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Structural Change in Germany: Challenges for Growth and Productivity

Germany is at the onset of a profound structural change that will have a lasting impact on the dynamics of productivity and economic growth. Global megatrends such as changes in international trade, digitalisation, decarbonisation and demographic change will accelerate structural change and have far-reaching consequences for productivity growth, the international competitiveness of the German economy and the dynamics of the labour market. The challenges lie, among other things, in securing long-term innovation and productivity growth.

Structural change describes long-term changes in the sectoral composition of the economy and employment. This process is inherent in economic growth and is triggered by a variety of factors (Herrendorf et al., 2014). In Europe, structural change has been strongly influenced by the deepening of the Single Market and EU trade policy, which altered the international division of labour within Europe as well as vis-à-vis global competitors (Draghi, 2024). Between 1995 and 2023, the share of manufacturing in gross value added fell on average in the EU, as well as in the USA and the UK (Figure 1). This decline was particularly pronounced prior to the 2009 financial crisis. Since then, the manufacturing sector's share of gross value added has stagnated for several European countries. In 2021, the EU average was 16%, while in the USA it was only 11%. Absolute real value added in the manufacturing sector is nonetheless increasing in most countries, just not as strongly as services value added.

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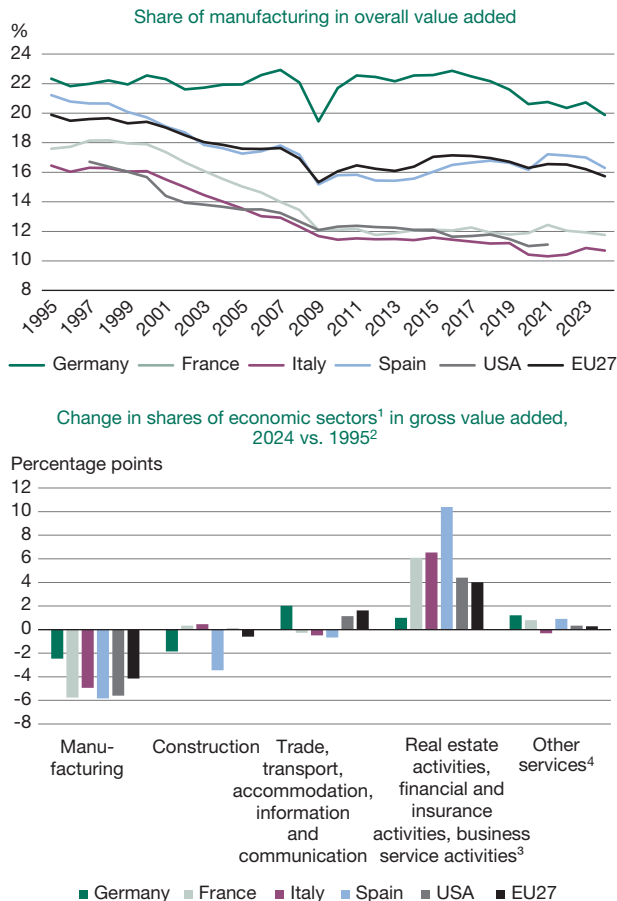
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Sectoral shifts in value added influence overall economic productivity growth, which is a decisive factor for the long-term economic development and prosperity of an economy (German Council of Economic Experts [GCEE], 2023). It makes it possible to produce more goods and services with the same input of resources, which leads to rising incomes, a higher standard of living and improved competitiveness. Historically, productivity growth in the manufacturing sector tends to be higher than in the service sector. This is partly due to the fact that industrial production is often characterised by a higher degree of automation, technological progress and economies of scale. In the course of structural change, traditionally high-productivity manufacturing industries are shrinking relative to services. The shift of economic activity to the service sector, where productivity gains are often more difficult to achieve, therefore leads to a slowdown in overall economic productivity growth, which in turn affects the long-term growth momentum of the economy as a whole. This challenge is acute throughout Europe, where lagging service-sector productivity and insufficient diffusion of digital technologies have been identified as key bottlenecks to competitiveness (Draghi, 2024).

This article focuses on Germany since the country's structural trajectory has a disproportionate impact on EU-wide growth and competitiveness. The country's strong industrial base makes it an important benchmark for assessing how structural change influences productivity across Europe. In Germany, the manufacturing sector's share of gross value added was exceptionally stable in international comparison at around 22% between 1995 and 2017, and most recently at 20% in 2023. This contributed to the fact that sectoral composition effects slowed productivity growth less than in other countries. Nevertheless, overall economic productivity growth has been slowing down for

Figure 1
An international comparison of structural change



Notes: ¹ According to NACE Rev. 2. ² For the USA: change in 2021 vs. 1997. ³ Business service activities: professional, scientific and technical activities, administrative and support service activities. ⁴ Public administration, defence, education, human health and social work activities, entertainment and recreation, other service activities, private households, extraterritorial organisations and bodies.

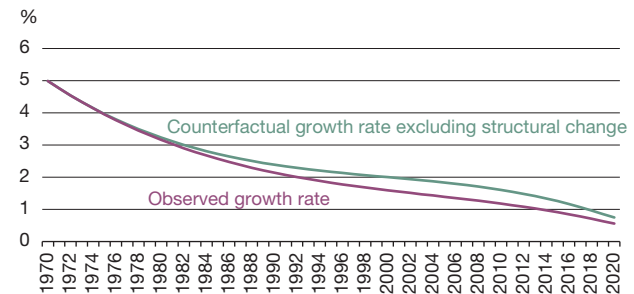
Source: Eurostat; authors' calculations.

years. According to a study by Duernecker and Sanchez-Martinez (2023), sectoral change has reduced productivity growth in the EU by around 0.4 percentage points per year since 1970. The spring report of the GCEE (2025) estimates this contribution for Germany at 0.25 percentage points (Figure 2).

Future structural change will have a sizeable impact on productivity for Germany. Duernecker and Sanchez-Martinez (2023) estimate that future productivity slowdown in Germany will be driven by a shift in economic activity towards service industries with stagnant productivity – showing zero growth – especially in business services.

Figure 2
Productivity growth in Germany: Contribution of structural change between the sectors

Growth rate of labour productivity



Note: Values smoothed using a polynomial.

Sources: Bontadini et al. (2023); EUKLEMS; authors' calculations.

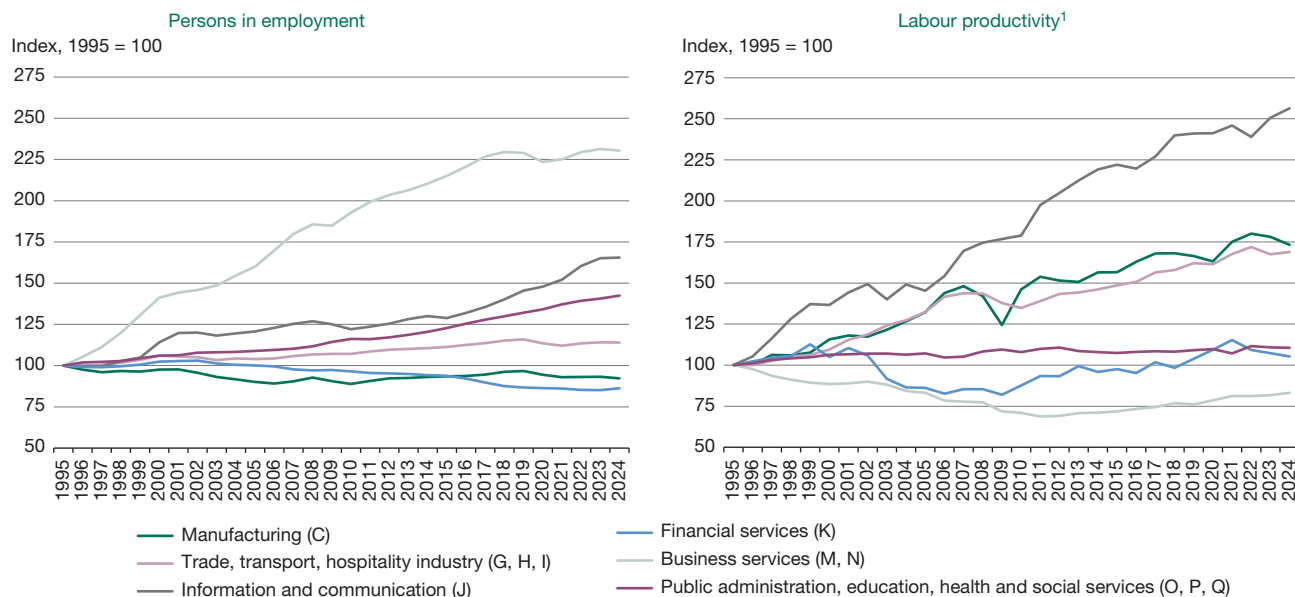
Indeed, value added shares and total employment in the manufacturing sector reached their recent peak in 2019 and have been declining since then, despite ongoing labour productivity gains. Employment in business services has grown strongly over the past 30 years, while labour productivity has been declining for many years, and growth rates remain persistently low (Figure 3). Employment in public administration, health and social services in Germany has been growing, with the strongest growth coming from human health services.

In view of the increasing importance of services and the challenges posed by new technologies, the question arises as to how structural change can be influenced to promote growth and how productivity growth rates in services can be increased. Productivity growth during structural change depends largely on whether new technologies – especially artificial intelligence (AI) – are used to increase productivity in the service sector. This is an issue at the European level, since scaling the adoption of AI and digital technologies should be based on cross-border investments.

Developments in knowledge-intensive industries and tertiarisation

A central aspect of the current structural change is the growing importance of knowledge-intensive industries and the trend towards tertiarisation, which manifests itself in an increase in the share of services in value creation and employment in the secondary sector (Vandermerwe & Rada, 1988; Baines et al., 2009; Khanra et al., 2021; Lehmann et al., 2025). Knowledge-intensive industries are characterised by the fact that a comparatively high

Figure 3
Employment and labour productivity by economic sector



Notes: According to the Classification of Economic Activities (WZ, 2008). ¹ Gross domestic product per hours worked by persons in employment.

Source: Federal Statistical Office; authors' calculations.

proportion of employees in these sectors has a tertiary education, i.e. a university degree or comparable qualification. These sectors include, for example, the finance and insurance industry, information and communication technology (ICT), the pharmaceutical and chemical industries, management consultancy, research and development and other knowledge-based services.

These industries play a crucial role in innovation, productivity growth and the international competitiveness of an economy. They are often pioneers in the development and application of new technologies, attract highly qualified workers, contribute to the creation of high-quality jobs and frequently generate a high level of value added.

In recent decades, the share of knowledge-intensive services in the economy has grown, particularly due to areas such as financial services, ICT and business-related services (Figure 4). While these services have expanded markedly in many advanced economies, growth in Germany has been comparatively subdued. In Germany the share of knowledge-intensive services rose by just 5.5 percentage points to 31% between 1995 and 2021, while in the USA the share rose by 10 percentage points to 42% over the same period (see Figure 4). Moreover, in some of these industries productivity growth is low in Germany (Kritikos et al., 2022; Duernecker & Sanchez-Martinez,

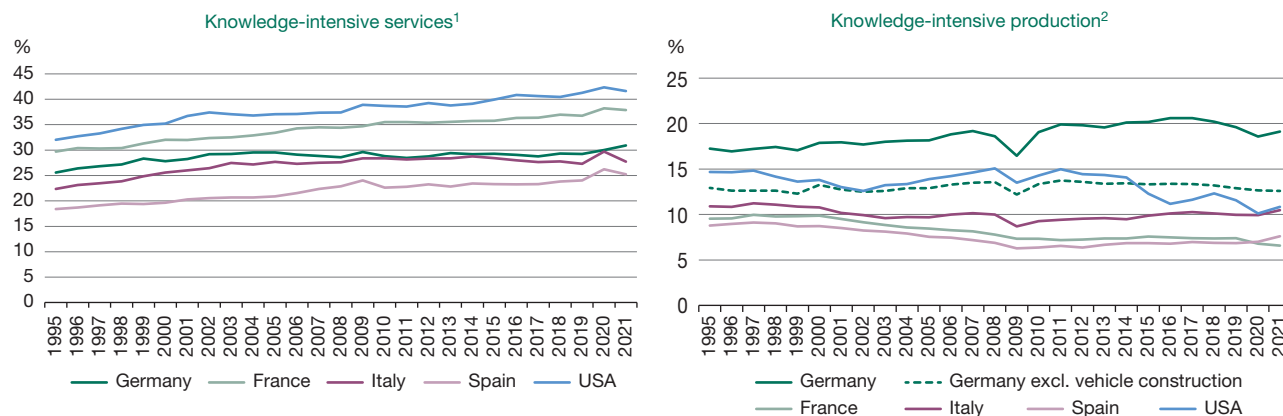
2023), which underlines the need for targeted measures to increase efficiency and innovative strength.

At the same time, an increasing tertiarisation can be seen within manufacturing industries. Tertiarisation describes the increase in the share of services in value added and employment, not only in the service sector itself, but also within the manufacturing sector. Services such as maintenance, research and development, and logistics are increasingly seen as an integral part of industrial value creation. Indeed, the share of services in industrial value added in Europe increased by around 10 percentage points between 1995 and 2011 (Stehrer et al., 2015).

This development makes the traditional distinction between the manufacturing industry and the service sector more difficult, as many companies are increasingly carrying out both production and service activities. It is also changing labour demand in the manufacturing sector, as service skills such as communication skills, customer orientation and problem-solving skills are increasingly in demand alongside traditional production skills.

In particular, the complementary use of ICT and knowledge-intensive services is crucial for productivity gains (van Ark et al., 2008; Bloom et al., 2012). Since the mid-1990s, the US has outperformed Germany and the euro-

Figure 4

Value-added components of knowledge-intensive economic sectors (share of gross value added)

Notes: According to NACE Rev. 2. The shares of the respective economic sectors in all economic sectors except sections L, O, P, Q, T and U are shown.

¹ Information and communication, financial and insurance services as well as business services. ² Mining, manufacture of coke and refined petroleum products, chemical and pharmaceutical industry, manufacture of electrical and optical equipment, mechanical engineering and vehicle construction.

Sources: Bontadini et al. (2023); EUKLEMS; authors' calculations.

zone in productivity growth (Lopez-Garcia & Szörfi, 2021; Bergeaud, 2024), partly due to more effective adoption of ICT (van Ark et al., 2008; Gordon & Sayed, 2020). US productivity gains have been driven by digital infrastructure investment and labour reallocation (Dao & Platzer, 2024). In Europe instead, ICT uptake has been hindered by resource constraints and weaker management capabilities (Bloom et al., 2012; Hsieh et al., 2019).

Four future key drivers of structural change, productivity and growth

Many of the megatrends described above influence productivity growth not only indirectly, via structural change, but also directly.

International trade

Globalisation and international trade have significantly impacted structural change in Germany in recent decades. The international division of labour has supported productivity growth through specialisation effects and economies of scale. In the past, Germany benefited greatly from the export of high-value capital goods, particularly in mechanical engineering and the automotive sector. This slowed the pace of structural change compared to other industrialised economies.

The technological catch-up process observed in Asia (Hsieh & Ossa, 2016; Mao et al., 2021), and particularly in China (Bickenbach et al., 2024), is calling traditional export strengths into question. Germany has lost market

shares for its 500 most important products, ranked by export value, in almost all world regions, whereas China has gained market shares in the respective products over the period of 2017 to 2022.¹

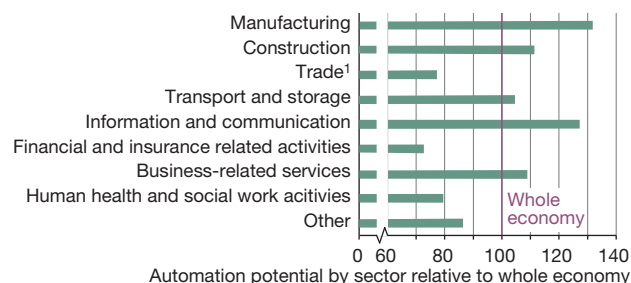
Should this shift in comparative advantages continue at the disadvantage of German companies, structural change will accelerate and specifically affect industries with high productivity. This in turn might reduce innovation efforts and R&D spending (e.g. Aghion et al., 2005; Sacco & Schmutzler, 2011; Aghion et al., 2006). To maintain Germany's comparative advantage in key industries, it is essential that firms in these sectors strengthen their innovation capacity and enhance productivity growth.

Digitalisation and AI

Digitalisation influences productivity through various channels: direct efficiency gains, new business models and automation. Studies show that companies with a high level of digitalisation achieve above-average productivity growth (Brynjolfsson et al., 2018; McElheran et al., 2024). Germany has some catching up to do here: AI adoption among German companies remains limited despite growing interest. Depending on the source, usage rates range from 12% (Rammer et al., 2024) to 20% (Federal Statistical Office, 2024) and up to 27% (ifo Institute, 2024). According to van Ark et al. (2008), US companies use digital technologies more efficiently, which, between 1995 and 2006, contributed significantly to their produc-

¹ See Chart 79 in German Council of Economic Experts (2025).

Figure 5
Automation potential through AI by sector



Notes: The automation potentials are a transfer of Webb's classification (2020) to the German occupational classification. The indicator measures the correspondence between the job descriptions of individual occupations and fields of application of AI from patent texts on a scale of 1 to 100. According to the Classification of Economic Activities (WZ, 2008). Calculated for the average employment structure for the years 2012 to 2019 using the Integrated Employment Biographies sample. ¹ Wholesale and retail trade; repair of motor vehicles and motorcycles.

Source: Institute for Employment Research (IAB) of the German Federal Employment Agency (BA).

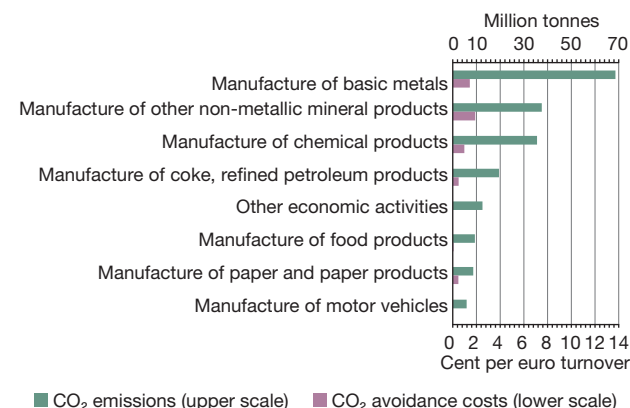
tivity advantage. AI offers new opportunities for productivity leaps, particularly in knowledge-intensive services and research and development. However, there are considerable regional and sectoral differences in the speed of implementation. The approach of Webb (2020), who uses job descriptions and AI patent data to assess automation potential for the German labour market, shows the highest substitution potential in manufacturing and ICT occupations, but much lower potential in commerce, healthcare and social work (Fregin et al., 2023) (see Figure 5). Bridging gaps in AI adoption will be key to ensure that digitalisation drives broad-based and sustainable productivity growth.

Decarbonisation

The transition to a climate-neutral economy as a significant driver of structural change also places high demands on innovation and efficiency improvements. It requires far-reaching changes in energy production, industry, transportation and other sectors. In the short term, rising energy costs and investments in low-emission technologies could have a negative impact on productivity, especially given that similar cost increases are not anticipated in non-European countries with more lenient climate policies. Even with a globally uniform carbon pricing system, Germany would face a cost disadvantage due to its relatively lower renewable energy potential (Verpoort et al., 2024). This could lead to the relocation of particularly emissions-intensive production abroad (see Figure 6). Given the higher emissions intensity of manufacturing compared to services, structural shifts towards the

Figure 6
Average CO₂ avoidance costs and emissions by economic sectors

Average values for 2017-2020



Notes: The CO₂ emissions are approximated on the basis of the energy sources in individual companies (with more than 20 employees) contained in the official company data for Germany. Non-energy-related emissions for economic sectors "Manufacture of chemical products", "Manufacture of non-metallic mineral products", "Manufacture of basic metals" are added on a flat rate basis. Industry specific values from the literature are assumed for CO₂ emissions costs. Avoidance cost of 50 euros per tonne were assumed for the economic sectors with missing values. Economic sectors according to the Classification of Economic Activities (WZ, 2008).

Sources: RDC of the Federal Statistical Office and the Statistical Offices of the Länder, DOI 10.21242/42.111.2021.00.01.1.1.0 and 10.21242/43.531.2021.00.03.1.1.0; authors' calculations.

service sector are likely to accelerate. In the long term, however, innovation boosts in areas such as the green hydrogen economy, energy storage and sustainable mobility offer significant productivity potential.

Demographic change and skill mismatches

Demographic change, in particular the ageing of the population and the decline in the birth rate, represents a significant challenge for the German labour market. According to forecasts, the German workforce could shrink by up to 20% by 2040 (Kubis & Schneider, 2024), leading to a marked decline in labour supply. This demographic contraction is expected to exacerbate existing shortages of skilled workers and weigh directly on the country's long-term growth prospects. At the same time, skill mismatches are emerging, i.e. a discrepancy between the qualifications of the workforce and the requirements of the labour market, as structural change is reshaping the landscape of occupations.

While the importance of industrial manufacturing occupations is declining, demand is rising for service-oriented

roles and higher-skilled workers (Boddin & Kroeger, 2022). Structural change is altering qualification requirements faster than education and training systems can react. Adão et al. (2024), for example, show that labour markets with greater skills flexibility are better able to cope with structural change in a way that increases productivity.

Options for action: Targeted promotion of growth dynamics and productivity

To shape structural change in a way that boosts growth and productivity, an economic policy strategy must be pursued that takes into account both sectoral and regional differences and shapes forward-looking industrial and structural policy. An active innovation and infrastructure policy, combined with a horizontal strengthening of knowledge-intensive economic sectors is essential to shape the transformation dynamics in a way that increases productivity. These measures must be aimed at the effective promotion of innovation in all economic sectors, the sustainable increase in productivity, the timely adaptation of qualification profiles of the workforce to the changing requirements of the labour market, and the design of a supportive regulatory framework that does not hinder change, but rather actively supports and shapes it.

Fostering conditions that actively promote innovation, investment and competition is of central importance. Instruments such as reliable CO₂ pricing stimulate productivity growth through efficiency incentives, while innovation-oriented funding programmes and tax incentives for research can encourage investment in new technologies.

Targeted support for research and development in companies, particularly for new technologies and climate-friendly production processes, plays a key role in strengthening the innovative power of the German economy and laying the foundations for future productivity growth. Encouraging researchers to engage in entrepreneurship and supporting knowledge transfer mechanisms can strengthen the link between scientific research and industrial innovation. Setting-up regional innovation clusters can generate spillover effects and accelerate the diffusion of new technologies. These clusters should be focused on priority topics with an emphasis on applied research. Germany should further push for the establishment of counterparts to the American Advanced Research Projects Agency (ARPA) to drive breakthrough innovation in critical fields such as the energy transition, defence and AI, and health-care at the European level. Such a programme could start as a joint Franco-German initiative, with all EU countries – and the UK – invited to participate (Franco-German Council of Economic Experts [FGCEE], 2025).

To take a leading role in the development of AI, significant investment in physical and digital infrastructure is required, particularly in structurally weak regions, to better connect them to the supra-regional centres of growth. The expansion of broadband networks and 5G infrastructure remains slow and should be prioritised, accompanied by programmes that actively support digitalisation in companies of all sizes.

Although the EU is well positioned in AI research, it lags behind the US in the development and commercialisation of AI. There is not only a lack of cloud computing infrastructure, but also a lack of a dynamic ecosystem and receptive sales markets. Various proposals to promote investment and innovation in AI are being discussed, including the creation of a European organisation for AI, an IT mission as part of Horizon Europe or the introduction of a European fund for digital infrastructure. Given the high fixed costs involved, no individual European country can achieve the required scale on its own. Building AI gigafactories can close the gap with global competitors. This again can be done as a joint initiative between interested European countries (FGCEE, 2025).

Start-ups are important drivers of innovation in AI. In order to strengthen the AI scene in Europe, the availability of private capital is of central importance in addition to the coordination of public investment, as discussed above. Currently, a large proportion of venture capital for AI flows to the US, while the EU is lagging far behind. Without a strengthening of the European capital markets and the activation of private investors, the European AI scene will not be able to catch up. A broader application of AI and ICT in small and medium-sized enterprises can be stimulated by sufficient cloud infrastructure, and technology pilots could help to convey best practice examples from large companies.

The labour market requires an offensive for further training and qualifications that offers low-threshold access and specifically promotes skills that are necessary for digitalisation and decarbonisation. This includes, in particular, programmes for on-the-job training and the systematic integration of future skills into school and vocational training curricula. Moreover, improving access to innovation careers through targeted education and outreach programmes in disadvantaged areas can help increase and diversify the innovator pool (Bell et al., 2019; Breda et al., 2023; FGCEE, 2025).

In view of the increasing interdependence of European economies, close coordination of economic policy measures at the EU level is essential to avoid inefficiencies, strengthen Europe's overall competitiveness and tackle

the challenges of structural change together. Finally, also from a long-term perspective, the trade policy framework must be modernised in order to secure open markets and better protect European companies against geo-economic risks. Diversifying export markets and strategically securing critical supply chains are essential for this. Additional measures may be necessary to mitigate short-term disruptions (see Bouët et al., 2025).

References

- Adão, R., Beraja, M., & Pandalai-Nayar, N. (2024). Fast and slow technological transitions. *Journal of Political Economy Macroeconomics*, 2(2), 183–227.
- Aghion, P., Bloom, N., Blundell, R., Griffith, R., & Howitt, P. (2005). Competition and innovation: An inverted-U relationship. *Quarterly Journal of Economics*, 120(2), 701–728.
- Aghion, P., Griffith, R., & Howitt, P. (2006). U-shaped relationship between vertical integration and competition: Theory and evidence. *International Journal of Economic Theory*, 2(3–4), 351–363.
- Baines, T. S., Lightfoot, H. W., Benedettini, O., & Kay, J. M. (2009). The servitization of manufacturing: A review of literature and reflection on future challenges. *Journal of Manufacturing Technology Management*, 20(5), 547–567.
- Bell, A., Chetty, R., Jaravel, X., Petkova, N., & Van Reenen, J. (2019). Who becomes an inventor in America? The importance of exposure to innovation. *The Quarterly Journal of Economics*, 134(2), 647–713.
- Bergeaud, A. (2024). *The past, present and future of European productivity* [Conference Paper]. ECB Forum on Central Banking, 2024.
- Bickenbach, F., Dohse, D., Langhammer, R. J., & Liu, W.-H. (2024). Foul play? On the scale and scope of industrial subsidies in China. *Kiel Policy Brief*, 173. Kiel Institute for the World Economy.
- Bloom, N., Sadun, R., & Van Reenen, J. (2012). Americans do IT better: US multinationals and the productivity miracle. *American Economic Review*, 102(1), 167–201.
- Boddin, D., & Kroeger, T. (2022). Servitization, inequality, and wages. *Labour Economics*, 77, 102011.
- Bontadini, F., Corrado, C., Haskel, J., Iommi, M., & Jona-Lasinio, C. (2023). EUKLEMS & INTANProd: Industry productivity accounts with intangibles – Sources of growth and productivity trends: Methods and main measurement challenges, Deliverable D2.3.1. LUISS Lab of European Economics.
- Bouët, A., Jaravel, X., Méjean, I., Malmendier, U., Schnitzer, M., Truger, A., Werding, M., Hinz, J., & Schularick, M. (2025). *A new world trade order? How the EU should respond to US tariff policy* [Joint statement]. Franco-German Council of Economic Experts & Conseil d'analyse économique.
- Breda, T., Grenet, J., Monnet, M., & Van Effenterre, C. (2023). How effective are female role models in steering girls towards STEM? Evidence from French high schools. *The Economic Journal*, 133(653), 1773–1809.
- Brynjolfsson, E., Mitchell, T., & Rock, D. (2018). What can machines learn, and what does it mean for occupations and the economy? *AEA Papers and Proceedings*, 108, 43–47.
- Dao, M., & Platzer, J. (2024). Post-pandemic productivity dynamics in the United States. *IMF Working Paper*, WP/24/124. International Monetary Fund.
- Draghi, M. (2024). *The Draghi report: The future of European competitiveness – A competitiveness strategy for Europe*. European Commission.
- Duernecker, G., & Sanchez-Martinez, M. (2023). Structural change and productivity growth in Europe – Past, present and future. *European Economic Review*, 151, 104329.
- Federal Statistical Office. (2024, November 25). *Jedes fünfte Unternehmen nutzt künstliche Intelligenz* [Press release, 444].
- Fregin, M. C., Koch, T., Malfertheiner, V., Özgül, P., & Stops, M. (2023). On the Automation of Job Tasks: Occupational exposure to Artificial Intelligence and Software. *IAB-Kurzbericht*, 21/2023. Institut für Arbeitsmarkt- und Berufsforschung der Bundesagentur für Arbeit.
- Franco-German Council of Economic Experts. (2025). *Joint Statement, Boosting Productivity and Growth: A Franco-German Agenda for Europe*.
- German Council of Economic Experts. (2025). Between hope and fear: Economic weakness and opportunities of the fiscal package, bureaucratic obstacles and structural change. *Spring Report of the German Council of Economic Experts 2025*.
- German Council of Economic Experts. (2023). Overcoming sluggish growth – Investing in the future. *Annual Report of the German Council of Economic Experts, 2023/24*.
- Gordon, R. J., & Sayed, H. (2020). Transatlantic technologies: The role of ICT in the evolution of US and European productivity growth. *CEPR Discussion Paper*, DP15011. Centre for Economic Policy Research.
- Herrendorf, B., Rogerson, R., & Valentinyi, Á. (2014). Chapter 6 – Growth and structural transformation. In P. Aghion, & S. N. Durlauf (Eds.), *Handbook of Economic Growth* (Vol. 2, pp. 855–941). Elsevier.
- Hsieh, C.-T., & Ossa, R. (2016). A global view of productivity growth in China. *Journal of International Economics*, 102, 209–224.
- Hsieh, C.-T., Hurst, E., Jones, C. I., & Klenow, P. J. (2019). The allocation of talent and U.S. economic growth. *Econometrica*, 87(5), 1439–1474.
- ifo Institut. (2024). *Mehr Unternehmen nutzen Künstliche Intelligenz*.
- Khanra, S., Dhir, A., Parida, V., & Kohtamäki, M. (2021). Servitization research: A review and bibliometric analysis of past achievements and future promises. *Journal of Business Research*, 131, 151–166.
- Kritikos, A. S., Schiersch, A., & Stiel, C. (2022). The productivity shock in business services. *Small Business Economics*, 59(3), 1273–1299.
- Kubis, A., & Schneider, L. (2024). *Zuwanderung und Arbeitsmarkt: Eine Analyse für Deutschland und die Bundesländer*. Bertelsmann Stiftung.
- Lehmann, R., Linz, S., & Wollmershäuser, T. (2025). Strukturwandel im Verarbeitenden Gewerbe. *ifo Schnelldienst digital*, 5/2025. ifo Institute.
- Lopez-Garcia, P., & Szörfi, B. (2021). The impact of the COVID-19 pandemic on labour productivity growth. *ECB Economic Bulletin*, 7/2021, Box 4, 46–51.
- Mao, J., Tang, S., Xiao, Z., & Zhi, Q. (2021). Industrial policy intensity, technological change, and productivity growth: Evidence from China. *Research Policy*, 50(7), 104287.
- McElheran, K., Li, J. F., Brynjolfsson, E., Kroff, Z., Dinlersoz, E., Foster, L., & Zolas, N. (2024). AI adoption in America: Who, what, and where. *Journal of Economics & Management Strategy*, 33(2), 375–415.
- Rammer, C., Doherr, T., Kinne, J., & Lenz, D. (2024). *KI-Einsatz in Unternehmen in Deutschland, Strategische Ausrichtung und internationale Position*. Bundesministerium für Wirtschaft und Klimaschutz (BMWK).
- Sacco, D., & Schmutzler, A. (2011). Is there a U-shaped relation between competition and investment? *International Journal of Industrial Organization*, 29(1), 65–73.
- Stehrer, R., Baker, P., Foster-McGregor, N., Koenen, J., Leitner, S., Schricker, J., Strobel, T., Vieweg, H.-G., Vermeulen, J., & Yagafarova, A. (2015). The relation between industry and services in terms of productivity and value creation. *wiiw Research Report*, 404. Vienna Institute for International Economic Studies.
- Van Ark, B., O'Mahony, M., & Timmer, M. P. (2008). The productivity gap between Europe and the United States: trends and causes. *Journal of Economic Perspectives*, 22(1), 25–44.
- Vandermerwe, S., & Rada, J. (1988). Servitization of business: Adding value by adding services. *European Management Journal*, 6(4), 314–324.
- Verpoort, P., Ueckerdt, F., Beck, Y., Bietenholz, D., Dertinger, A., Fleiter, T., Grimm, A., Luderer, G., Neuwirth, M., Odenweller, A., Sach, T., Schimmel, M., & Sievers, L. (2024). Transformation der energieintensiven Industrie – Wettbewerbsfähigkeit durch strukturelle Anpassung und grüne Importe. *Ariadne-Report*. Kopernikus-Projekt Ariadne. Potsdam Institut für Klimafolgenforschung.
- Webb, M. (2020). *The impact of Artificial Intelligence on the labor market*. Stanford University.