

Germany as a business location: selected aspects of current dependencies and medium-term challenges

The German economy is under considerable pressure to adapt. Demographic change is weighing on prospects for growth and intensifying competition for skilled workers. In foreign trade, there are significant dependencies on China. A sudden break with China would likely bring about far-reaching disruptions to supply chains and production in the short term. In order to reduce dependence on imported fossil fuels and to supply low-emission energy at reasonable costs, it will be vital to expand the supply of renewable energy and to lower energy demand by increasing efficiency. Digitalisation may provide opportunities that could significantly boost growth. What is crucial here is not only the production of digital goods, but also the diffusion of these products in the form of intermediate inputs to other areas.

Overall, the German economy still appears to be in a good position. Thus far, demographic change has been counteracted by employing immigrants, amongst other measures. German enterprises continue to make great use of the opportunities offered by international markets. All in all, industry has been able to mitigate the direct energy price shock fairly well due to its good profitability and financing as well as temporary government assistance measures. Despite coming under numerous strains, the price and cost competitiveness of the economy remains quite favourable on average. Differences between sectors are likely to be considerable, though.

Nevertheless, there is broad-based pressure to take action. The problems that must be overcome are complex and, in some cases, intertwined. For example, the supply of energy must be ensured and international dependencies need to be reduced. At the same time, in order to achieve climate targets, it is likely that substantial imports of storable energy sources and certain raw materials will still be needed. For the foreseeable future, transformation processes such as digitalisation and decarbonisation will require a large supply of skilled workers, which is diminishing due to demographic change. Amidst all of this, the scale and speed of the necessary structural change are not easy to gauge.

Central, state and local levels of government can contribute to the attractiveness of Germany as a business location by creating suitable framework conditions. These include the ability to plan ahead in the area of energy supply, such as through consistent and predictable climate policy. Transformative processes such as decarbonisation and digitalisation will be all the more manageable if the education system provides students with the right key skills and, above all, the ability to adapt to structural change. Greater diversification of suppliers in international trade – for example through regional free trade agreements – would reduce the risk of excessive dependencies on China. Improving the integration of immigrants into the labour market as well as increasing the efficiency of government administration and approval processes would likewise make Germany more attractive as a business location. Policymakers are currently taking some steps in this direction. However, these must also be implemented and pursued.

Deindustrialisation in Germany?

*Germany's
"business
model" in
danger?*

For some time now, doubts have been raised concerning Germany's "business model" and its prospects for the future. The discussion has intensified in recent months in light of Russia's war of aggression against Ukraine and other geopolitical turmoil. Germany's business model is said to revolve around a relatively strong industry-based economy supported by cheap Russian gas. By all accounts, the success of foreign trade is linked to pronounced supply chain dependencies on "problematic" states and the persistently high need for skilled workers is met through immigration. This orientation of the German economy is thought to be unsustainable. As a consequence of Russia's war against Ukraine, energy costs rose massively. It is argued that it will become more difficult to cover Germany's labour shortage through immigration, partly because demographic change is impacting some neighbouring countries to even greater degrees. The stability of cross-border supply chains appears to be under threat due to the prevailing geopolitical tensions. It is for these reasons that Germany's business model is reportedly in danger. Without further – and, in some cases, substantial – economic policy intervention, Germany would be at risk of deindustrialisation.

*Major chal-
lenges posed by
energy crisis,
international
dependencies
and demo-
graphic change*

The energy supply, international dependencies and demographic change are undoubtedly major challenges facing the German economy. An assessment of these challenges should begin by taking stock of the German economy's critical dependencies. On this basis, it will be easier to evaluate how much action is needed. In this context, it must be kept in mind that Germany's business model is not a result of government planning and design. The structures of economies arise from complex market-based processes within a government framework. Here, enterprises are constantly adapting to a changing market environment, and appropriate government framework conditions can make this easier.

The significance of industry to the German economy

Industry has a special status in Germany.¹ Last year, the manufacturing sector accounted for 18% of gross domestic product (GDP) and 16% of employment; these figures are significantly higher than in most other advanced economies. It is also noteworthy that German industry's share of value added remained stable from the 1990s up until the COVID-19 pandemic. Like in other advanced economies, it saw a marked decline during the pandemic. The shift in value added and employment towards the services sector has been slower than in other countries and can be explained, in part, by the comparatively high productivity gains in German industry.² Nevertheless, in Germany, as in other advanced economies, the largest share of value added by far is attributable to the services sector, standing at around 60%. A certain convergence in the size of the German industrial sector to the proportions seen in other advanced economies would not be cause for concern, per se, especially if it were to occur gradually.

*High significance
of industry in
Germany*

In aggregate terms, productivity growth in Germany since the 1990s has not been systematically higher or lower than in economies in which the shift towards the services sector progressed more rapidly. The digital transformation has been one contributing factor in this. Sectors of the economy that produce predominantly digital goods have recorded above-average growth in productivity over recent decades and have thus been key drivers of aggregate prod-

*Efficiency gains
through digital
transformation,
but with dimin-
ishing effect
over time*

¹ In this article, the term "industry" refers to the manufacturing sector in Germany. The remaining areas of the production sector are not the main focus here, as they include, for example, energy companies, some segments that only account for small shares of value added in GDP (such as mining) and segments that are oriented towards the domestic economy (such as construction).

² For more information, see Deutsche Bundesbank (2021a).

activity growth.³ Bundesbank analyses show that, alongside investment in digital goods, digital intermediate inputs that feed into a wide variety of goods via production linkages were also significant in this context.⁴ However, much like in other advanced economies, the efficiency gains resulting from digitalisation have tended to diminish over time.⁵

Sustainable boost to digitalisation requires improved institutional conditions

Evidence from a survey conducted by the Bundesbank in 2022 suggests that digitalisation has seen a boost in some parts of the corporate sector since the pandemic.⁶ However, it remains to be seen how persistent this boost and the associated changes in enterprises' work processes will be. To enhance productivity growth in the future, it will be crucial to better exploit the potential offered by the digital transformation. In this context, changes in institutional conditions to create an efficient digital infrastructure could bring about significant incentive effects.

Challenges cannot be denied

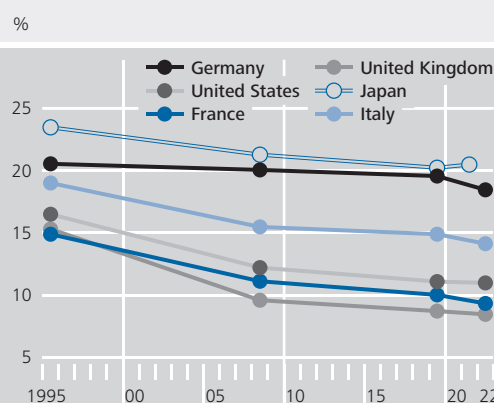
The present debate surrounding the state of German industry should, however, be viewed against the backdrop of the far-reaching, concurrent challenges posed by decarbonisation, the demographic transition and changes in the international environment. Moreover, if digitalisation is to succeed, significant further adjustments need to be made in the corporate sector. The challenges to industry arising from potentially disruptive changes in these four areas cannot be denied.

International linkages of the German economy

World trade lost momentum after global financial and economic crisis

While some of these developments are only recent, most have longer histories. The German economy has been confronted with a changing global economic environment for some time now. Following the global financial and economic crisis, world trade lost significant momentum after having grown strongly for 30 years. The driving force behind this weakness in world trade was not just the slowdown in

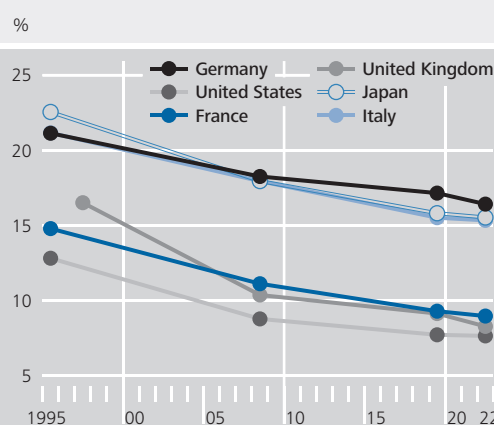
Gross value added in the manufacturing sector in relation to GDP*



Sources: World Bank and Bureau of Economic Analysis. * Data between 1995, 2008, 2019 and 2021/2022 are interpolated linearly.

Deutsche Bundesbank

Employment in the manufacturing sector in relation to total employment*



Source: National data. * Data between 1995/1997, 2008, 2019 and 2022 are interpolated linearly.

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global economic growth. Besides this, the share of world trade in global GDP did not increase further. This is, in part, a reflection of the rising significance of emerging market economies; for these countries, GDP growth was less trade-intensive.⁷ In addition, the tailwinds

³ The digital sectors typically comprise segments of the manufacturing sector (manufacture of computer, electronic and optical products; manufacture of electrical equipment) as well as parts of the services sector (information and communication). For more information, see Deutsche Bundesbank (2023a).

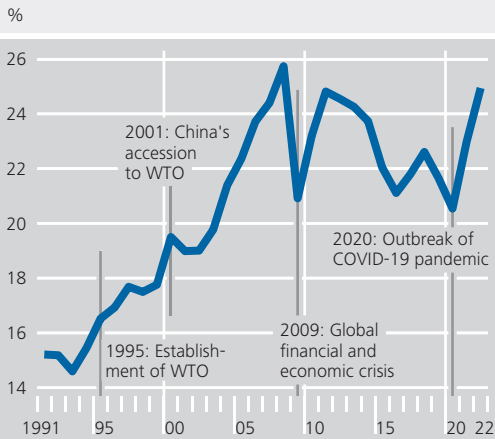
⁴ A detailed description of the model used can be found in Deutsche Bundesbank (2023a).

⁵ See Deutsche Bundesbank (2023a).

⁶ See Deutsche Bundesbank (2022a).

⁷ See Deutsche Bundesbank (2016).

Global trade in relation to global economic output



Sources: IMF, World Bank and Bundesbank calculations.
 Deutsche Bundesbank

Number of new trade policy measures* worldwide



Source: Global Trade Alert. * Affecting trade in goods or services. Data excluding late reports for the respective reporting year (the cut-off date is 31 December of each year).
 Deutsche Bundesbank

for trade provided by falling costs for information, communication and transport are likely to have diminished.⁸ Furthermore, protectionist movements have also slowed down international trade. These were especially apparent in the trade dispute between the United States and China. However, tariffs and non-tariff barriers to trade have been on the rise in other parts of the world, too. According to the Global Trade Alert database, the number of new measures worldwide restricting trade has reached new highs in recent years.⁹

In Germany, too, foreign trade linkages developed more slowly following their recovery

from the global financial and economic crisis of 2008-09.¹⁰ In fact, like in other advanced economies, integration in global value chains declined slightly. Nevertheless, Germany's degree of openness continued to exceed those of other major advanced economies in North America, Europe, and Asia by far, with the gap even widening further in some cases. This means that German enterprises have been making greater use of the opportunities arising on international markets in the recent past. This applies to both sales prospects in foreign markets as well as opportunities for the purchase of foreign-manufactured goods or for offshore production.

Closely intertwined cross-border linkages also harbour risks and dependencies, however. This was clearly demonstrated by the supply chain disruptions resulting from the COVID-19 pandemic and Russia's war of aggression against Ukraine. The geoeconomic tensions between China and the West have also highlighted the risks arising from those dependencies. A significant part of the strong growth in German exports and an even larger part of the growth in imports over the past two decades have been attributable to China.

China is an important sales market for individual categories of goods, especially for motor vehicles and machinery. It also plays an important, but not exceptional, role for the goods exported by the German economy as whole.¹¹ The same picture emerges even if the share of German value added consumed in China is approximated using input-output tables. Less

Foreign trade ratio in Germany significantly higher than in other advanced economies

China is one of many customers of German industry ...

⁸ See Antràs (2020).

⁹ Global Trade Alert (<https://www.globaltradealert.org>) is an initiative that was launched by the Centre for Economic Policy Research (CEPR). See also Deutsche Bundesbank (2020).

¹⁰ The slowdown in the pace of globalisation played a role in this. The sharp rise in the foreign trade ratio in 2022 was mainly attributable to the considerable increases in the prices of import and export goods.

¹¹ In 2022, around 7% of Germany's total goods exports were destined for China. China was thus the fourth most important destination country for German exports.

than 3% of German value added depends on final demand in China.¹²

... but is more important as a supplier in some cases ...

From the perspective of goods imports, however, China has much greater significance. The goods for which China accounts for a large proportion of deliveries in terms of value include certain intermediate inputs (such as batteries and electronic components) as well as final products from the capital goods sector (computer and telecommunications equipment). In addition, sizeable shares of various final products from the consumer goods sector (e.g. consumer electronics and electrical household appliances) come from China. Chinese intermediate inputs constitute a significant share of imported intermediate inputs, particularly in the production of computer, electronic and optical products as well as electrical equipment. Other segments of the manufacturing sector, such as construction and machinery, also use sizeable shares of intermediate inputs from China.

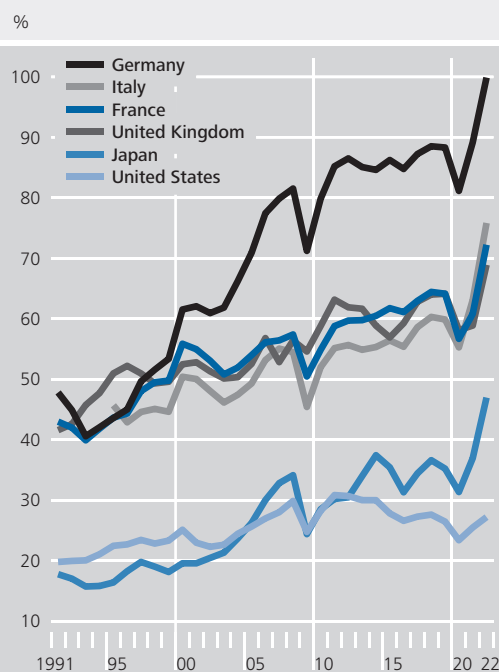
... especially for some intermediate inputs that would be difficult to replace

Whilst other imports of raw materials and intermediate inputs from China are low in terms of value, they are often difficult to replace with imports from other countries.¹³ According to a survey conducted by the Bundesbank, many German firms make use of critical intermediate inputs from China in their production processes; the options for replacing these goods are often limited (for more information on dependence on China, see the box on pp. 21f.). This applies, in particular, to the manufacturing sector. German firms have already taken measures to reduce their strong focus on China with regard to their sourcing of critical intermediate inputs. In many cases, however – especially for intermediate inputs considered “very difficult” to replace – no efforts have yet been made to reduce dependencies on China. A sudden break

¹² These calculations are based on the OECD Inter-Country Input-Output Tables (version 2022) for 2020.

¹³ According to the International Energy Agency (IEA), China produces 60% of the world’s rare earth elements. In addition, the refining of rare earth elements (90%), lithium, and cobalt (between 60% and 70% each) was also concentrated in China. See International Energy Agency (2021).

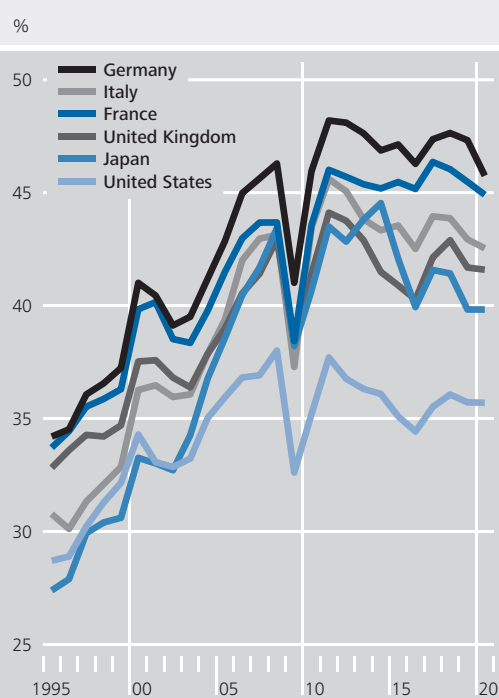
Foreign trade ratios* of selected advanced economies



Sources: Bureau of Economic Analysis, Cabinet Office of Japan, Eurostat, Office for National Statistics, Federal Statistical Office and Bundesbank calculations. * Sum of nominal exports and imports (goods and services) in relation to gross domestic product.

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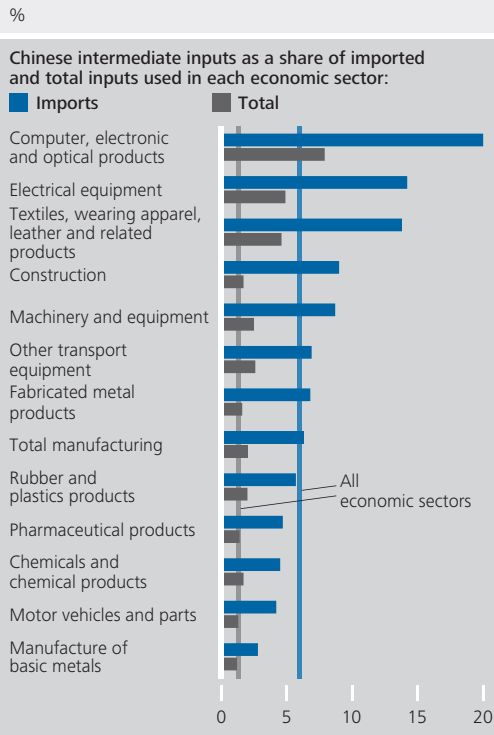
Participation in global value added chains of selected advanced economies*



Sources: OECD (2023) TIVA database and Bundesbank calculations. * Sum of foreign value added content in a country’s gross exports and its value added content in foreign gross exports in relation to said country’s gross exports.

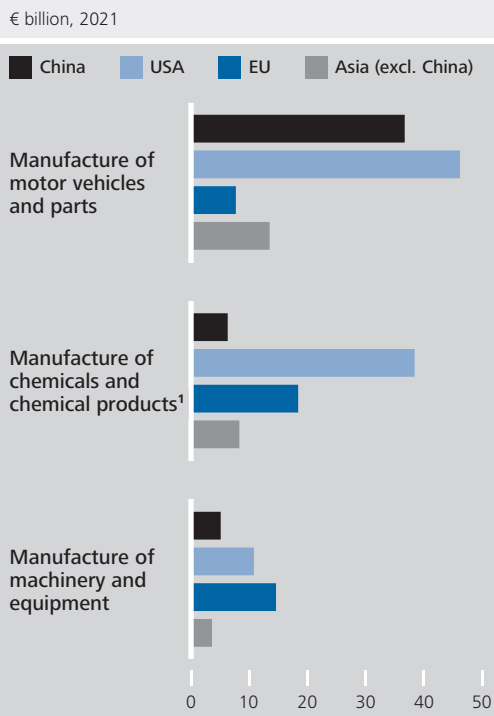
Deutsche Bundesbank

Importance of intermediate inputs from China for German output



Sources: OECD (2021) ICIO database and Bundesbank calculations.
 Deutsche Bundesbank

German foreign direct investment in important regions by individual sector*



* Broken down by the sector of the German parent companies.
¹ For China and Asia (excluding China), data were available only up to the end of 2019.
 Deutsche Bundesbank

with China would likely bring about far-reaching disruptions to supply chains and production in Germany, at least in the short term.¹⁴

According to the stock figures from the foreign direct investment statistics collected by the Bundesbank, the foreign direct investment stock of German enterprises is distributed widely around the world. As a location for German foreign direct investment, China was in third place behind the United States and Luxembourg, which is an important holding location. All the same, China's share of German foreign direct investment only amounted to just under 6% in 2021. By comparison, turnover and income from foreign direct investment in China are high. According to the most recent figures, Chinese affiliates of German corporate groups generated turnover of €382 billion and profits of €23 billion. This means that 22% of Germany's global turnover and 15% of Germany's global investment income were generated from foreign direct investment in China.¹⁵

High turnover and investment income from foreign direct investment in China

In the past, German corporate groups benefited greatly from internationalisation via foreign direct investment and increased their international competitiveness in this way.¹⁶ Although the level of foreign direct investment in China is relatively low at present, China's share in Germany's total foreign direct investment has doubled since 2010. This is a reflection of China's robust and, in global terms, comparatively strong growth. China plays a prominent role in the automotive sector, in particular, accounting for 29% of German foreign direct investment. However, China is also a major location for investment in the manufacture of machinery and equipment (13%) as well as the

Increasing importance of China for foreign direct investment

¹⁴ This would particularly affect the production of goods in which critical intermediate inputs play a role. Over the longer term, however, it is likely that part of the intermediate inputs from China could be replaced with intermediate inputs produced in Germany or other countries, which would mitigate losses.

¹⁵ For 2021, the data is on turnover. For 2022, the data is on investment income.

¹⁶ See Deutsche Bundesbank (2021b).

The significance of China as a supplier of critical intermediate inputs to German firms

The past few years have highlighted the risks to economic development arising from significant unilateral dependence on intermediate inputs from abroad. The COVID-19 pandemic and Russia's war of aggression against Ukraine led to disruptions in supply chains. More recently, the geopolitical and economic tensions between China and the West have made China the focus of economic policy discussion. This is because there was no other country from which German firms imported more in 2022, and this included numerous intermediate inputs. The dependence on China is not simply apparent from aggregate trade data, as this perspective underestimates existing dependencies on the import side. Even intermediate inputs with low shares of value in the total intermediate inputs used can be essential for production processes and may be difficult to source from other countries. These include, for example, commodities such as rare earths as well as lithium and cobalt, for which production and further processing is globally dominated by China.¹

The assessment of the Bundesbank Online Panel – Firms (BOP-F) survey for the months of April to June 2023 paints a more detailed picture. It also provides information on the scope available to German firms for reducing their dependence on intermediate inputs sourced from China.

In the period covered by the survey, 29% of firms in Germany sourced critical intermediate inputs from China. "Critical intermediate inputs" are goods or services without which a relevant portion of a firm's production processes or business activities would cease or only be possible with considerable delays or at greatly reduced standards of

quality.² It is noteworthy that the majority of these firms source critical intermediate inputs via domestic or foreign intermediaries. Many of the firms that rely on Chinese intermediate inputs therefore do not maintain direct import relations with China, but are nevertheless highly dependent on Chinese intermediate inputs.

According to the BOP-F survey, almost one-half of firms in the manufacturing sector rely on Chinese intermediate products for their production processes.³ Furthermore, these firms largely assess the possibilities for replacing critical intermediate inputs from China with products from other countries to be limited. Among the industrial firms that are dependent on China, 80% reported that it would be "difficult" or "very difficult" to source replacement products from other countries. According to the survey, firms with higher turnover are especially dependent on intermediate inputs from China and have little scope for sourcing substitutes. Overall, firms that source critical intermediate inputs from China and consider the possibilities of sourcing substitutes to be "very difficult" generated just under one-quarter of the turnover of the German manufacturing sector in 2022.⁴ In the short to medium

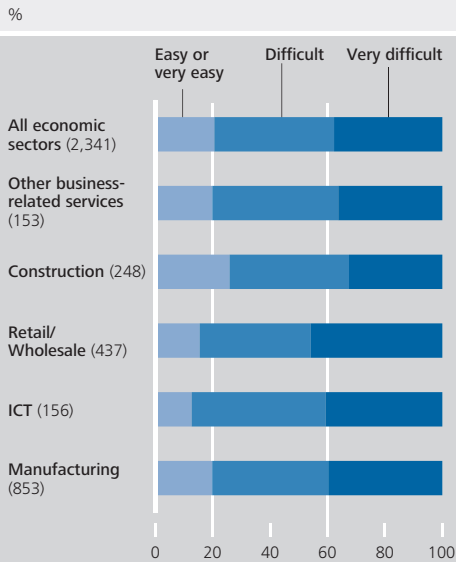
¹ See International Energy Agency (2023).

² See Deutsche Bundesbank (2023d).

³ This is consistent with a survey conducted by the ifo Institute, which found that 46% of firms in the manufacturing sector are dependent on critical intermediate inputs from China. See Baur and Flach (2022). According to the BOP-F survey, other sectors also source critical intermediate inputs from China. This applies, in particular, to wholesale and retail trade, as well as to construction and the information and communication services sector.

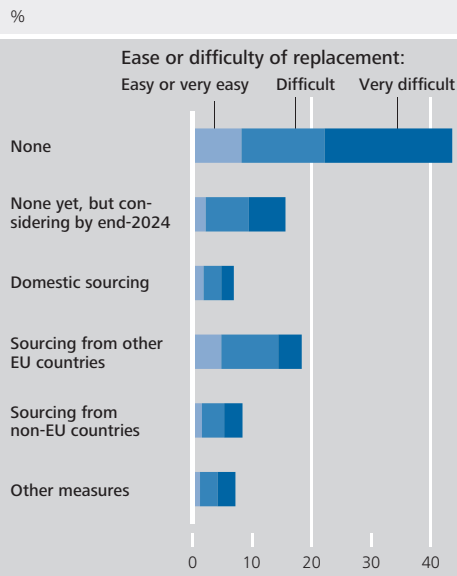
⁴ If industrial firms that consider the possibility of replacing intermediate inputs from China to be "difficult" were also included here, the share of turnover would increase to 57%.

Ease or difficulty of replacing critical intermediate inputs from China*



Source: Bundesbank calculations based on Bundesbank Online Panel - Firms (BOP-F) survey conducted Q2 2023. * Weighted results based on the number of firms in each economic sector (shown in parentheses). BOP-F question: "Imagine a scenario in which intermediate inputs from China were suddenly no longer available. In such a scenario, how easy or difficult would it be for your enterprise to replace the missing products with intermediate inputs from other countries?"
 Deutsche Bundesbank

Measures to reduce critical sourcing exposure from China in the manufacturing sector*



Source: Bundesbank calculations based on Bundesbank Online Panel Firms (BOP-F) survey conducted in Q2 2023. * Weighted results based on 853 firms from the manufacturing sector. BOP-F question: "Has your enterprise undertaken or is your enterprise currently undertaking measures to reduce purchases of Chinese intermediate inputs?"
 Deutsche Bundesbank

term, the economic damage caused by an abrupt break in trade relations with China could thus be considerable.

Among the industrial firms that imported critical intermediate inputs from China in 2022 or 2023, just over two-fifths have already taken measures to reduce their dependence. In this context, these firms are mainly turning to imports of intermediate inputs from the European Union (18%), but some are also sourcing inputs from non-EU countries (8%) or domestically (7%). A further 16% of these firms are considering such measures for the near future.

However, more than two-fifths of firms that are dependent on China have taken no action so far. Within this group, the proportion of firms that consider substituting Chinese intermediate inputs to be "very difficult" is remarkably large. Accordingly, reducing dependence on China is still pending in

many cases, especially for intermediate products considered "very difficult" to replace. Although some firms have already taken steps towards reducing their dependence on China, it may take some time to develop new supply capacities in other regions of the world and to build up new supplier relationships.⁵

⁵ According to estimates from the International Energy Agency, in the past, projects aimed at developing new mining capacity for critical minerals took an average of 16 years from discovery to first production. See International Energy Agency (2021).

manufacture of chemicals and chemical products (8%). In this case, German enterprises primarily use their Chinese affiliates to ensure their supplies of critical intermediate inputs or to gain access to the Chinese sales market.

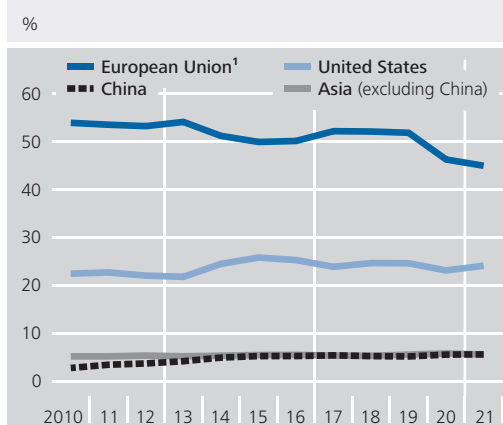
Diversification of trading partners essential for stability of supply chains

In light of the rising geopolitical tensions and the risks that these bring, it may make sense for enterprises and policymakers to rethink the established structure of supply chains and further expansion of foreign direct investment in China. Above all, this would mean adjusting the balance between efficiency and resilience to take account of the changed environment. Greater diversification of supply sources and adjusted inventory management could reduce risks.¹⁷ Focusing more on resilience can also be justified from an efficiency standpoint. This is especially true in cases where enterprises, up until now, have not taken sufficient consideration of the economic and political risks that arise from international value chains.¹⁸ Furthermore, current policy initiatives aim to ensure that enterprises orient their supply chains more strongly toward countries that are systemically closer to their own. Other measures, such as the US Inflation Reduction Act, even intend to relocate production sites to domestic locations, at least for strategically important goods. There are corresponding plans at the EU level, too, such as the European Chips Act, the European Critical Raw Materials Act, and the EU-funded Important Projects of Common European Interest, which include projects in the area of battery cell production.¹⁹

Free trade agreements useful instruments in this regard

Direct government intervention in international trade should fundamentally be restricted to establishing the general framework. This is because restrictions on international trade are usually accompanied by welfare losses, which, depending on the significance of the trading partner in question, can be considerable.²⁰ By contrast, regional free trade agreements make it easier for enterprises to diversify their trading partners.²¹ In this way, businesses can reduce their dependencies on the policies of individual

Share of German foreign direct investment in important regions



¹ Up to 2019 including the United Kingdom, from 2020 excluding the United Kingdom.
 Deutsche Bundesbank

states and thus lower the risk of far-reaching disruptions to their supply chains.

¹⁷ According to business surveys, some firms are examining ways to make their supply chains more resilient, for example by diversifying their sources of supply or by increasing their inventories. See Aksoy et al. (2022) and German Chamber of Commerce and Industry (2021).

¹⁸ This is the case, for example, if enterprises take account only of their own risk and not that of their suppliers, which are themselves reliant on other suppliers, or if short-term profits are considered more important than medium-term resilience due to performance-based remuneration. It is also possible that risks are being reassessed based on recent experiences with supply chain disruptions. A partial restructuring of value chains could therefore also be justified from an efficiency standpoint.

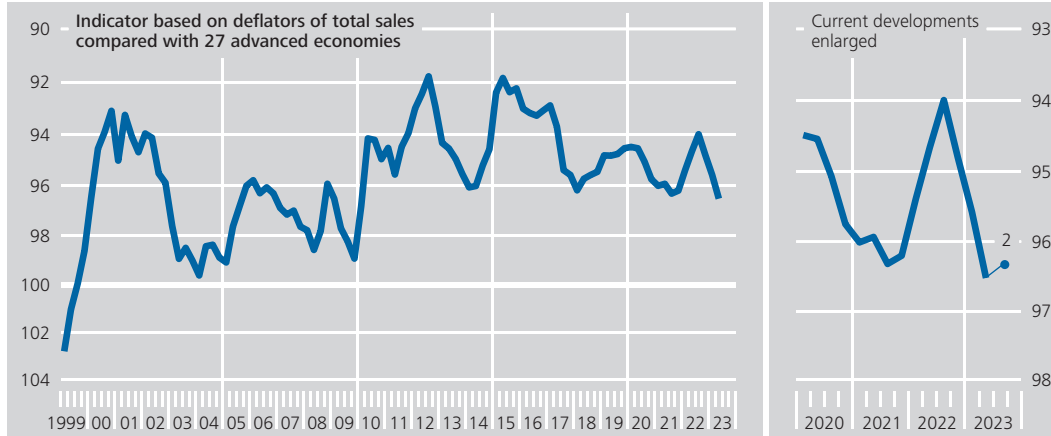
¹⁹ For more information on the European Chips Act, see European Commission (2022); for more information on the European Critical Raw Materials Act, see European Commission (2023a); and for more information on the Important Projects of Common European Interest in the production of battery cells, see European Commission (2019).

²⁰ See Dorn et al. (2022), Felbermayr et al. (2023) and Fuest et al. (2022).

²¹ The Comprehensive Economic and Trade Agreement (CETA) between the European Union and Canada has been applied provisionally since 2017, as ratification is still pending in some EU Member States. The EU-Mercosur Association Agreement is still awaiting formal legal review before the process of approval and ratification by the European Union and its Member States can begin. There are also, amongst others, ongoing negotiations between the European Union and the ASEAN countries as well as Australia. Negotiations between the European Union and India had previously been suspended, but were resumed last year. By contrast, the negotiations on the Transatlantic Trade and Investment Partnership (TTIP) between the European Union and the United States have been on hold since the beginning of 2017 and are not being pursued further.

Price competitiveness of the German economy

Average since 1975=100, quarterly, log scale¹



1 Inverted scale: a rise in the curve (fall in values) denotes an increase in price competitiveness. **2** Last data point: 12 September 2023.
 Deutsche Bundesbank

Energy cost burden for German enterprises

Increased energy cost burden for the German economy ...

The second major challenge relates to the higher cost of energy. The decrease in Russian gas supplies following Russia's invasion of Ukraine as well as the fundamentally high level of uncertainty surrounding the supply of energy have led to large rises in energy prices. In Germany, energy prices are likely to remain above pre-war levels in the years to come.²² However, rising energy costs are not only a consequence of the war. Measures to limit climate change may likewise be contributing to the higher prices of fossil fuels. This trend could become stronger, primarily via rising carbon prices, as efforts towards decarbonisation intensify.

... but quite manageable so far

Initially, German industry was able to effectively cushion the energy price shock due to its favourable profitability and financing.²³ According to Bundesbank simulation results based on extrapolated corporate data for various segments of the manufacturing sector, the direct corporate profitability losses were quite manageable.²⁴ The temporary government support measures introduced since the start of Russia's war of aggression against Ukraine were a contributing factor here. Nevertheless, there were more significant impairments in the particularly

energy-intensive segments of the manufacturing sector.²⁵

Despite the temporary sharp rise in energy prices compared with major partner countries, Germany's price and cost competitiveness, as measured by its long-term average, has remained quite favourable in recent years. For a time, this was attributable largely to the depreciation of the euro against the US dollar up until September 2022.²⁶ However, in sectors

Germany's price and cost competitiveness remains quite favourable

²² Current forward rates indicate that the prices for gas and electricity in Germany will be higher over the coming years than the spot prices from before the outbreak of the war.

²³ For more information on German enterprises' profitability and financing in 2021 – before the energy crisis – see Deutsche Bundesbank (2023b).

²⁴ See Deutsche Bundesbank (2023c).

²⁵ According to the Bundesbank Online Panel – Firms (BOP-F) survey conducted in the first quarter of 2023, the share of energy costs in total production costs in the manufacturing sector in 2022 was, on average, less than 10%; for the median manufacturing firm, this share was 5%. However, some enterprises in the manufacturing sector are very energy-intensive. For the enterprises among the top 5% of enterprises with the highest shares of energy costs, this share was 30% or more. In this regard, output in the energy-intensive industry segments dropped by around 17% between February 2022 and July 2023, according to the latest data available. By contrast, overall industrial output declined only by around 3% over the same period; it remained almost unchanged if the energy-intensive industry segments are factored out of the calculation.

²⁶ Alongside the nominal effective exchange rate, the indicator for price and cost competitiveness also factors in the deflators of total domestic sales as well as a weighted average of the relevant trading partners.

with greatly above-average shares of energy costs, the burdens imposed by higher energy prices are likely to be much more significant. These include the chemical industry, the paper industry, the production of basic metals, and the glass and ceramics industry. Higher energy prices in Germany than those abroad could cause price competitiveness to deteriorate in the future due to weaker productivity growth and, in some cases, higher sales prices.

Adjustment to high energy costs already foreseeable ...

According to a survey conducted by the Bundesbank, German enterprises – including those in industry – have already taken measures to adjust to higher energy prices (see the box on measures against higher energy prices on pp. 26 ff.). On the one hand, these include short-term adjustments such as saving energy or passing on costs to customers. On the other hand, they are planning to increase their energy efficiency or make greater use of renewable energy. Relocations of production abroad have so far been rather rare, even in the manufacturing sector and its energy-intensive segments. In addition, the turnover share of the enterprises planning to relocate abroad has so far been rather small. According to the survey, there are no signs of broad-based deindustrialisation in Germany.²⁷

... but impairment of growth potential inevitable

Nevertheless, the surge in energy prices is hampering the medium-term growth potential of the German economy, according to Bundesbank estimates.²⁸ Based on these estimates, persistently higher energy prices will lead to losses in potential output, as enterprises – in the case of imperfect substitutes – tend to curb their energy use and their production. The supply-side effects of higher energy prices are likely to be significantly stronger than those of the COVID-19 pandemic.²⁹

Energy supply during the transition to a low-emission economy

Climate change mitigation is one of the largest challenges facing society today. The transition to a less carbon-intensive economy may place considerable burdens on enterprises, including costs arising as a result of emissions pricing, increased prices for emissions-intensive intermediate inputs, outlays to avoid emissions and losses from asset repricing. The economic consequences for enterprises are likely to depend heavily on the nature and design of the interventions as well as the characteristics of the sector, such as emission intensity,³⁰ which is typically relatively high in energy-intensive industries and also in the energy production sector itself.

Germany's energy supply remains heavily dependent on fossil fuels, which are largely imported.³¹ Its liquefied natural gas terminals, both those that have been operating since 2022 and those that are scheduled for the next few years, only reduce supply risk for natural gas. Further steps are needed to reduce the country's dependence on imported fossil energy. These are in line with Germany's necessary efforts to achieve its declared climate targets (reduction of greenhouse gas emissions by at least 65% by 2030 compared with 1990

Far-reaching effects of climate policy on macro-economic developments

German energy supply highly dependent on imported fossil energy, which would be reduced by expanding climate-friendly energy production

²⁷ In the manufacturing sector, employment subject to social security contributions has recovered only minimally since the end of 2021 following the adjustments made during the pandemic. However, there has been no indication of a reduction in employment in industry since the sharp rises in energy prices up to mid-2023. Disaggregated sectoral data on employment subject to social security contributions in the energy-intensive industry segments are available only for the period up to the end of 2022. These data likewise do not show any signs of structural shifts in employment. The same applies to gross value added in the manufacturing sector, which even grew slightly compared to its level at the end of 2021.

²⁸ See Deutsche Bundesbank (2022b).

²⁹ For an assessment of the damage to potential output brought about by the COVID-19 pandemic, see Deutsche Bundesbank (2021c).

³⁰ See simulations using the environmental multi-sector DSGE model EMuSe in Deutsche Bundesbank (2022c).

³¹ This is still true even though only very small amounts of energy were imported directly from Russia in 2023. By contrast, imports of liquefied natural gas increased sharply.

Measures introduced or planned by German enterprises in response to rising energy costs

The sharp rises in energy prices since 2021 have had a severe impact on the German economy, especially last year. The fact that German enterprises were, on average, in favourable financial positions helped to mitigate the direct impact on their profitability and financing.¹ In future, however, how they fare will increasingly depend on how they adapt to the changed conditions regarding the supply and costs of energy. It will also hinge on the extent to which rising energy prices weaken growth potential, particularly in the manufacturing sector. An evaluation of the Bundesbank Online Panel – Firms (BOP-F) survey from the first quarter of 2023 provides detailed information on the measures that German enterprises either have recently implemented or are planning for the future. This information is not included in conventional statistics.

In 2022, an especially large number of enterprises responded to rising energy costs by saving energy, for example on heating, lighting or hot water consumption. In addition, when weighted by firm turnover, more than half of the enterprises raised the prices for their products and services in 2022. In doing so, many businesses passed on their higher energy costs – at least in part – to their customers.² Enterprises also took longer-term measures aimed at improving their energy efficiency or increasing their use of renewable energy. In turnover-weighted terms, one-third of enterprises invested in energy efficiency in 2022, compared with just one-fifth in 2021.³ In 2022, a further one-quarter of firms were also planning to make this type of investment in the near future. Together with the energy savings, this is consistent with data indicating that growth in the energy productivity

of the German economy almost tripled last year compared with the average of previous years.⁴

By contrast, production cuts and relocations of production abroad were relatively rare overall in 2022. Just over 6% of enterprises – measured in terms of their turnover – scaled back their production in 2022 owing to high energy costs. Less than 3% of turnover was attributable to the enterprises that moved parts of their production abroad. However, relocations of production could continue to some extent in the future. This can be explained by the fact that enterprises accounting for a total share of around 4% of turnover have been planning to move parts of their production abroad in the near future due to increased energy costs. This is also consistent with the fact that, given the rise in energy costs so far, 4% of firms – weighted by turnover – have been planning to step up their imports of energy-intensive products. Such projects could render parts of domestic production obsolete.

¹ See Deutsche Bundesbank (2023c).

² An economic survey conducted by the German Chamber of Industry and Commerce in the autumn of 2022 suggests that just under 60% of enterprises passed on high energy prices to their customers. See German Chamber of Industry and Commerce (2022).

³ Investments in energy efficiency are aimed at reducing energy consumption in existing buildings (e.g. energy insulation, replacement of windows, installation of a ventilation system) or in technical installations (e.g. purchase of smart meters, energy-efficient IT systems, lighting systems, production facilities, cooling systems).

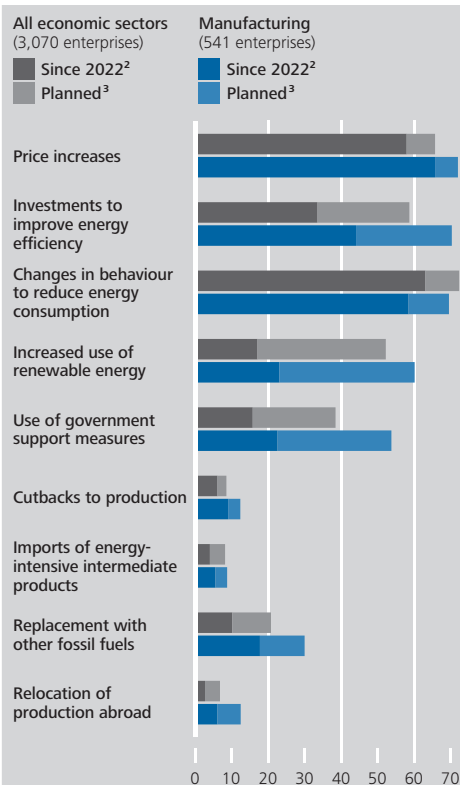
⁴ According to data from the Working Group on Energy Balances, primary energy productivity growth (real GDP per gigajoule of energy used), adjusted for temperature effects, almost tripled last year compared with the average for the years 2011 to 2021. This was the highest growth rate in one year since 1991. See Working Group on Energy Balances (2023).

The rise in energy prices has had the hardest impact on the manufacturing sector, as this area has the highest primary energy and gas consumption within the corporate sector.⁵ Accordingly, enterprises in industry have more frequently undertaken measures intended to mitigate the impact of the energy crisis compared with other sectors such as the construction or services sectors. Measured in terms of turnover, a significantly larger proportion of enterprises switched from natural gas to other fossil fuels in 2022 than in 2021. This is hardly surprising, however, as the gas consumption of some large firms could probably be replaced much more quickly with mineral oil or coal, for example, than with renewable energy. It is noteworthy that the enterprises in the manufacturing sector that either had invested or were planning to invest in energy efficiency in 2022 accounted for around two-thirds of turnover. According to the results of the BOP-F survey, the turnover share of the firms that had switched or were planning to switch to renewable energy was also considerable, at 60%. Based on these findings, the adjustment processes in industry to high energy costs and away from fossil fuels are already clearly discernible.⁶ Enterprises made comparatively seldom use of government support measures in 2022.⁷

To date, relocations of production abroad have also been rather rare in the hard-hit manufacturing sector. Where mention is made of such plans, it is primarily by larger enterprises. In terms of turnover, the share of manufacturing enterprises that in 2022 either had relocated parts of their production abroad or wanted to do so in the near future was just over 6%.⁸ Based on this survey, the risk posed by relocations of production abroad resulting from higher energy prices seems so far to be limited for German industry as a whole. This also holds

Measures implemented or planned by German enterprises in response to the rise in energy prices since 2021*

As a percentage, weighted answers based on enterprise turnover¹



Source: Bundesbank calculations based on Bundesbank Online Panel – Firms (BOP-F) survey in Q1 2023. * BOP-F question: "What measures have been taken since 2021 or are planned for the near future as a result of the increased energy costs in your enterprise?" 1 Enterprise turnover figures winsorised at p95. 2 Measures have either been taken since 2022 or are also planned for the future. 3 Measures are exclusively planned for the future.

Deutsche Bundesbank

true for energy-intensive enterprises.⁹ In 2022, of the energy-intensive enterprises in the manufacturing sector, around 20% had

⁵ See Federal Statistical Office (2022a, 2022b).
⁶ The survey does not provide any information on the scale of investment, however.
⁷ Large enterprises with significant natural gas consumption made most use of the support measures. However, owing to the price brakes introduced at the start of 2023 and the extension of existing relief measures, the share of enterprises that have made or will make use of government support measures recently saw marked growth.
⁸ The survey does not provide any information on the scale of production relocations.
⁹ Energy intensity is measured as the percentage share of energy costs in total production costs. Enterprises with a share of over 10% are classified as energy-intensive.

cut their production and 11% were planning to do so in the near future (in each case measured in terms of turnover).¹⁰ In this case as well, though, the turnover share of those enterprises that in 2022 either had relocated parts of their production abroad or were planning to do so was quite small, at just under 6%.

¹⁰ These data are subject to particular uncertainty owing to the smaller sample size used.

levels, greenhouse gas neutrality by 2045). The expansion of domestic energy production through low-emission renewable energy sources is one step along this path. Others include a reduction in energy consumption and an increase in energy efficiency. According to various studies modelling transitional paths to achieving these climate targets, Germany would still ultimately need to import energy (in this case from non-fossil energy sources) in order to meet its energy needs. However, the net import volume would be smaller than before the transition.³²

Energy transition requires strong expansion of electricity supply and additional technologies

However, energy is likely to remain a scarce commodity on the path to transition, as demand for electricity, in particular, would rise sharply and requires a huge expansion of production capacity. This would also entail an extensive need for technologies such as storage and power grids to reconcile renewable energy production and energy needs.³³ This is one of the reasons why the shift towards low-emission

energy supply requires high additional investment in the aggregate capital stock over a longer period of time.³⁴

The expansion of domestic energy production from renewable energy sources could be accelerated in Germany by improving framework

³² See Boston Consulting Group (2021), Institute of Energy Economics at the University of Cologne (2021), Fraunhofer Institute for Solar Energy Systems (2021), Prognos et al. (2021) and Stolten et al. (2021).

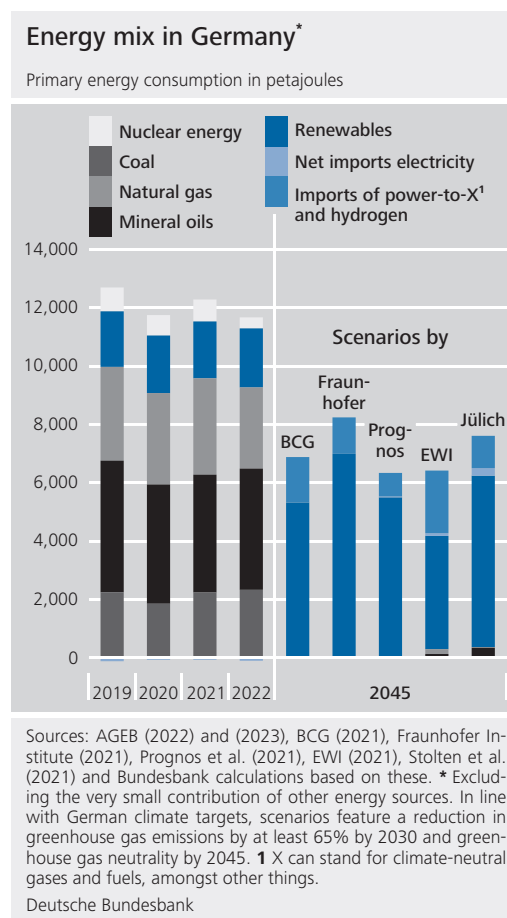
³³ Furthermore, the 65% reduction in greenhouse gas emissions by 2030 compared with 1990 levels appears ambitious, as the annual reduction in the remaining period would have to be just over twice as large as the average of the past 32 years.

³⁴ See KfW Research (2021). Moreover, it is likely that there will be additional adjustment costs related to the impact of ongoing climate change. The effects of climate change mitigation investment on the aggregate capital stock are a priori unclear, as additional investment is offset by increased depreciation. Hence, existing fixed assets that would not have reached the end of their useful lives without decarbonisation investment would need to be replaced. It is difficult to quantify the additional depreciation, as this requires a detailed analysis of the capital replacement needed to decarbonise the economy in the various areas of the capital stock. See Joint Economic Forecast Project Group (2022).

Better government framework conditions needed for expansion of renewable energy sources, as is consistent and reliable climate policy ...

conditions. Greater incentives to use renewable energy could arise from the inclusion of all sectors in the EU emissions trading system.³⁵ A comprehensive emissions trading scheme of this kind would harmonise the costs of CO₂ emissions and would provide a transparent safeguard for existing climate targets. EU emissions trading has so far covered the energy and energy-intensive industry segments.³⁶ The European Union's plans to create an additional trading system covering buildings and transport are a step in the right direction.³⁷ For reasons of efficiency, however, it seems sensible to aim for a uniform system in the long term, setting a single carbon price for all sectors.³⁸ Consistent and reliable climate policy provides enterprises with the planning certainty needed for investment and reduces the macroeconomic costs of climate policy.³⁹

Other approaches to accelerating the energy transition include tailored land use plans, con-



35 The faster reduction in the number of emission permits issued free of charge would also contribute here. This would also require earlier implementation of the Carbon Border Adjustment Mechanism.

36 EU emissions trading currently covers just under 40% of total EU greenhouse gas emissions. In addition to the energy and energy-intensive industry segments, intra-European aviation is also included in the existing emissions trading system. These sectors account for around 5% of aggregate gross value added. Shipping is also to be included from 2024.

37 The European Union intends to create an additional, independent emissions trading system for the buildings and road transport sectors and other industrial sectors from 2027 onwards.

38 The European Commission intends to assess by 31 October 2031 whether the integration of the two trading systems should be pursued.

39 According to the Bundesbank's scenario calculations using the environmental multi-sector DSGE model EMuSe, the costs of a disorderly climate policy are higher than those of an orderly one; see Deutsche Bundesbank (2022c). Strict carbon pricing is implemented at an early stage in an orderly climate policy and the degree of intervention is gradually tightened, whereas disorderly climate policy is assumed to intervene noticeably later but commensurately more strongly.

40 See Leibniz Centre for European Economic Research (2023a).

41 On this topic, the European Commission recently presented a proposal to reform the design of the EU electricity market. The aim is to accelerate the expansion of renewable energy in Europe by increasing the use of long-term electricity contracts and other measures, whilst at the same time promoting European industry through more stable electricity prices. See European Commission (2023b).

siderably simplified approval processes and faster judicial review procedures for the expansion of production facilities and networks. In addition, it would be very important to promote research and development – especially with a view to ensuring a cost-effective balance between foreseeable strong fluctuations in supply and demand, for example for energy storage.

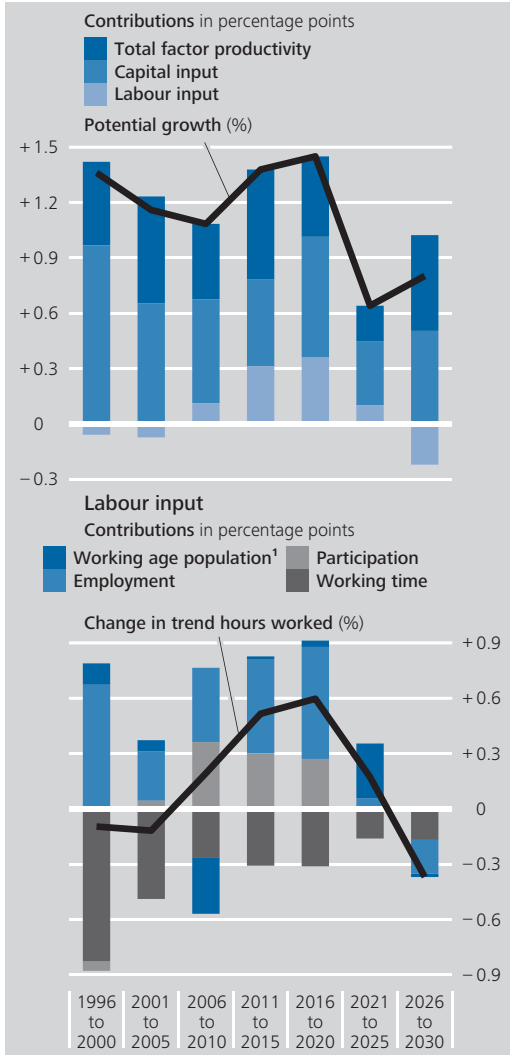
Energy-intensive industries, in particular, need time to adapt to higher energy prices, whether temporary or otherwise. The proposed industrial electricity price cap is intended to contribute to this. Overall, however, there is a risk that such subsidies will slow down structural change, weakening incentives to avoid emissions by also promoting electricity generated using fossil fuels.⁴⁰ It therefore seems more effective to use the available funds to improve the framework conditions for the expansion of renewable energy, including network infrastructure.⁴¹

... as well as more efficient government administration and approval processes

Price signals for energy are important for avoiding emissions

Potential output in Germany*

Year-on-year change



* June 2023 estimate. ¹ Including migration.
 Deutsche Bundesbank

Demographic change

Demographic changes weigh on labour supply ...

Demographic change is another major challenge facing the German economy, reducing labour supply and increasing competition for skilled workers. From the second half of the 2020s onwards, the working age population will decline. This demographic process started among the domestic population some time ago, but was offset by immigration. As baby boomers reach retirement age over the next 15 years, even immigration is unlikely to offset this effect. A more significant factor in the reduction in labour supply is the effect of changes in

the age structure. The higher share of older workers alone will cause the participation rate of 15 to 74-year-olds in Germany to fall in a few years' time, even if the participation rate continues to increase in individual age groups. The share of prime age workers, the group in which the participation rate is highest, is dwindling. This age structure effect is also likely to dampen average working hours, as older persons have a higher preference for part-time work.

The decline in labour supply will also dampen fixed capital formation in the future, as fewer workers will need to be provided with capital.⁴² Productivity developments may also be dampened by the increasing pace of population ageing. There is evidence that individual labour productivity tends to decline among elderly employees and that ageing reduces the capacity to innovate and adapt to new technologies.⁴³ In addition, resources will tend to be increasingly diverted to areas of below-average productivity, such as services for the support and care of older generations. This resource channelling means that the demographic decline in labour supply will dampen the German economy's potential output in the medium term.

... and thus German economy's potential output

The above dampening effects on potential output are the result of the status quo of the economic policy framework. However, the strength of these demographic developments can be mitigated by an increased influx of skilled workers from outside Germany. Third countries deserve greater attention here, as, owing to similar demographic developments, economic migration from other EU countries will no longer be able to play the dominant role it has assumed over the past decade. The various initiatives taken by the Federal Government in this

Making immigration more attractive to skilled workers could mitigate brunt of population ageing

⁴² See Deutsche Bundesbank (2017).
⁴³ See Deutsche Bundesbank (2021a).

area are steps in the right direction.⁴⁴ Immigrants outside the influx of skilled workers should also be quickly integrated into the labour market if they have long-term prospects of remaining in Germany.

Increase in labour force participation and working hours

In order to increase labour force participation and working hours beyond the expected trend, the institutional framework needs to be adjusted in two main ways. First, the participation rate of women, in particular, could increase if there were better childcare facilities for children (and possibly for those in need of long-term care) and if the tax and social contributions system provided greater incentives for second earners to work.⁴⁵ Second, in order to prolong working life as life expectancy increases, it seems appropriate to tie the statutory retirement age to life expectancy. This would not only bolster economic strength, but would also ensure that social contribution and tax rates do not need to rise as sharply.⁴⁶

Education and training of employees important for transformation of economy

Enterprises can also set incentives themselves, for example through more flexible working time models. In addition to incentives for investment, skilled labour is needed to ensure that any transformation is successful and productivity potential can be tapped. This will require better digital skills training, not only for employees but also in the education system.

ergy that is necessary to achieve climate targets, as this progress is partly dependent on technology components from China. In the medium and long term, it is important to create the conditions for ensuring that the low-emission energy supply remains reliable and that energy costs remain affordable. This will necessitate an increase in the supply of renewable energy and a reduction in energy demand. Given all of this, it is difficult to gauge the extent of both the required and the expected structural changes.

So far, the German economy has been in large part well positioned. German enterprises continue to make great use of the opportunities offered by international markets. With regard to the energy crisis, German enterprises appear to have mitigated the immediate effects well on average owing to their good profitability and financing alongside government assistance. Enterprises have also already taken steps to adjust in the face of higher energy prices. The price and cost competitiveness of the German economy remains favourable on average. It also has a well-trained workforce, infrastructure that remains sound, wage bargainers seeking consensus and comparatively stable underlying conditions. However, international competitiveness rankings point to the need for action.⁴⁷ The largest need to catch up is likely

... but is generally well positioned

Summary and economic policy conclusions

German economy faces major challenges in medium term such as demographic change, supply chain dependency and low-emission energy supply ...

The challenges facing the German economy are complex and often intertwined. Demographic change is weighing on growth prospects and exacerbating competition for skilled workers, who are also needed to make the energy transition and the digital transformation a reality. In foreign trade, there are considerable dependencies on China. A sudden break with China would likely cause far-reaching disruptions to supply chains and production in Germany, at least in the short term. It would also curb progress in the transition to renewable en-

⁴⁴ These include the supplement to the 2020 Skilled Immigration Act (*Fachkräfteeinwanderungsgesetz*), the transposition of the EU Blue Card for highly qualified persons into national law (and opening it up to medium-skilled labour) and the indefinite extension of the Western Balkans regulation.

⁴⁵ For an overview, see, for example, German Council of Economic Experts (2021), pp. 232 ff.

⁴⁶ See, for example, the simulations in Deutsche Bundesbank (2022d).

⁴⁷ In the World Economic Forum's global competitiveness ranking, which was updated annually before the pandemic, Germany regularly performed well, albeit with a recent declining trend (dropping four places to rank seventh out of 141 countries); see Schwab (2019). For an up-to-date ranking, see, inter alia, International Institute for Management Development (2023). This ranking shows a more unfavourable picture and further deterioration: Germany now ranks 22nd out of 64 countries (a drop of seven places).

Government framework conditions conducive to competitiveness and transformation are important

to be in the arena of digitalisation.⁴⁸ This could provide a significant boost to growth.⁴⁹

It is the government's task to support structural change with reliable framework conditions. Policymakers could improve conditions in Germany as a business location in a number of areas that fall under government remit.⁵⁰ Reliable and consistent energy and climate policy is essential for sufficiently mobilising private investment to finance the path to transition. The pricing of greenhouse gas emissions via certificate trading is an efficient tool for this purpose. In addition, Germany would need to simplify and speed up planning and approval processes. This would also include making the administration and performance of government tasks more efficient in general. Digitalisation should contribute significantly to this. The government could support enterprises' digitalisation efforts, for example, by promoting digital skills more strongly in schools and digitalising administrative processes.⁵¹

Ready tax and social contributions system to withstand demographic change

If the statutory retirement age were linked to developments in the life expectancy of older people, this could support labour force participation in the face of demographic change. Later retirement would allow labour force potential to be exploited more strongly. Furthermore, a school education providing the requisite skills would need to be ensured and immigrants would need to be better supported in terms of integration into the labour market. There is also a need for a tax and social contributions system that provides performance and employment incentives, can withstand demographic change and ensures a politically acceptable distribution of wealth. Furthermore, it is important to future-proof Germany's transport infrastructure. It would be off the mark for the government to give the impression it would provide a broad economic safety net to protect against any macroeconomic slowdown or problems in the corporate sector.

Finally, sound government finances do not hamper economic development – they are in fact an important prerequisite for it. This applies to Germany and the euro area. Effective fiscal rules ensure sound government finances. They do not imply that important political projects should be neglected. They do, however, force priorities to be set. This means that additional needs would have to be financed directly through lower expenditure or additional revenue elsewhere. Fiscal rules have recently been interpreted very broadly by central and state governments. It is important to be able to rely on credible and binding fiscal rules again in the future. At present, the debt brake is making the borrowing framework relatively restrictive. A reform that moderately raised the regular limits of the debt brake and simultaneously increased its binding force would therefore also be justifiable in the interests of stable government finances. The Bundesbank has made proposals for a stability-oriented reform.⁵² For example, the scope for deficits could be extended if the debt ratio is below 60%. If investments were to be prioritised within the limits, leeway could be reserved for net investment.

In view of the improvement to government framework conditions, the ten-point plan presented by the Federal Government at the Cabinet meeting in Meseberg in August 2023 deserves support. It addresses important structural problems and weaknesses, but is not yet sufficient to truly address the challenges. Success will also depend on how the plan is implemented and pursued.

Sound government finances do not contradict but instead provide a foundation for solid growth

Meseberg decisions move in right direction – but not yet sufficient

⁴⁸ See Schwab (2019).

⁴⁹ For more information on the macroeconomic importance of digitalisation, see Deutsche Bundesbank (2023a).

⁵⁰ The corporate tax burden in Germany is high by international standards; see Leibniz Centre for European Economic Research (2023b). This makes the other conditions making Germany favourable as a business location all the more important.

⁵¹ See German Council of Economic Experts (2021).

⁵² See Deutsche Bundesbank (2022e).

■ List of references

Aksoy, C., A. Baur, L. Flach and B. Javorcik (2022), Reacting to Supply Chain Disruptions: Evidence from German Firms, ifo Schnelldienst digital, Vol. 3, No 7, 01-05.

Antràs, P. (2020), De-Globalisation? Global Value Chains in the Post-COVID-19 Age, NBER Working Papers, 28115, National Bureau of Economic Research, Inc.

Baur, A. and L. Flach (2022), Deutsch-chinesische Handelsbeziehungen: Wie abhängig ist Deutschland vom Reich der Mitte?, ifo Schnelldienst, Vol. 75, No 4, 13 April 2022.

Boston Consulting Group – BCG (2021), Klimapfade 2.0. Ein Wirtschaftsprogramm für Klima und Zukunft, expert report for the Federation of German Industries, October 2021.

Deutsche Bundesbank (2023a), The impact of digitalisation on labour productivity growth, Monthly Report, March 2023, pp. 43-65.

Deutsche Bundesbank (2023b), German enterprises' profitability and financing in 2021, Monthly Report, March 2023, pp. 67-81.

Deutsche Bundesbank (2023c), Impact of higher energy costs on the profitability of German industrial enterprises, Monthly Report, March 2023, pp. 69-70.

Deutsche Bundesbank (2023d), Documentation of the Bundesbank Online Panel Firms (BOP-F), Questionnaire 13, Waves 27-29, April-June 2023, p. 20.

Deutsche Bundesbank (2022a), Digitalisation in the German corporate sector since the onset of the coronavirus pandemic, Monthly Report, September 2022, pp. 54-55.

Deutsche Bundesbank (2022b), Impact of permanently higher energy costs on German potential output, Monthly Report, December 2022, pp. 29-30.

Deutsche Bundesbank (2022c), Climate change and climate policy: analytical requirements and options from a central bank perspective, Monthly Report, January 2022, pp. 33-61.

Deutsche Bundesbank (2022d), Pension insurance scheme: long-term scenarios and reform options, Monthly Report, June 2022, pp. 47-61.

Deutsche Bundesbank (2022e), Central government's debt brake: options for stability-oriented further development, Monthly Report, April 2022, pp. 49-66.

Deutsche Bundesbank (2021a), The slowdown in euro area productivity growth, Monthly Report, January 2021, pp. 15-46.

Deutsche Bundesbank (2021b), Cross-border corporate takeovers: the impact of internationalisation on enterprises in Germany, Monthly Report, July 2021, pp. 15-30.

Deutsche Bundesbank (2021c), Pandemic-induced damage to German potential output moderate so far, Monthly Report, December 2021, pp. 30-32.

Deutsche Bundesbank (2020), Consequences of increasing protectionism, Monthly Report, January 2020, pp. 45-66.

Deutsche Bundesbank (2017), Demographic change, immigration and the potential output of the German economy, Monthly Report, April 2017, pp. 35-47.

Deutsche Bundesbank (2016), On the weakness of global trade, Monthly Report, March 2016, pp. 13-35.

Dorn, F., L. Flach, C. Fuest and L. Scheckenhofer (2022), Langfristige Effekte von Deglobalisierung und Handelskriegen auf die deutsche Wirtschaft, ifo Schnelldienst, 2022, Vol. 75, No 9, 14 September 2022.

European Commission (2023a), Proposal for a regulation of the European Parliament and of the Council establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) 168/2013, (EU) 2018/858, 2018/1724 and (EU) 2019/1020, COM/2023/160 final.

European Commission (2022), Proposal for a regulation of the European Parliament and of the Council establishing a framework of measures for strengthening Europe's semiconductor ecosystem (Chips Act), COM/2022/46 final.

European Commission (2019), State aid: Commission approves €3.2 billion public support by seven Member States for a pan-European research and innovation project in all segments of the battery value chain, press release of 9 December 2019, https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6705

Federal Statistical Office (2022a), Umweltökonomische Gesamtrechnungen, Energiegesamtrechnung, Berichtszeitraum 2000-2020, Tabelle 3.1 Primärenergieverbrauch – Kraftwerksverluste und Eigenverbrauch beim Verbraucher, p. 57.

Federal Statistical Office (2022b), Facts on gas supply: natural gas is major energy source for industry and households, Press release, No N 044, 21 July 2022.

Felbermayr, G., H. Mahlkow and A. Sandkamp (2023), Cutting through the value chain: the long-run effects of decoupling the East from the West, *Empirica*, Vol. 50.

Fraunhofer Institute for Solar Energy Systems ISE (2021), Wege zu einem klimaneutralen Energiesystem. Die deutsche Energiewende im Kontext gesellschaftlicher Verhaltensweisen, Update November 2021: Klimaneutralität 2045, November 2021.

Fuest, C., L. Flach, F. Dorn and L. Scheckenhofer (2022): Geopolitische Herausforderungen und ihre Folgen für das deutsche Wirtschaftsmodell, ed.: Bavarian Business Association, study prepared by the ifo Institute, August 2022.

German Chamber of Commerce and Industry (2022), Economy in the wake of the energy price crisis, DIHK Economic Survey Fall 2022, p. 16.

German Chamber of Commerce and Industry (2021), DIHK-Umfrage zu Lieferengpässen und Rohstoffknappheit, Blitzumfrage Lieferengpässe, August 2021.

German Council of Economic Experts (2021), Shaping the transformation: education, digitalisation and sustainability, Annual Report 2021/22.

Institute of Energy Economics at the University of Cologne (EWI) (2021), dena-Leitstudie Aufbruch Klimaneutralität. Klimaneutralität 2045 – Transformation der Verbrauchssektoren und des Energiesystems, ed.: Deutsche Energie-Agentur GmbH (dena), October 2021.

International Energy Agency (2021), The Role of Critical World Energy Outlook Special Report Minerals in Clean Energy Transitions, World Energy Outlook Special Report.

International Institute for Management Development (2023), World Competitiveness Yearbook, 2023.

Joint Economic Forecast Project Group (2022), From Pandemic to Energy Crisis – Economy and Politics under Permanent Stress, Spring 2022.

KfW Research (2021), Investing EUR 5 trillion to reach climate neutrality – a surmountable challenge, Focus on Economics, No 350.

Leibniz Centre for European Economic Research (2023a), Brückenstrompreis: Fehler aus der Vergangenheit fortführen?, ZEW policy brief, No 06, May 2023.

Leibniz Centre for European Economic Research (2023b), Mannheim tax index – 2022 update, <https://www.zew.de/mannheim-tax-index>

Prognos, Öko-Institut and Wuppertal Institute (2021), Climate-Neutral Germany 2045: How Germany can achieve its climate targets even before 2050, summary commissioned by the Climate Neutrality Foundation, Agora Energiewende and Agora Verkehrswende, June 2021.

Schwab, K. (2019), Global Competitiveness Report 2019, World Economic Forum.

Stolten, D., P. Markewitz, T. Schöb, F. Kullmann, L. Kotzur et al. (2021), New targets using old pathways? Strategies for a greenhouse gas neutral energy supply by 2045, abridged version, Forschungszentrum Jülich GmbH.

Working Group on Energy Balances (2023), Energy Consumption in Germany in 2022, March 2023.

Working Group on Energy Balances (2022), Evaluation Tables on the Energy Balance, data covering 1990-2021, September 2022.