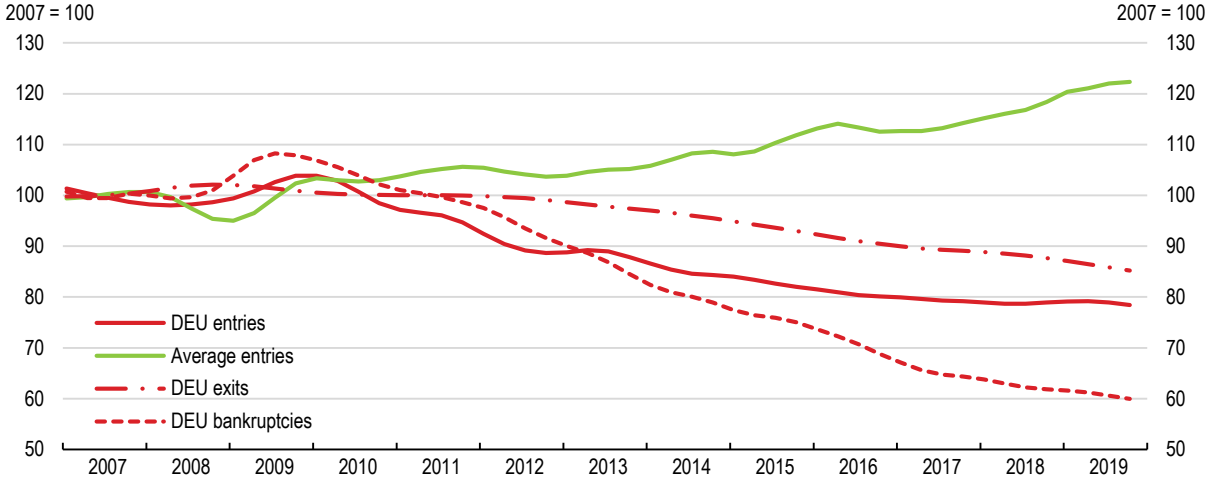
2.5. Supporting business dynamism during the recovery to boost technology diffusion

Business dynamism is essential for the diffusion of ICT tools and activities and for productivity. Policies that foster business dynamism have become even more important in the context of the COVID-19 crisis. This includes policies that favour reallocation and technology diffusion, notably measures that facilitate young and small firms' access to finance, restructuring and realignment of established firms, and the closure of non-viable firms (Sorbe et al., 2019[143]). In addition, digital government, notably digital public services, can facilitate firm creation and reduce administrative costs.

Misallocation of resources and unequal diffusion of ICT tools and activities have damped business dynamism and productivity across the OECD for some time. Business dynamism, as characterised by firm entries, exits, and job re-allocation, tends to be higher in digital-intensive sectors than in the rest of the economy, but declined in many OECD countries over the past 20 years, in particular in digital-intensive sectors (Calvino and Criscuolo, 2019[144]). Productivity growth also slowed in most OECD countries over the same period, affected by many factors, including the misallocation of resources (Adalet McGowan and Andrews, 2018[145]), unequal diffusion of ICT tools and activities and a divergence of productivity growth between frontier and laggard firms (Andrews, Criscuolo and Gal, 2016[146]). In Germany, there is also a gap between highly productive firms and others, in particular in services, though this gap did not widen between 2003 and 2014 (Schiersch, 2019[147]).

In Germany, business dynamism was losing momentum and draining productivity growth already long before the COVID-19 crisis. Contrary to the average across several OECD countries, entry rates in Germany are on a long-term decline, alongside decreasing exits and bankruptcies (Figure 2.15), and productivity growth slowed significantly over the past two decades (Sachverständigenrat, 2019[148]). Start-up activity is slowing in all sectors, including in knowledge-intensive industries and high-tech manufacturing (OECD, 2018[3]). Decreasing entry rates might partly reflect demographic trends, such as a shrinking share of the age group most likely to start a business (30-50 years), relatively high wages, and a tight labour market (European Commission, 2018[112]). However, other factors discussed below are important as well.

Figure 2.15. Business dynamism was slowing down long before the COVID-19 crisis



Note: Index constructed with business demography data. See here for more information on the methodology. "Average entries" includes data for Belgium, Denmark, Finland, France, Germany, Iceland, Italy, Japan, Netherlands, Norway, Sweden, and the United States.
Source: OECD, Timely indicators of entrepreneurship (ISIC 4). Data sources vary according to the country.

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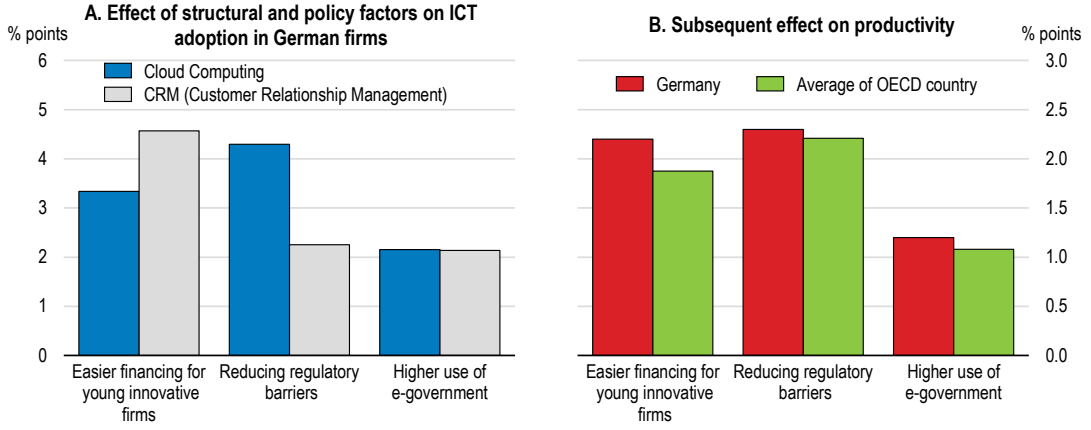
Multiple initiatives exist to facilitate business creation. Two online portals are targeting potential entrepreneurs, the Existenzgründungsportal and the Gründer Plattform, providing practical information on planning, financing and starting a business. The former features the start-up campaign GO! that promotes an entrepreneurial mind-set, strengthens relevant skills in schools and universities, and empowers women and migrants to start a business. The start-up contest Gründerwettbewerb – Digitale Innovationen rewards innovative digital business ideas, and the Digital Hub initiative operates twelve hubs across Germany that facilitate networking among start-ups, SMEs, science and administration in seminal industries. To kick-start international start-ups, a German accelerator was set up in Singapore and a second one is planned in India (BMWi, 2020[142]). These are well-targeted measures, but could potentially be more effective if bundled under a digital innovation agency or foundation, such as VINNOVA in Sweden or NESTA in the United Kingdom. The above measures are also unlikely to reverse the trend of declining business dynamism alone, without additional structural policies.

Key structural policy levers to revitalise business dynamism include measures to improve firms' access to start-up and growth finance, to reduce regulatory barriers, and to accelerate progress towards digital government. All three levers can have significant direct effects on the diffusion of ICT tools and activities, such as CRM and cloud computing, that in turn can support multifactor productivity growth (Figure 2.16). Such policies should be considered alongside policies to overcome key barriers to firms' successful digital transformation (Section 2.4) and policies to improve skills to thrive in the digital age (Section 2.6).

Figure 2.16. Policies supporting business dynamism, technology diffusion and productivity



Note: Estimated effect on the average adoption rate of selected ICTs (Panel A) and the multi-factor productivity (MFP) of the average firm (Panel B) of a range of policy and structural factors. For each of the underlying indicators, it is assumed that half of the gap to the best performing country in the sample is closed. It is also assumed that policy factors in each group are largely independent from each other.
Source: Based on (Sorbe et al., 2019[143]).

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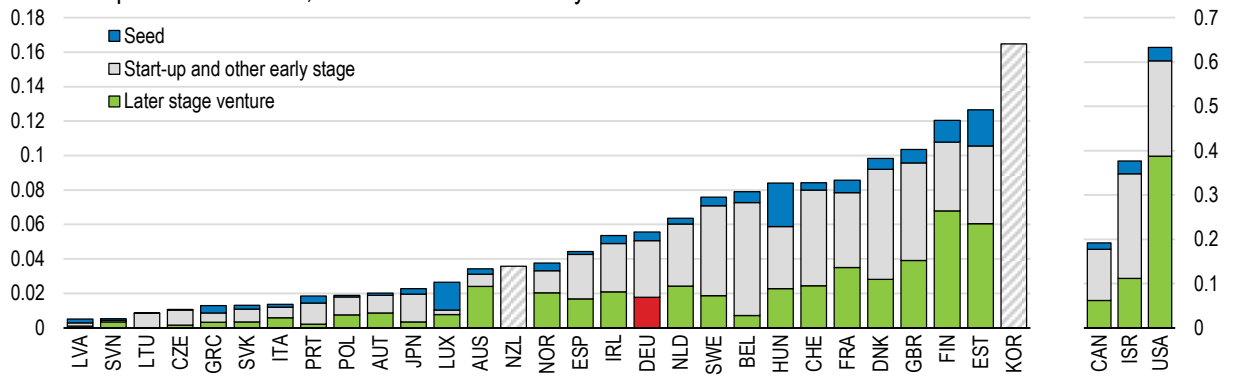
Improve access to start-up and growth finance

Access to finance at different development stages of a business, from creation to scale-up and growth, is a key ingredient for business dynamism. Among the range of available financing instruments, venture capital (VC) is essential to finance start-ups with high growth potential (OECD, 2019[149]). While an important non-official VC market through big firms' VC arms in Germany is not captured in official figures, internationally comparable VC investments are far below those in the best performing countries, in particular for seed and later stage funding (Figure 2.17). While between 2014 and 2019, VC as a share of GDP in Germany grew faster (19% per year) than on average (14% per year), and some German cities have become hot spots for start-up funding in Europe, notably Berlin (EY, 2019[150]), the current level is still below half of that in Finland and Estonia and at least 10 times smaller than in the United States.

Figure 2.17. Much potential remains for seed and later stage venture capital investments

Venture capital as % of GDP, 2019 or latest available year



Note: For Korea and New Zealand, no breakdowns of venture capital by stage are available.
Source: OECD Entrepreneurship Financing Database.

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Following the 2008 financial crisis, several countries maintained or created new equity support measures, including Canada, Chile, Denmark, Finland, France New Zealand, Sweden and the United Kingdom, which have arguably helped stabilise or grow VC investments since (OECD, 2020[151]). Germany also has a range of instruments to support seed and later stage funding. Key instruments targeting early stage start-up funding include the high-tech start-up funds, the INVEST and EXIST programmes, and a micro-mezzanine fund (BMWi, 2019[152]). Key instruments targeting later stage funding, predominantly financed by the ERP-Special Fund, include the venture capital fund Coparion, the joint ERP/European Investment Fund (EIF) VC fund of funds, the European Angel Fund Germany, the KfW Capital fund of funds programme ERP Venture Capital Fund investments, the ERP/EIF Growth Facility as well as the ERP/EIF/*Länder* Mezzanine fund of funds and the Tech Growth Fund including the KfW bank's Venture Tech Growth Financing-programme (BMWi, 2020[153]).

Further development of VC policy should aim to improve the effectiveness of existing instruments, including by avoiding complexity and by scaling up in particular later stage funding, for example through co-investment and fund of funds. One example is British Patient Capital, a subsidiary of the British Business Bank, which invests around EUR 3 billion in venture and growth capital alongside private sector equity funds, supporting a total of EUR 9 billion of investment over a decade (BBB, 2020[154]) (OECD, 2019[149]). The uptake of different instruments in Germany should be further monitored and improved where possible, taking feedback from beneficiaries into account, to address the lack of private VC.

A shortcoming of the German and European VC market is that institutional investors are only marginally involved, in particular compared to the United States, where 5% of pension funds' investment goes to start-ups (European Commission, 2018[112]). As a consequence and due to a stipulation by the ruling parties to establish an additional EUR 10 billion start-up fund for next generation technology, the government is considering strengthening the role of KfW Capital to become more active in growth financing and is examining approaches to make investment conditions more attractive to institutional investors (BMWi, 2020[142]). These efforts should be pursued further.

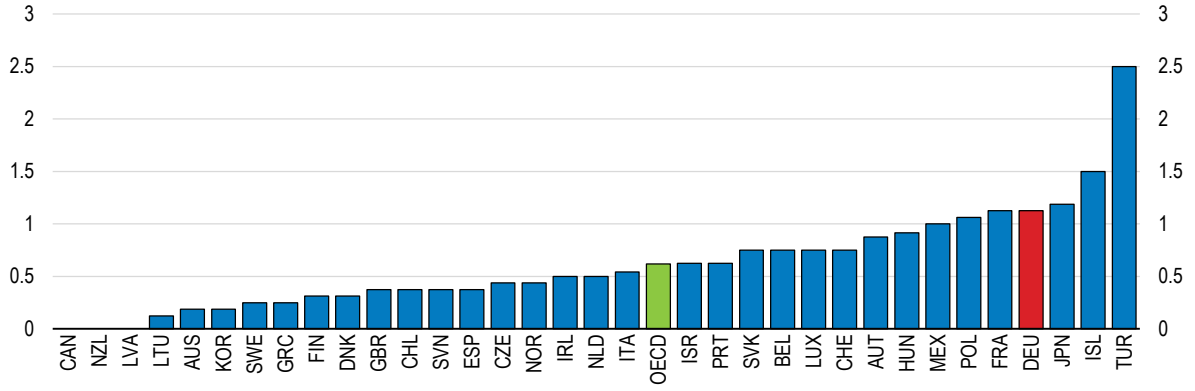
Reduce remaining bureaucratic burdens

Firms continue to perceive bureaucratic burdens in Germany as high and consider them a key barrier to growth. Almost half of all firms admit not implementing all bureaucratic requirements and focusing on the most important ones. This could weaken the effectiveness of the regulatory framework over time (IfM, 2019[155]). SMEs face the greatest difficulties, considering regulatory simplification and support for the implementation of digital transformation projects as key areas for improvements (IfM, 2018[156]).

Overall, administrative burdens for start-ups in Germany are low, compared to other countries. However, administrative requirements for limited liability companies and personally owned enterprises are still among the highest in the OECD (Figure 2.18). This notably concerns requirements to set up such enterprises (Vitale et al., 2020[157]). To start an enterprise in Germany, entrepreneurs have to make appointments with several different bodies, some of which require tedious paper work. Digitalising this process and providing a central online portal for the business creation online could help (bjdw, 2018[158]). In Estonia, entrepreneurs can create a business entirely online, even from abroad, a process that enabled 98% of companies to be established online and 95% to file online tax declarations (EAS, 2020[159]).

Figure 2.18. Administrative burdens for limited liability companies and personally owned enterprises are high

Countries ranked in ascending order from most (0) to least (6) competition friendly



Note: Personally owned enterprises are business entities owned and run by one natural person and in which there is no legal distinction between the owner and the business. Limited liability companies that are not quoted on the stock market. The US and Estonia are not yet included in the PMR database. Information refers to laws and regulations in force on 1 January 2018 and for a few countries 1 January 2019. For federal countries, where matters are regulated at state level, the values reflect the situation in one state (selected so as to be representative).
Source: OECD 2018 PMR database.

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Reforms have eased some regulatory burdens, but more could be done to reduce one-time compliance costs. The “one-in-one-out” rule, which obliges the government to eliminate a bureaucratic burden each time it creates a new one, has proven successful so far. The third Bürokratieentlastungsgesetz (BEG III, law to reduce bureaucracy) has lowered regulatory burdens for firms by an estimated EUR 1.1 billion. However, the BEG III only applies to ongoing compliance costs, while one-time compliance costs are still high. From 323 new regulations introduced between 2011 and 2019, only 51 resulted in ongoing compliance costs, while they created over EUR 12 billion in one-time compliance costs for firms (NRCC, 2019[160]).

Potential also remains for improving stakeholder engagement (Vitale et al., 2020[157]) in developing primary laws and subordinate regulations, which decreased over the past years (OECD, 2019[161]; OECD, 2019[162]). ICT tools could be better used to systematically engage stakeholders, in particular firms, many of which are willing to engage and to share their experience and expertise (IfM, 2019[155]).

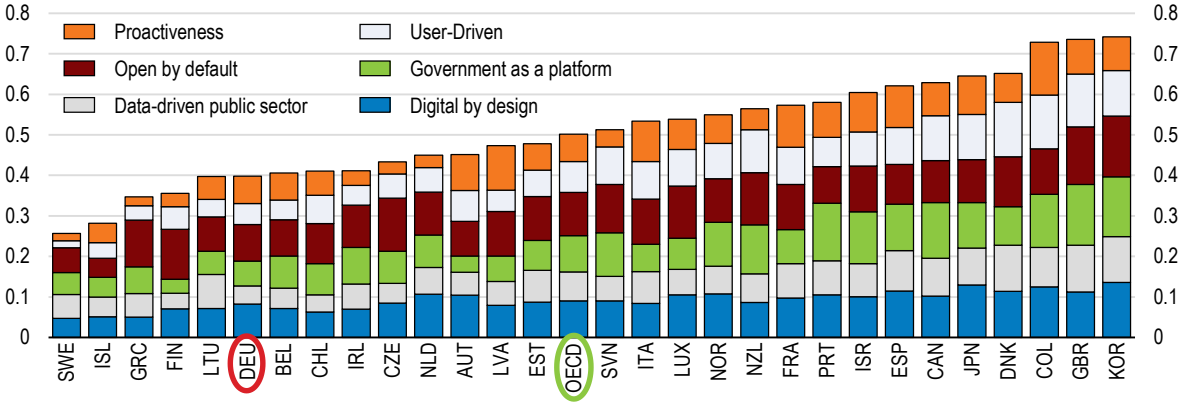
Accelerate progress towards digital government

To enable digital transformation across the economy and society, governments need to go digital themselves. For many countries, this implies an evolution towards a coherent and user-driven approach to digital government, guided by the needs of citizens and businesses (OECD, 2019[1]). While Germany has reinforced its efforts on digital government over recent years, much work remains to be done and priority should be given to accelerate the implementation of existing legislation and planned measures.

Germany performs below the OECD average on the OECD's Digital Government Index, a pilot exercise measuring digital government maturity (Figure 2.19). Germany notably lags behind on a data-driven public sector, which is characterised by using data to anticipate and respond to the needs of users and to deliver better services (OECD, 2019[25]). The government's forthcoming Data Strategy (Section 2.3) can play an important role in providing an effective framework for data governance also for a more data-driven public sector.

Figure 2.19. Germany lags behind on digital government

OECD Digital Government Index, 2019, score 0 to 1



Note: Data are not available for Australia, Hungary, Mexico, Poland, Slovakia, Switzerland, Turkey and the United States.
Source: OECD Survey on Digital Government 1.0.

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Integrated and user-driven digital public services are a key component of digital government and a lever for technology diffusion and subsequent productivity growth (Figure 2.16 above). Important potential remains to digitalise and improve public services in Germany. If paperwork was eliminated only for the most common service transactions, German companies would save EUR 1 billion in administrative cost (Stern et al., 2018[163]). Before the COVID-19 pandemic, the growth in the share of individuals and firms using the Internet to interact with public authorities was low and lagged behind many OECD countries (NKRG, 2019[164]; OECD, 2019[33]). Limited supply, lack of user- and mobile-friendliness and mistrust seem to constrain the number of interactions. For example, 7% of Germans do not submit completed forms online to public authorities because of unavailable digital services, four times more than in most other OECD countries (OECD, 2019[33]). Germany also performs below the EU average for basic online services for businesses, including service availability across borders (Figure 2.20).

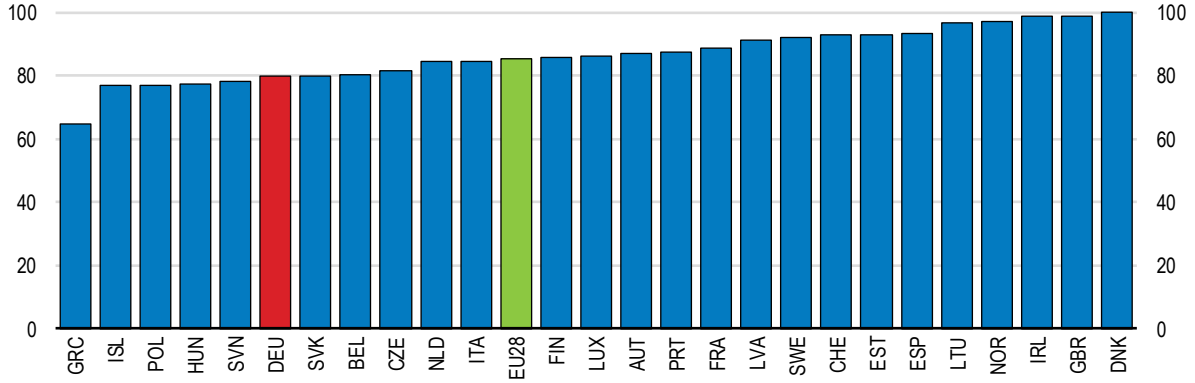
Germany's Online Access Act (OAA) mandates public administrations to offer their services digitally by 2022, with priority given to services with high demand and potentially large cost savings from digitisation. While the OAA is based on the principle of user-centricity, administrations currently use a variety of IT-systems that are not always interoperable, creating inefficiency and hindering user friendliness (Weilage and Chapters, 2018[165]). An important approach in the implementation of the OAA is the "one for all/many " model, which suggests that a digital service developed by one or more states should be made available to all other states. The objective is that the division of labour among states accelerates the implementation of the OAA and saves resources.

Nonetheless, authorities will have to collaborate better to meet the OAA's targets. Despite efforts of the IT-planning council to co-ordinate between federal and state levels on many digital government related issues (IT-Planungsrat, 2020[166]), and despite rising willingness to co-operate, challenges remain (NRCC, 2019[160]). A new institution (FITKO, Föderale IT-Kooperation) was founded in January 2020 to improve co-ordination. Its main objectives are to bundle the activities of the IT-planning council on digitising administration, manage the digitisation budget and serve as a knowledge and networking hub. As part of

the recovery package, an additional EUR 3 billion are earmarked (until the end of 2022) to accelerate the implementation of the OAA, improve the underlying IT-architecture and interoperability, and develop common standards. In the UK, to ensure efficient implementation, the UK's Service Manual is actively maintained by a team of content designers who work with the different professional communities (such as design, delivery and products) to document best practices and inform other teams throughout the public sector (OECD, 2020[167]).

Figure 2.20. Public services for businesses are not always available online and across borders

Digital government services for businesses, 2018, score 0 to 100



Note: The DESI eGovernment Services for Business indicator measures the degree to which basic public services for businesses, when starting a business and for conducting regular business operations, are online available and cross-border. This indicator is calculated based on the national, and cross-border online availability of the basic services Business life events (Regular business operations and Business start-up).
Source: European Commisssion, Digital Economy and Society Index Report 2019, https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=59975.

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Another key component of digital government is access to open government data, which can foster social participation, business opportunities and innovation. While the availability and accessibility of open government data have improved over recent years, and are close to OECD average, Germany still lags significantly behind most OECD countries in terms of policies supporting the reuse of open government data. The latter is due to limited monitoring of the impact of open government data and a lack of initiatives to promote data use and data literacy among civil servants in Germany.

Several actions could be taken to improve access to and reuse of open government data. The Open-Data-Gesetz (§12 of the e-government law) mandates federal authorities to release their data in open and machine-readable formats, free of charge, and with associated metadata on the federal metadata portal GovData.de. The last progress report on open data highlighted the need for a cultural change in public administration in the handling of data (Deutscher Bundestag, 2019[168]). This could be facilitated by raising awareness and improving the understanding of the potential of open government data across the administration, beyond the technical implementation of the law. Other countries were successful with targeted strategies. Ireland's National Open Data Strategy, Poland's Public Open Data Programme, and Slovenia's Public Administration Development Strategy are examples that have resulted in good progress in terms of open government data in recent years (OECD, 2019[169]). Further engaging in and leveraging open data-related partnerships, such as the Germany-Austria-Switzerland-Liechtenstein Cooperation and Code for Germany could also benefit greater reuse of open government data.

Germany has a large public procurement market, accounting for around 15% of GDP. From 2020, the use of electronic tools has become mandatory for all public supply and service contracts awarded by federal authorities and increasingly at the *Länder* level. This will result in cost reductions to bidders and the authorities and may improve project quality due to a broader distribution of winners, more of which are likely to come from outside the region where the work takes place (Lewis-Faupel et al., 2014[170]). E-procurement also facilitates the collection and use of procurement-related data, which in turn can help

to further improve procurement. Tapping into this opportunity requires systematic data collection and use, as well as digital integration of e-procurement with other public sector information systems (OECD, 2019[171]).

To ensure simpler, clearer and faster procurement of ICTs, Germany would benefit from establishing a digital marketplace for products and specialists. In the UK, such a marketplace is shaping how digital goods are procured and how expectations are set. Two different frameworks allow either cloud suppliers to list their goods, or public sector buyers to list their specific technology or skill needs, to which eligible suppliers can propose solutions (OECD, 2020[167]).

2.6. Improving skills to thrive in the digital age

The digital transformation of labour markets was in full swing even before the COVID-19 crisis and skills have become a key condition for people, firms and governments to thrive in the digital age (OECD, 2019[162]). The use of ICT in the workplace is now required in almost all occupations. Even employees who work outside the traditional office, like dairy farmers and car mechanics, have increased their use of ICT tasks and skills (Curtarelli et al., 2017[172]). The mix of skills that workers require includes foundational numeracy and literacy skills, science, technology, engineering and math (STEM) skills, ICT skills, as well as complementary skills (OECD, 2019[1]). Different policies are needed to address both short-term skill demand, such as signalled by labour market imbalances or training needs, as well longer-term supply, notably through education.

Foundational numeracy and literacy skills are in high demand

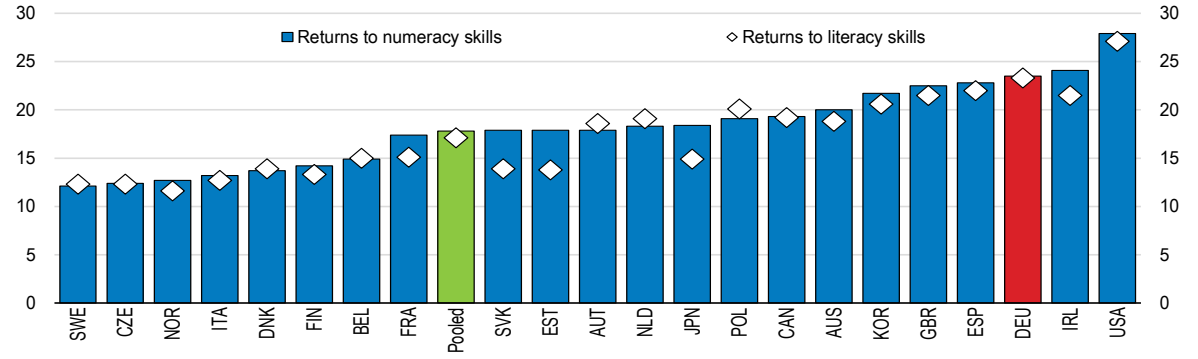
Workers in rapidly growing occupations, where ICT use and non-routine tasks are often more intensive, perform tasks involving reading, writing and numeracy more often (OECD, 2019[162]). Such foundational skills are also an important foundation for developing other, more specific, skills and competencies (Rammstedt et al., 2013[173]) and allow workers to adjust to new technologies and occupations more easily. Longer careers due to higher life expectancies and a large share of the service sector also heighten the importance of acquiring better foundational skills, including to better facilitate life-long learning. Adult proficiency in literacy, as measured in the OECD Programme for the International Assessment of Adult Competencies (PIAAC), is slightly below the OECD average. Adult proficiency in numeracy and problem-solving skills in technology-rich environments is slightly above the OECD average but lags behind leading countries. Reading performance of 15-year-olds declined in 2018, reversing the increasing trend of earlier years.

The impact of better foundational skills on relative earnings and probability of being employed is larger in Germany than in most OECD countries (Figure 2.21), which may reflect stronger specialisation on skill-intensive activities (Hampf, Wiederhold and Woessmann, 2017[174]; Fuentes Hutfilter, Lehmann and Kim, 2018[175]). In Germany, a one-standard deviation increase in numeracy or literacy skills is associated with about a 23 percent hourly wage increase. Advanced methods for calculating returns to skills indicate that the causal relationship may be even higher (Hampf, Wiederhold and Woessmann, 2017[174]). The impact of better ICT skills on relative earnings is of similar magnitude (Falck, Heimisch and Wiederhold, 2016[176]).

High returns to foundational skills signal that demand outstrips supply and that higher investment in such skills is economically worthwhile. More investment in early childhood education and schools to ensure individuals obtain strong foundational skills may also raise participation in adult education in the future since higher skilled individuals are more likely to participate in adult education (Desjardins, Rubenson and Milana, 2006[177]).

Figure 2.21. Returns to foundational skills are large

Percentage change in wages associated with a change of one standard deviation in proficiency in numeracy and literacy, after controlling for actual work experience and gender



Note: Least squares regressions weighted by sampling weights. Dependent variable: log gross hourly wage. Sample: full-time employees aged 35–54 (Canada includes part-time employees). Numeracy and Literacy score standardized to std. dev. 1 within each country. Pooled specification includes country fixed effects and gives same weight to each country. Sample: the 23 countries that participated in the first round of the survey (in 2011–2012).
Source: (Hanushek et al., 2015[178]).

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Better acquisition of foundational skills, especially for those with disadvantaged backgrounds, would also help reduce inequality and secure opportunities for upward intergenerational mobility. The gap in PISA results between advantaged and disadvantaged 15 year-old students is among the largest in OECD countries and increased since 2009 (OECD, 2019[118]). As the education system moves towards greater use of ICT tools, even more so after the COVD-19 pandemic, the gap between advantaged and disadvantaged students could increase further, as access to devices and parents' skill levels become more important.

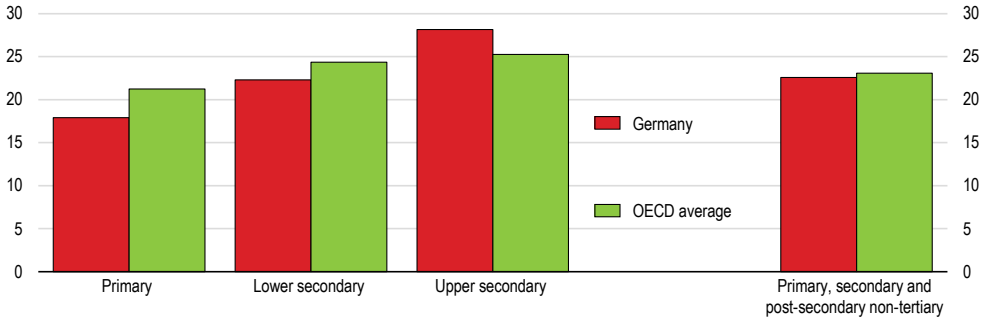
Prioritise early education and strengthen the foundational skills of VET graduates

For the digital age, it has become more important than ever to address inequality of opportunity starting at an early age. New technologies tend to complement skilled labour and replace low-skilled workers in the performance of routine tasks (OECD, 2019[162]). This effect is a prominent explanation for the rising wage inequality in many OECD countries since the 1980s, including Germany (Antonczyk, Deleire and Fitzenberger, 2010[179]). Investing in children's education at an early stage can produce high returns on investment since it creates a crucial foundation for future learning, especially for children with weak socio-economic backgrounds. Those who lack foundational skills are less likely to benefit from the opportunities of the digital transformation (OECD, 2019[162]).

Although the best period to acquire foundational skills is at early ages, spending on primary education and early childhood education is relatively low (Figure 2.22). Participation in early childhood education has increased rapidly over the past 15 years to just above the OECD average. Nevertheless, the quality of childcare is uneven. For example, there are differences in the staff-to-children ratio and in qualification levels (Fuentes Hutfilter, Lehmann and Kim, 2018[175]). Further improving professional development of day-care staff and monitoring the quality and standards of the educational institutions is therefore essential. Working with dual language learners is a top priority for professional development needs (OECD, 2019[180]). Improving access and quality of full-day schooling, as recommended in the previous economic survey, would be one way of prioritising primary education (Fuentes Hutfilter, Lehmann and Kim, 2018[175]).

Figure 2.22. While foundational skills are best acquired early, primary education spending is low

Total expenditure on educational institutions per full-time equivalent student relative to GDP per capita, 2016



Note: The graph uses data on the OECD Education at a Glance Indicators, Indicator C1: How much is spent per student on educational institutions?
Source: (OECD, 2019[181]).

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A complementary investment with more immediate returns would be to strengthen foundational skills of vocational education and training (VET) graduates. Thanks to the combined work and school-based programmes, Germany enjoys a very good integration of young people in the labour market. However, a trade-off seems to exist. The acquisition of occupation-specific skills at a relatively early age – at the expense of numeracy and literacy skills, and skills that facilitate continuous learning such as creativity and critical thinking – reduces later adaptability to changing environments. From the age of 45 individuals with a general education have higher employment probabilities in countries with the highest intensity of industry-based vocational education, including Germany (Hampf and Woessmann, 2017[182]). In Germany, people without a vocational education background also have higher salaries after about 8 years of labour market experience (Cörvers et al., 2011[183]). Research using data from the German microcensus found similar results. Additionally, it found that individuals completing a general education are more likely to acquire career-related education as they become older (Hanushek et al., 2017[184]). Rapid technological changes stemming from automation and digital transformation may make the obsolescence of occupation-specific skills even more pronounced (Krueger and Kumar, 2004[185]).

Ensuring that VET graduates have strong foundational skills is therefore essential. One way to provide them with these skills is to strengthen general education within the VET track, as the 2018 Economic Survey suggested (OECD, 2018[3]). To achieve this goal, one option could be to put more weight on mathematic and German skills in the final exams, which determine whether apprentices receive their formal VET qualification. This would increase motivation and highlight the importance of foundational skills, in particular for digital-intensive occupations. More time dedicated to strengthening foundational skills would also help students who are behind academically to find an apprenticeship (Bergseng, Degler and Lüthi, 2019[186]).

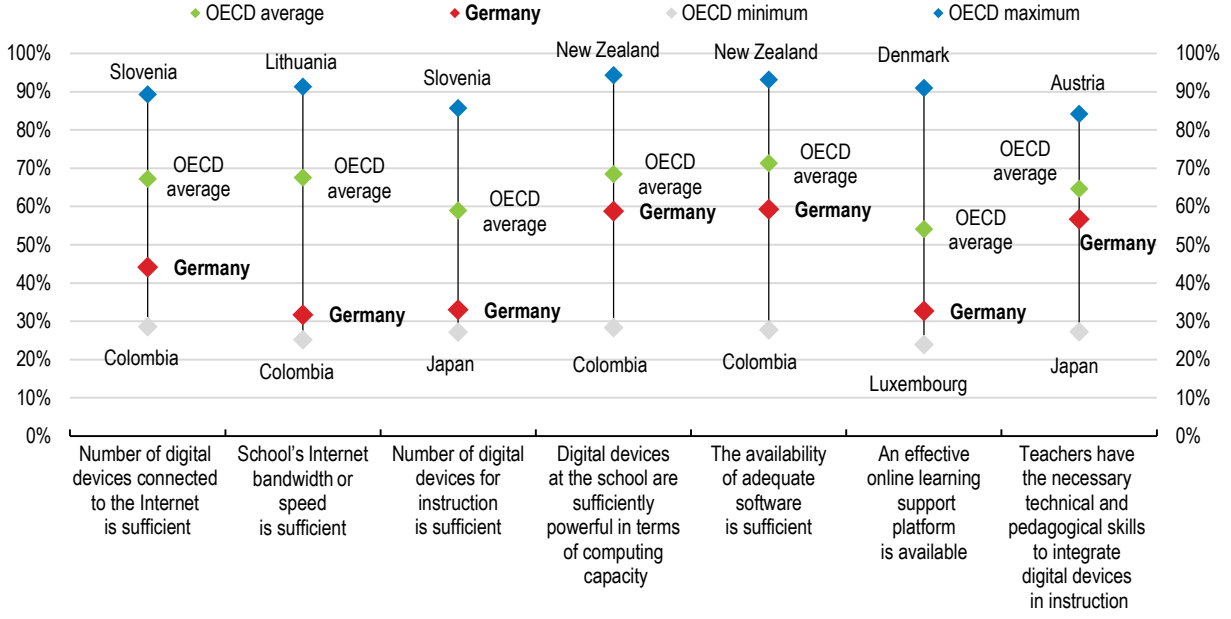
Postponing between-school tracking would be another way to strengthen foundational skills. In Germany, student selection for different programmes generally starts at the age of 10, compared with 15 or 16 in the majority of OECD countries. Therefore, low- and high-performing students are clustered in certain schools more often than the OECD average (OECD, 2019[118]). There is considerable international evidence that early tracking is associated with inequality in education, both in student performance and in the extent to which individual student achievement and other life outcomes reflect family background (OECD, 2016[187]). Nor is there any evidence of a positive effect of early tracking for the top students (Smidova, 2019[188]). The association between student performance and socio-economic background is significantly lower in Berlin and Brandenburg, where all primary schools are comprehensive until age 12, which does not come at a cost of lower average performance (Woessmann, 2009[189]).

Complement greater use of ICTs in schools with more ICT training for teachers

If teachers have the right skills, the use of ICT tools in schools and classrooms can help students develop skills for the 21st century and enhance student engagement. According to school principals' perceptions, Germany is lagging behind other OECD countries when it comes to the adequacy of ICT tools available in schools and the skills of teachers in using them effectively (Figure 2.23).

Figure 2.23. Germany lags on use of ICT tools in schools and teachers' preparedness

Percentage of students in schools whose principal agreed or strongly agreed with statements about the school's capacity to enhance learning and teaching using digital devices



Source: OECD calculations based on PISA (2018).

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As part of the DigitalPakt Schule, the federal government has allocated about EUR 6.5 billion to improve digital infrastructure, to provide all schools with a broadband connection and to equip all teachers and – if necessary – children with suitable devices. In practice, a year into the programme, disbursement was slow; accelerating disbursement is urgent in the current context of schools' increasing reliance on digital means to ensure continuity of education.

Extensive use of technologies at school needs to be combined with providing teachers with the necessary skills to use the new infrastructure, devices and software. The use of digital resources by teachers lacking appropriate skills, such as unfamiliarity with digital technologies, may distract and harm learning outcomes (OECD, 2019[190]). Teachers' lack of experience is also likely to make learning from home less efficient.

Investing in teacher training would help to improve students' skills and integrate ICT tools in teaching methods. In recent years, the federal government and the states increased efforts to strengthen initial teacher preparation (BMBF, 2019[191]). Improving ICT skills of the existing pool of teachers remains a challenge. Countries across the OECD have been tackling the need for ICT training through a range of policies, from introducing compulsory training to national accreditation standards or certification for teachers (OECD, 2019[162]) (Box 2.6).

Box 2.6. Policies for the development of teachers' ICT skills

Standardisation is one way that OECD countries improve teachers' ICT skills. Denmark, for instance, has developed a voluntary Pedagogical ICT Licence that combines pedagogical knowledge of ICTs and basic ICT skills training. After initial implementation for in-service training, this license was expanded to initial teacher education and general upper secondary education. While not mandatory, the licence is integrated into the curriculum of teachers who graduate from education colleges (OECD, 2019[162]).

Teachers' training can take the form of traditional face-to-face or on-line courses. In Spain, France, Slovenia, Sweden and the United Kingdom, courses on digital education tend to progressively develop into on-line training. In France, most of the digital skills training courses are provided on-line; and since 2014, 362,000 teachers were trained via digital platforms. Self-assessment tools may help teachers evaluate effectiveness and detect areas for improvement. In Finland, teachers can measure and analyse their use of ICT in teaching through an online self-assessment tool. It provides teachers, school and municipalities representatives information on how their ICT usage compares to others (European Commission, 2019[192]).

Integrating digital technologies into national testing could encourage teachers (and students) to enhance their ICT skills. In Finland, the national final test for upper secondary education has been gradually digitalised, becoming fully digital in 2019 (European Commission, 2019[192]). Additionally, Finland created 2 500 temporary mentoring positions to assist teachers in using new technologies and to promote using digital environments (European commission, 2018[193]).

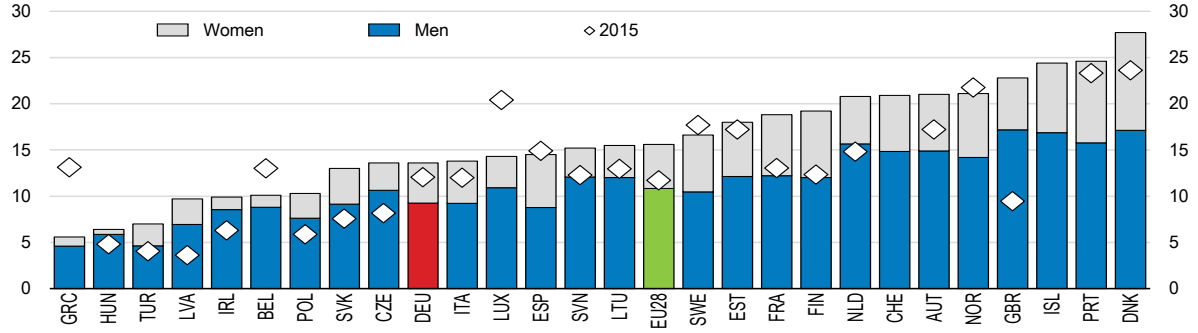
Source: (OECD, 2019[162]); (European Commission, 2019[192]); (European commission, 2018[193]).

Computational and programming skills need to improve, notably among women

Computational thinking and programming skills continue to gain importance, and curricula should be updated accordingly. Since the mid-1990s, the share of computer scientists within the STEM occupations increased dramatically (Spitz-Oener, 2018[194]). In 2017, 12% of 20-24 year-olds in Germany undertook a programming activity in the preceding 12 months, compared with just 3% of the population aged 45-54. However, Germany lags behind most EU countries in this domain and has hardly progressed since 2015 (Figure 2.24). The gender gap is particularly noticeable. Women comprised 32% of 16-24 year-old programmers, compared with about 38% in Finland, Denmark and Spain. Like many EU countries, Germany recently reformed the national curriculum related to digital competences. However, the strategy does not include programming as part of the learning objectives, in contrast to most EU countries (European Commission, 2019[192]).

Figure 2.24. A low share of young adults are able to program

16-24 year-old individuals who can program, % of all Internet users aged 16-24, 2019



Source: OECD Going Digital Toolkit, https://goingdigital.oecd.org/en/indicator/54/.

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Introducing computational thinking to the majority of students at early stages of education would empower people and underpin competitiveness of the German economy. When students are exposed to computational thinking through programming, they can increase both their problem-solving and digital competencies, as well as acquire a deeper understanding of the underlying mechanisms and concepts of new technologies. France introduced a mandatory upper secondary school course on computational sciences and technology in 2019 (OECD, 2019[162]). In the near future, the priority could be to improve computational thinking, rather than programming specifically, as computational thinking can be integrated into many subjects and be taught by the current pool of teachers.

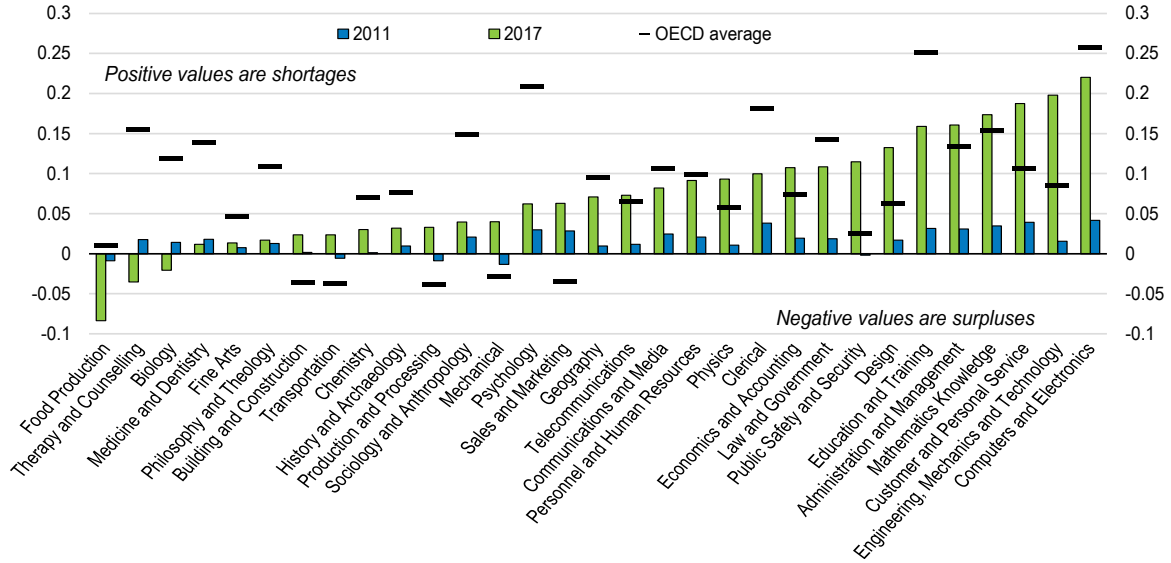
Positive early experience with programming may also help reduce gender gaps. A recent study found that giving first-grade girls an opportunity to try programming increases their interest in technology and self-efficacy, and that this experience eliminated related gender differences (Master et al., 2017[195]). In Italy, a coding course targeting female middle-school students resulted in a 10% increase in participants' interest to become a computer programmer (Carlana and Fort, 2020[196]).

Increasing opportunities to study STEM and ICT-related fields

Prior to the COVID-19 pandemic, the most prominent skills shortages were in computers and electronics, engineering and mathematics, with more severe shortages in 2017 than in 2011 (Figure 2.25) even though the migration of workers with these skills has increased significantly (Anger et al., 2020[197]). These knowledge domains are closely associated with Science, Technology, Engineering and Mathematics (STEM) fields of study. Adults with a tertiary degree in engineering, manufacturing and construction and those with a degree in ICT related fields earn about double compared to those with upper secondary education, one of the highest premiums among OECD countries (OECD, 2019[181]). Because demand has outpaced supply for these skills, the STEM premium has increased since the mid-1990s, for both men and women (Spitz-Oener, 2018[194]).

Figure 2.25. Significant shortages exist in STEM related knowledge domains

Knowledge domains that are in shortage and surplus



Note: The Skills for Jobs database defines skills as either in shortage or in surplus. These imbalances are measured following a two-step approach. First, an "occupational shortage indicator" is calculated for 33 occupations, based on the analysis of the wage growth, employment growth, hours worked growth, unemployment rate and the change in under-qualification. For each country, long-run trends are compared to the economy-wide trend. Based on the O*NET database, the "occupational shortage indicator" is then used to build indicators of skills shortages and surpluses. Knowledge domains refer to the body of information that makes adequate performance of the job possible (for example, knowledge of mathematics for an economist).

Source: OECD skills for jobs database.

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In addition, demand for ICT specialists was picking up and enterprises reported growing difficulties in filling vacancies before the COVID-19 pandemic. From 2012 to 2018, the number of persons employed as ICT specialists grew by 20%, 2.8 times the increase in total employment. However, the share of ICT specialists in total employment in Germany is still below the EU average. Supply constraints seem to prevent a greater increase. In 2018, more than two thirds of enterprises searching for ICT specialists reported recruitment problems, up from less than half in 2014. Skills shortages cause wage increases. Between 2001 and 2016, wages of workers in the ICT sector rose by 35% compared with a 25% increase in total labour productivity (OECD, 2017[198]).

The limited supply of STEM graduates and ICT and data specialists is slowing the adoption of new technologies and hampering innovation. The employment of ICT specialists in firms, for example, is strongly associated with the adoption of key ICT tools and activities (Table 2.2) that underpin digital transformation and data-driven innovation. The limited supply affects in particular SMEs, which may help explain why SMEs have not increased R&D expenditure over the past decade (Weilage, 2018[199]). The skill shortage suggests that incentives to invest in R&D, without complementary actions to increase skills supply, will not be enough for firms to benefit from digital transformation, and may instead just increase the wages of the existing pool of workers.

Table 2.2. ICT specialists are essential for firms' adoption of key ICT tools and activities

Estimated percentage point changes in the adoption of ICT tools and activities for German firms by employment of ICT specialists and provision of IT training to their employees

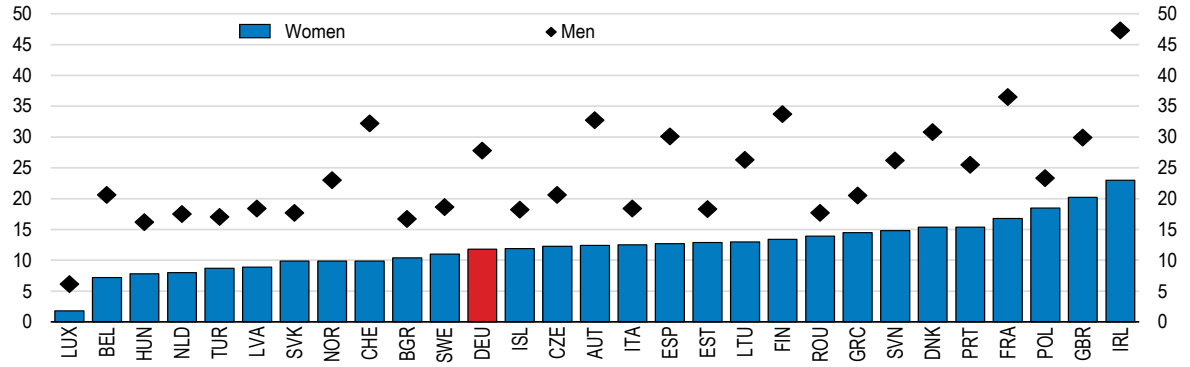
	ERP	CRM	e-purchase	e-sales	Social media	Cloud computing	BDA
Employment of ICT specialists	10.668***	7.185***	5.423***	6.284***	9.403***	6.141***	3.561***
IT training of employees	10.012***	7.835***	8.015***	4.581***	3.027***	5.631***	3.221***
Observations/Firms	24685/22316	24593/22241	24857/22467	30126/26511	26330/22724	9488/8546	5821/5821
Survey years	2012-2015, 2017	2012, 2014, 2015, 2017	2012-2015, 2017	2012-2017	2013-2017	2014, 2016	2016

Note: Firms with 10 or more employees, excluding financial sector. This table reports OLS regression results based on a representative micro-data sample of German firms. Coefficients reflect the percentage point increase in the likelihood of a firm adopting a given ICT tool or activity associated with employing ICT specialists or providing IT training to employees. In addition to a broad set of control variables, regressions (except big data) control for year, municipality and industry (4 digit) fixed effects. Big data uses fixed effects at the county level instead of the municipality level. Table A1 in the Annex provides additional detail. Standard errors clustered at the municipality level (not reported); ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. ERP stands for enterprise resource planning, CRM for customer relationship management, and BDA for big data analysis.
Source: (Alipour, forthcoming[14]).

Increasing opportunities to study STEM and ICT-related fields at universities and technical colleges is key to tackle skills shortages in the long-run. Although Germany's share of STEM graduates among tertiary graduates is one of the highest in the OECD, the share of STEM graduates (of all ages) per 1000 population aged 20-29 is lagging behind leading EU countries, especially for women (Figure 2.26). The share of tertiary ICT graduates is lagging behind leading OECD countries as well (OECD, 2019[33]). The STEM Action Plan, introduced in 2019, aims to raise enthusiasm to take up STEM education and careers. Networking, funding and communication measures that are part of the plan are focused especially on girls' and women's needs.

Figure 2.26. The share of STEM graduates lags behind leading countries

Graduates in tertiary education, in science, mathematics, computing, engineering, manufacturing, construction, per 1000 of population aged 20-29, 2018



Source: Eurostat, education and training (educ) database.

StatLink https://doi.org/10.1787/888934201420

Easing the transition between educational systems may increase accessibility. Despite significant reforms, the route from post-secondary VET to academic higher education remains rarely travelled (Fazekas and Field, 2013[200]; OECD, 2019[181]). Further use of bilateral credit transfer systems between technical colleges and universities would be one way to facilitate those transitions. Increasing supply of interdisciplinary ICT related programmes could help to increase the participation of women. There are relatively high shares of German women in studies such as bio-informatics, media informatics and medicine informatics (empirica, 2019[201]).

Shorter programs may help reallocate furloughed employees and fresh graduates to occupations and sectors in higher demand. In Estonia, for example, supply was boosted by a programme allowing postgraduates to earn a bachelor degree in programming by attending a six-month software developer programme. In Germany, the post-secondary VET institutions could supply these kinds of programs. This approach equips people holding valuable prior experience and knowledge with digital knowhow. Such multidisciplinary skills may be valuable both to the ICT sector and traditional sectors, and may help build better links between the two (OECD, 2019[202]). Immigration from third countries can also increase the supply of talented workers.

A change in gender-specific perceptions about ICT occupations would help increase the supply of STEM graduates and ICT specialists, and decrease the gender pay gap. Women made up just 18% of ICT specialists in 2018, and the share of women among engineers is similar. Wages for engineers and ICT specialists are high for both men and women, and the gender pay gap for those who work as ICT specialists is below that in most occupations (Wrohlich and Zucco, 2017[203]). One reason for the lower gender pay gap is greater flexibility in working hours and work location (Goldin, 2014[204]). Even before the COVID-19 crisis, about 75% of ICT workers in Germany frequently or occasionally worked from home, the highest share among all occupations except teaching (Alipour, Falck and Schüller, 2020[205]).

Making female role models more visible, fighting gender stereotypes and providing girls with opportunities to interact with technology at the earliest ages could help change gender-specific perceptions about ICT (OECD, 2019[206]). At 15 years of age, only 0.8% of girls wish to become ICT professionals, compared with 6.6% of boys (OECD, 2019[206]). Society, notably parents and teachers (Carlana, 2018[207]), may convey stereotypes and social norms that influence choices about the future. Campaigns advocating for choices free from gender stereotypes, such as the Cliché Free Initiative since 2016, are therefore welcome. A higher likelihood of women dropping out of STEM (Vom, Isphording and Qendrai, 2019[208]) highlights the importance of enhancing persistence, alongside efforts to raise motivations to enter STEM fields. Women already in STEM may benefit from same-gender mentoring (Dennehy and Dasgupta, 2017[209]), learning communities (Russell, 2017[210]) and alternative teaching methods.

Encourage low-skilled individuals to take part in adult education

Although adults with low skills are most at risk of experiencing deteriorating labour market prospects, they are less than half as likely to participate in adult learning as those with higher skills. This may reflect lower returns on investment in training, in part due to poor foundational skills that impair the capacity to learn and to apply adult learning. Employers returns may be especially low as they risk losing employees to competitors, after they have invested in their skills (OECD, 2003[211]). Another reason for lower participation may be that adults with low skills find it more difficult to recognise their learning needs and hence are less likely to seek out training opportunities (Windisch, 2015[212]).

Nevertheless, the social returns of life-long learning for adults with low skills are likely to be higher because it may help reduce unemployment benefit claims and other transfer spending for low-income households, and boost inclusive growth (OECD, 2018[213]). In the course of the digital transformation, further learning among low-skilled adults could increase the social returns further, as it supports the adjustment process and thus prevents structural unemployment (IAB, 2019[214]). Additionally, the association between training and faster adoption of key ICT tools and activities is stronger for low- than for high-skilled workers (Andrews, Nicoletti and Timiliotis, 2018[215]).

Outreach through the workplace can be effective in engaging adults in learning (OECD, 2019[216]). Counselling and assistance for businesses, especially SMEs, can help identify suitable training, and, hence, increase motivation and alignment with future needs. The government recently took steps in this direction with the Qualifizierungschancengesetz (Skills Development Opportunity Act) (BMAS and BMBF, 2019[217]). Trade unions can provide a bridging function between employers and employees with low skills, who might be hesitant to communicate their training needs to employers (OECD, 2019[216]).

Life-long learning measures are essential to build and adapt skills over time and should be informed by systematic identification of skills and training needs. Career counselling is an essential element of Germany's approach to accompany the workforce throughout their entire educational and working life with professional advice and orientation. The Work of Tomorrow Act (Arbeit-von-Morgen-Gesetz), from 2020, aims to facilitate adult learning through increased financial support and decreased bureaucratic efforts for employers and employees. Such measures are most effective if they are linked to systematic identification of skills and training needs, such as in the Portuguese initiative on digital competences 2030 (Box 2.7).

Better validating uncertified skills including those acquired on the job, as suggested in the last survey (OECD, 2018[3]), can boost incentives to participate in adult education and help workers adjust to new technologies. Skill recognition can shorten the path to qualification, reducing costs for learners. Over two million Germans aged between 20 and 34 do not have any certified vocational qualifications (BMAS and BMBF, 2019[217]); and migration flows create a pool of workers with unrecognised skills. Migrants with a foreign qualification in Germany are at least three times more likely to be overqualified for their job compared with native peers, even when they have similar literacy skills. In most OECD countries, the gap between migrants and natives is lower. Further steps to reduce duration of apprenticeship for those who have relevant experience may help decrease the number of workers with unrecognised skills. This will only be successful if all stakeholders, including employers, benefit from recognising workers' skills. A different apprentice wage scale over the shortened duration of the apprenticeship may be a way to ensure support of employers (Kis and Windisch, 2018[218]).

Box 2.7. The Portuguese National Initiative on Digital Competences 2030

The Portuguese National Initiative on Digital Competences 2030 (INCoDe.2030) aims to broaden digital literacy, promote employability and professional training in digital technologies and raise participation in R&D networks. INCoDe.2030 takes a broad view of digital competences, including skills to effectively use ICTs and manipulate data as well as communication and digital content production skills.

INCoDe.2030 includes initiatives to identify needed digital competences as well as measures to facilitate training and labour market inclusion. It offers citizens to benchmark their level of skills and identify knowledge gaps on a dynamic framework based on the European initiative DigComp 2.0. Specific programmes are designed to target vulnerable groups, including via a freely accessible online training platform. The programme also includes life-long learning and active labour market programmes to help displaced workers integrate in a dynamic labour market.

Source: (OECD, 2020[7]).

The government recognised the challenges facing skills policy with the National Skills Strategy in 2019. The strategy aims to reorganise all of the federal and state training programmes, align them with market needs and establish a new training culture. Additionally, it aims to improve training statistics and improve counselling services, existing support systems, quality assurance and the visibility of skills acquired through informal learning. Furthermore, it extends support for workers who are affected by structural changes regardless of their qualifications, and develops educational institutions into centres of excellence for continuing vocational education and training.

Reap the potential of online education as a universal learning tool

ICT tools can improve accessibility, flexibility and quality of adult learning. Open education and massive open online courses enable people of all ages to study anytime and anywhere. These courses are usually free, or very cheap, and often provided by universities, including many top ones. However, use of these tools is low. In 2012, only 5% of Germans participated in open or long-distance education, compared with 9% on average among OECD countries. The share in Korea, a country with a considerable experience with open education, is close to 20% (OECD, 2019[162]). Widely available high-speed Internet, co-operation between key government agencies in supporting ICTs in education, and a big education market contribute to enable Koreans to participate in digital learning. During the COVID-19 crisis, Korea has provided a virtual training platform that enables learning providers to upload their course content, supported by subsidies and quality assurance mechanisms (OECD, 2020[219]). The UK introduced a Skills Toolkit, an online platform that brings together free online courses in a variety of areas, including digital skills, digital marketing and coding (HM Government, 2020[220]).

For those who complete online courses, certification and/or recognition remains a challenge (OECD, 2019[1]). To get certification right, it is crucial for the government to co-operate with education and training providers, employers, job-search agencies and social partners to reap the full potential of open education as a universal learning tool. Stringent skill certification tests would decrease employer uncertainty and improve the benefits to new workers (Kässi and Lehdonvirta, 2019[221]).

MAIN FINDINGS	RECOMMENDATIONS (key recommendations in bold)
Developing a national digital transformation strategy	
Germany has multiple digital related strategies and distributes responsibilities for digital policies across line-ministries, with only ad hoc or light co-ordination of digital matters.	Develop a comprehensive national digital transformation strategy that integrates and/or co-ordinates other digital related strategies and policies, led by a ministry or body with a strong mandate for co-ordination.
Addressing connectivity bottlenecks and increasing quality of service	
A very low share of fibre results in low broadband speeds. Public funds for broadband deployment have been disbursed slowly.	**Shorten administrative approval times for communication network deployment, including obtaining rights of way, and improve co-ordination between public authorities.**
There is a high concentration in the fixed broadband market with two companies owning more than 70% of fixed broadband connections.	Facilitate passive infrastructure sharing and increase the transparency of information on existing passive infrastructure such as ducts. Carefully monitor competitive dynamics in the German fixed broadband market and foster competition and investment in the connectivity of multi-dwelling buildings.
Germany has fewer mobile broadband subscriptions than the OECD average and falls behind in data usage and connection speeds.	Implement the Mobilfunkstrategie according to schedule. Increase the availability of public assets for the deployment of mobile infrastructure. Streamline obtaining rights of ways and administrative procedures.
The entrance of a fourth player to the mobile market has the potential to promote competition and innovation.	**Support competition through facilitating that the market entrant can obtain national roaming agreements. Consider all market participants when existing spectrum licenses expire**. Ease and promote infrastructure sharing while ensuring an adequate level of infrastructure competition.
Strengthening foundations for firms' digital transformation	
Firms lag behind in adopting key ICT tools and activities for the data economy, notably SMEs and firms in small and remote municipalities. Firms could also use more data from their own sensors and devices for big data analysis.	Ensure that the forthcoming *Data Strategy* provides an effective data governance framework to enhance access to and sharing of data, including in the public sector, and helps firms to boost their collection and effective use of (firm-related) data.
Digital transformation creates opportunities and challenges for the automotive industry, in particular in autonomous driving and shared urban mobility.	Strengthen standard-setting related to autonomous driving technologies through a strategic and co-ordinated approach across standardisation bodies, consortia and industry domains.
Overcoming key barriers to firms' successful digital transformation	
Firms' investments in knowledge-based capital that is crucial for data-driven innovation, including software, databases, and organisational capital, are low and have hardly increased over the past decade.	**Improve conditions for firms to invest in knowledge-based capital, including by reviewing the cap for R&D tax incentives to make them more applicable to mid-range companies.**
SMEs are behind large firms on digital transformation and would benefit from greater adoption of advanced ICT tools and activities and from more investment in complementary intangible assets.	Accelerate SMEs' digital transformation by swiftly implementing existing SME support, increasing it if needed, and ensuring that investment incentives for physical capital do not discourage expenditures on digital services.
Digital security concerns retard the adoption of key ICT tools and activities; too few firms carry out continuous risk assessment; the cybersecurity strategy lacks a strong business perspective based on digital security risk management.	Promote digital security risk management by firms through a revised national cybersecurity strategy; raise awareness and empower all stakeholders to understand and manage digital security risk, and incentivise continuous risk assessments in firms.
Supporting business dynamism during the recovery to boost technology diffusion	
Venture capital investments as a share of GDP are much lower than in best performing countries, in particular for seed and later stage funding.	Improve the effectiveness of start-up and growth financing instruments, including by avoiding complexity, scaling up later stage funding and improving conditions for institutional investors to invest in venture capital.
Certain bureaucratic burdens for firms remain high, notably one-time compliance costs and burdens to start a business; scope also remains to improve stakeholder engagement in regulatory policymaking.	Consider one-time compliance costs when revising the *Bürokratieentlastungsgesetz* (law to reduce bureaucracy); use ICT tools to simplify the administrative process of business creation and to improve stakeholder engagement in regulatory policymaking.
The share of individuals and firms interacting with public authorities online is growing only slowly and Germany lags behind on open government data; the now mandatory e-procurement could be further improved.	**Accelerate progress towards digital government and a data-driven public sector, focusing on high-impact services, collaboration across levels of government and open government data, and systematically collect and use data from e-procurement processes.**
Improving skills to thrive in the digital age	
Strong numeracy and literacy skills help people adjust to new technology. Their impact on earnings and employment is higher in Germany than in most OECD countries, reflecting high demand for such skills.	Prioritise early education by increasing spending on primary education, and improve foundational skills of VET graduates, for example by strengthening general education within the VET track or postponing between-school tracking.
The use of ICT in schools lags behind most OECD countries and computational thinking and programming skills have much scope to improve, in particular among women.	**Increase ICT training for teachers to ensure effective use of ICTs**. **Introduce computational thinking earlier (particularly benefitting girls) while avoiding gender stereotypes in education and career guidance.**
Before the COVID-19 pandemic, demand for ICT specialists and programming skills was picking up: wages grew rapidly and enterprises were reporting more difficulties in filling vacancies.	Raise accessibility of STEM and ICT fields of study, for women in particular, by easing the transition between post-secondary educational systems, establishing learning communities and encouraging same-gender mentoring.
Adults with low skills are less likely to participate in adult learning, although their jobs are at higher risk of change due to digital transformation.	Facilitate participation of low-skilled individuals in adult education by taking further steps to validate uncertified skills, including those acquired-on-the job, and through workplace outreach.

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Annex A.

Annex Table 1. Correlations in the adoption of ICT tools and activities

Estimated percentage point change in the likelihood of adopting ICT tools and activities for German firms by speed tiers of broadband subscription, ICT skills and training, and other characteristics

	ERP	CRM	e-purchase	e-sales	Social media	Cloud computing	BDA
Internet speed tiers							
<10 Mbps (baseline speed)							
Broadband 10-30 Mbps	0.925	-0.008	1.814**	1.322*	2.966***	1.520	-0.236
Broadband 30-100 Mbps	1.604*	2.057**	2.568***	2.867***	6.613***	6.962***	-1.201
Broadband 100+ Mbps	3.317***	3.073***	1.122	4.321***	9.747***	6.850***	3.074**
ICT skills and training							
ICT specialists employed	10.668***	7.185***	5.423***	6.284***	9.403***	6.141***	3.561***
IT training to employees	10.012***	7.835***	8.015***	4.581***	3.027***	5.631***	3.221***
Other characteristics							
Size	7.999***	2.903***	2.902***	5.064***	4.780***	2.335***	2.443***
Multi-plant	-0.277	0.251	0.951	-0.031	2.079**	5.097***	-0.388
State-owned	0.355	-4.991**	-0.964	-4.738***	-6.961***	-5.124**	-2.283
Listed	0.001	1.771	1.462	3.527**	8.980***	3.611	6.085*
Controls							
Regional controls	x	x	x	x	x	x	x
Municipality FE	x	x	x	x	x	x	
County FE							x
Industry FE (4-digit)	x	x	x	x	x	x	x
Year FE	x	x	x	x	x	x	
Observations/Firms	24685/22316	24593/22241	24857/22467	30126/26511	26330/22724	9488/8546	5821/5821
Survey years	2012-2015, 2017	2012, 2014, 2015, 2017	2012-2015, 2017	2012-2017	2013-2017	2014, 2016	2016
Adjusted R-squared	0.34	0.15	0.06	0.23	0.22	0.10	0.07

Note: Firms with 10 or more employees, excluding financial sector. ERP stands for enterprise resource planning, CRM for customer relationship management, BDA for big data analysis. This table reports OLS regression results based on representative repeated cross-section survey data of German firms for the period 2012-2017. Dependent variables equal 100 if a given ICT tool or activity is adopted and 0 otherwise. For Internet speed tiers, coefficients reflect the percentage point change in the likelihood of a firm adopting a given ICT tool or activity associated with broadband speed tiers of 10-30 Mbps, 30-100 Mbps and 100+ Mbps, respectively compared to a baseline speed of <10 Mbps. For ICT skills and training, coefficients reflect the percentage point change in the likelihood of a firm adopting a given ICT tool or activity associated with employing ICT specialists or providing IT training to employees. Regional controls include the following municipality-level variables: Log of number of inhabitants, share of working age population (ages 15-64), share of people aged 65+, employment rate, log of area in sqkm, share of university graduates (measured at the county level). For Big data (surveyed only in 2016) additional controls account for the remoteness of the municipality (travel time by car to nearest international airport and to higher-order centre) and the years since the introduction of basic broadband (> 256 Kbps) in the municipality. Additional firm controls include: Size (log of number of employees) and indicators identifying whether a firm is state-owned, listed or multi-plant, respectively. Standard errors are clustered at the municipality level (not reported); ***, ** and * denote significance at the 1%, 5% and 10% level, respectively.
Source: (Alipour, forthcoming[14]).

Endnotes

[1] Digitisation is the conversion of analogue data and processes into a machine-readable format.

[2] Digitalisation is the use of ICT tools and data as well as interconnection that results in new or changes to existing activities.

[3] Under article L. 34-8-3 of the Post and Electronic Communications Code ("Code des postes et des communications électroniques", CPCE), introduced by the Law of the Modernisation of the Economy ("Loi de modernisation de l'économie", LME) in 2008.

OECD Economic Surveys

GERMANY

The German economy entered a deep recession in 2020 due to the coronavirus pandemic. A strong government response has reinforced health system capacity while protecting jobs and firms. The response to the crisis has included increases in investment to meet structural challenges from the energy transition and digital transformation. Further public investment is needed to resolve the infrastructure backlog, along with steps to remove delivery bottlenecks. Emissions pricing in transport and heating will help reduce greenhouse gas emissions, though further steps will be needed to meet targets. The German government has made good progress in addressing some key barriers to digital transformation, but can do more to unleash its full benefits. Alleviating connectivity bottlenecks, incentivising investment in knowledge-based capital and supporting business dynamism during the recovery by reducing administrative burden, facilitating access to financing, and accelerating progress towards digital government can boost technology diffusion and productivity. To empower everyone to thrive in digital environments, computational thinking should be introduced earlier and training for teachers increased to ensure effective use of digital technologies in schools.

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