UNIVERSITY OF CAMBRIDGE

Cambridge Industrial Innovation Policy

Insights from Germany

Understanding sectoral sources of aggregate productivity growth: a cross-country analysis

About this report

This report analyses sectoral sources of labour productivity growth in Germany during the 1998–2017 period. The overall project includes an overview report for eight economies, a summary report and eight economy-specific studies for China, France, Germany, the Republic of Korea, Taiwan, Singapore, the United Kingdom and the United States. Together, they seek to inform policies aimed at boosting productivity by improving the understanding of how sectors account for aggregate productivity gains and losses and how this differs across economies.

Contributors

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Design by Ella Whellams, IfM Engage, University of Cambridge. Cover image: Adobe Stock

Copy-editing by Amanda George, Perfect Words.

Acknowledgements

This report has been made possible by core funding from the Gatsby Charitable Foundation.

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Cambridge, United Kingdom | 2022

Insights from Germany

Key messages

How does Germany's productivity performance compare with that observed in other economies?

- Germany had the fifth-lowest labour productivity level, from the sample of economies studied, at US$85,815 output per worker in 2017. This productivity level represents approximately two-thirds of that seen in Singapore and almost four times the output per worker seen in China. Between 1998 and 2017, Germany experienced a modest productivity growth, the third lowest, observing an annual average growth rate of 1.7% (output per worker) in the period of 1998–2017.
- After the UK, Germany's labour productivity was the most impacted during the global financial crisis of 2008. Productivity growth more than halved; however, unlike the UK, in 2011–17 Germany's productivity grew at rates even higher than those observed before the financial crisis.
- Germany is the only economy, from the sample studied, that experienced faster productivity growth in the post-crisis period than in the decade before the crisis. Factors likely to explain this strong recovery include: a competitive export position supported by the euro and the restructuring of the labour market; the expansion of German value chains to Eastern Europe; and efficiency gains based on management improvements and technology adoption.

Which sectors are the main sources of Germany's aggregate labour productivity growth?

- The sectors that made the largest contributions to Germany's labour aggregate productivity in 1998–2017 include: manufacturing (23.9%); real estate activities (9.8%); wholesale and retail trade (9.7%); administrative and support service activities (8.0%); and human health activities (6.5%).
- During the crisis and in its aftermath (2008–10) mostly non-market services drove productivity growth. In the decade that followed (2011–17) manufacturing, wholesale and retail trade, and professional, scientific and technical activities, saw an increase in their relative and absolute contributions to aggregate productivity growth.

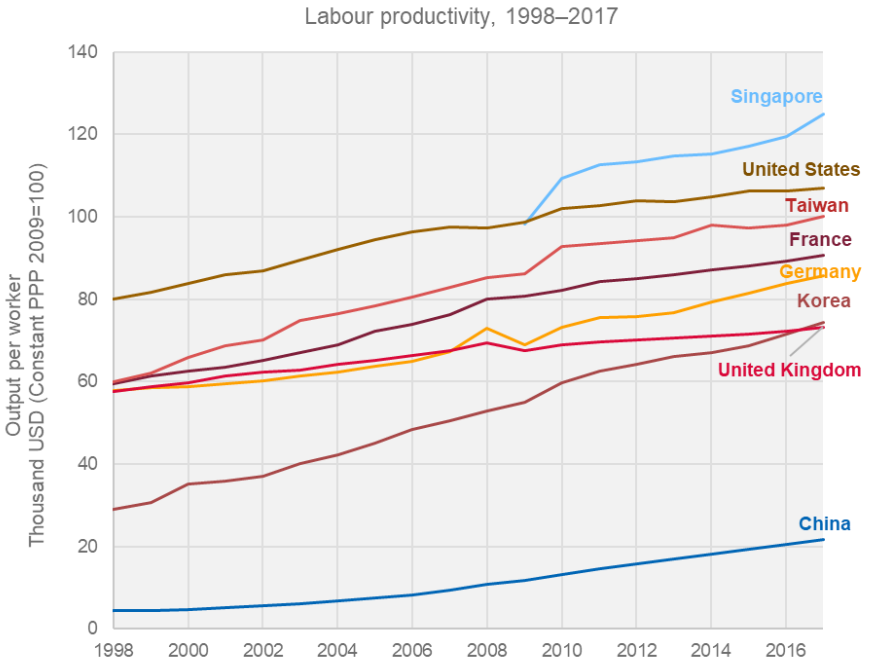
How do sectoral dynamics explain recent trends in aggregate productivity growth?

- The contribution of manufacturing to aggregate productivity growth is explained by its large size (22.8% output and 17.2% employment shares in 2017) and high productivity growth (3.0%, on average, in 1998–17). A variety of factors help to explain the remarkable performance of Germany's manufacturing sector, including: a skilled workforce, a strong innovation ecosystem and a competitive export position.
- Within manufacturing, transport equipment is the manufacturing sub-sector with the largest contribution to aggregate productivity growth, at 9% (0.19 percentage points) in 1998–2017.
- Although manufacturing continues to be a key driver of Germany's productivity growth, it experienced a significant contraction in the last two decades, particularly between 1998 and 2010. This contraction slowed down aggregate productivity growth, by -0.14 percentage points, on average, in 1998–2017.
- As the manufacturing sector contracted, services increased their participation in the economy. Service activities that saw among the largest improvements in their contributions to aggregate productivity growth between the pre-crisis and post-crisis periods include: human health activities (0.08 percentage points); wholesale and retail trade (0.07 percentage points); residential care and social work activities (0.05 percentage points); and professional, scientific and technical activities (0.05 percentage points).

1. How does Germany's productivity performance compare with that observed in other economies?

Germany had the fifth-lowest labour productivity level, from the sample of economies studied,[1] at US$85,815 output per worker[2] in 2017. This productivity level represents approximately two-thirds of that seen in Singapore and almost four times the output per worker seen in China. Between 1998 and 2017 Germany experienced a modest productivity growth, the third lowest, observing an annual average growth rate of 1.7% (output per worker) in the 1998–2017 period (Figure 1).

FIGURE 1: WHOLE ECONOMY LABOUR PRODUCTIVITY GROWTH, 1998–2017, SELECTED ECONOMIES



Economy	Output per worker in 2017 (thousand USD, constant PPP, 2009 = 100)
Singapore	124,967
United States	107,075
Taiwan	100,075
France	90,791
Germany	85,815
Korea	74,431
United Kingdom	73,258
China	21,706

Economy	Growth rate, 1998–2017 (annual average)
China	8.9%
Korea	5.1%
Singapore[1/]	3.1%
Taiwan	2.7%
France	2.2%
Germany	1.7%
US	1.6%
UK	1.1%

Note: [1/] The 2010–17 period for Singapore.

Source: Authors' computation, based on data from Asian Productivity Organization (APO) Productivity Database 2020 Ver.1 (5 August 2020); OECD Structural Analysis Database (2020 ed.); Singapore Department of Statistics; Singapore Ministry of Trade and Industry; Manpower Research & Statistics Department; Taiwan Statistical Bureau UK Office for National Statistics; US Bureau of Economic Analysis and US Bureau of Labor Statistics.

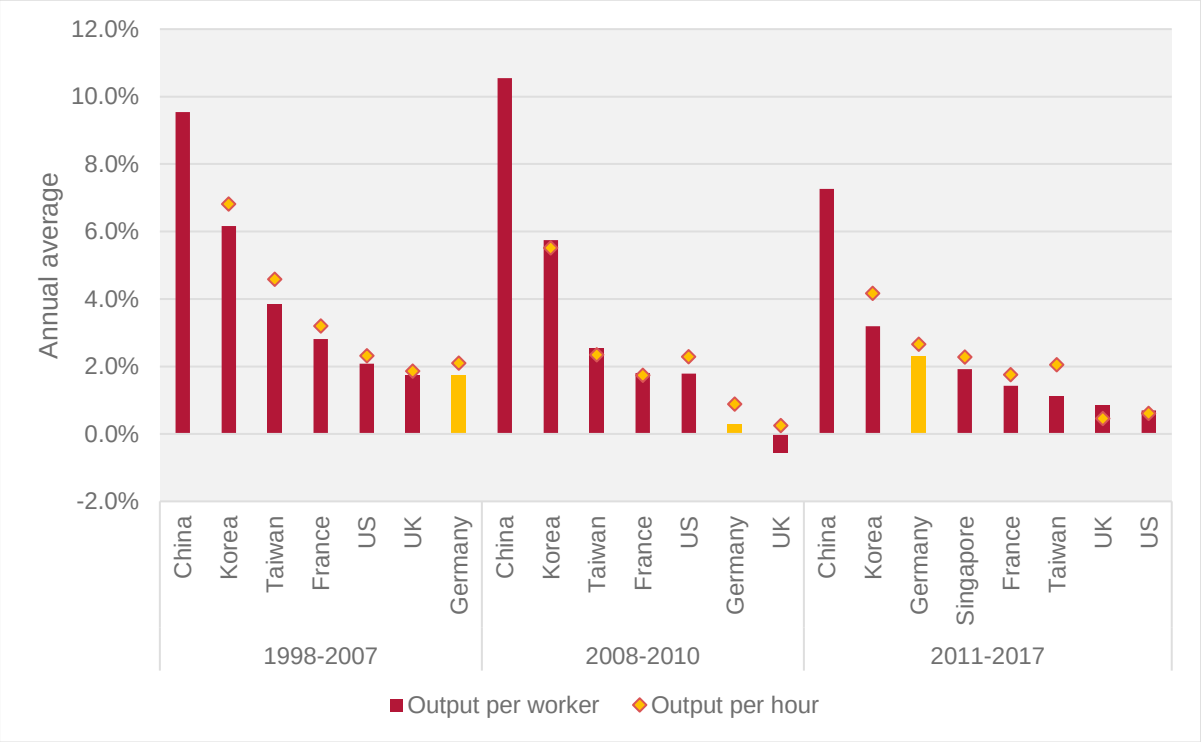
After the UK, Germany's labour productivity was the most impacted during the crisis of 2008. Productivity growth more than halved, from 2.1% in 1998–2007 to 0.9% in 2008–10 (measured as output per hour). However, unlike the UK, in 2011–17 Germany's productivity grew at rates that were even higher than those observed before the global financial crisis (Figure 2).

[1] China, France, Germany, the Republic of Korea, Taiwan, Singapore, the United Kingdom and the United States.
[2] Constant purchasing power parity (PPP), 2009 = 100.

From our sample of economies, Germany is the only one that experienced faster productivity growth in the post-crisis period (2.7%) than in the decade before the crisis (2.1%). Factors likely to explain this strong recovery include a competitive export position supported by the euro and the restructuring of the labour market; the expansion of German value chains to Eastern Europe; and efficiency gains based on management improvements and technology adoption.[3]

The restructuring of the labour market began in the 1990s and was further reinforced in the early 2000s (Hertz reforms). The labour reform involved the decentralisation of wage negotiations, restraining wage growth, but at the cost of extreme wage inequality.[4]

FIGURE 2: WHOLE ECONOMY LABOUR PRODUCTIVITY GROWTH, 1998–2017, SELECTED ECONOMIES



Source: Authors' computation, based on data from APO Productivity Database 2020 Ver.1 (5 August 2020); OECD STAN Industrial Analysis (2020 ed.); Korea Productivity Center; Singapore Department of Statistics; Singapore Ministry of Trade and Industry; Manpower Research & Statistics Department; Taiwan Statistical Bureau UK Office for National Statistics; US Bureau of Economic Analysis and US Bureau of Labor Statistics.

[3] Marin, D. (2018). Explaining Germany's Exceptional Recovery. London: Centre for Economic Policy Research.
[4] Micossi, S., D'Onofrio, A. and Peirce, F. (2018). On German external imbalances. Policy Insights. Centre for European Policy Studies.

2. Which sectors are the main sources of Germany's aggregate labour productivity growth?

The sectors that contributed the most to Germany's labour aggregate productivity in 1998–2017 include: manufacturing (23.9%); real estate activities (9.8%); wholesale and retail trade (9.7%); administrative and support service activities (8.0%); and human health activities (6.5%).

In the pre-crisis period (1998–2007), the top five sectors driving productivity growth were: manufacturing (26.7%); real estate activities (12.5%); wholesale and retail trade (10.4%); administrative and support service activities (8.5%); and information and communication (7.6%).

During the crisis and in its aftermath (2008–10) mostly non-market services drove productivity growth. In the decade that followed (2011–17), manufacturing, wholesale and retail trade, and professional, scientific and technical activities, saw an increase in their relative and absolute contributions to aggregate productivity growth, in comparison with those observed in the pre-crisis period (Figure 3).

FIGURE 3: TOP FIVE SECTORS CONTRIBUTING TO GERMANY'S AGGREGATE PRODUCTIVITY GROWTH (1998–2017)

Germany: top five sectors
(based on their contribution to aggregate productivity growth measured as output per hour)

Pre-crisis (1998–2007)
Aggregate productivity growth rate: 2.1%

Sector	% of aggregate productivity growth	Percentage points
Manufacturing	26.7	0.56
Real estate activities	12.5	0.26
Wholesale and retail trade	10.4	0.22
Administrative and support service activities	8.5	0.18
Information and communication	7.6	0.16

Crisis (2008–2010)
Aggregate productivity growth rate: 0.9%

Sector	% of aggregate productivity growth	Percentage points
Human health activities	24.8	0.22
Public administration and defence	22.3	0.20
Construction	20.8	0.18
Electricity, gas, steam and air conditioning supply	16.9	0.15
Education	15.7	0.14

Post-crisis (2011–2017)
Aggregate productivity growth rate: 2.7%

Sector	% of aggregate productivity growth	Percentage points
Manufacturing	27.6	0.73
Wholesale and retail trade	10.7	0.28
Professional, scientific and technical activities	7.5	0.20
Administrative and support service activities	7.5	0.20
Real estate activities	6.7	0.18

Whole period (1998–2017)
Aggregate productivity growth rate: 2.1%

Sector	% of aggregate productivity growth	Percentage points
Manufacturing	23.9	0.50
Real estate activities	9.8	0.21
Wholesale and retail trade	9.7	0.20
Administrative and support service activities	8.0	0.17
Human health activities	6.5	0.14

Source: OECD (2020). Structural Analysis Database (STAN).

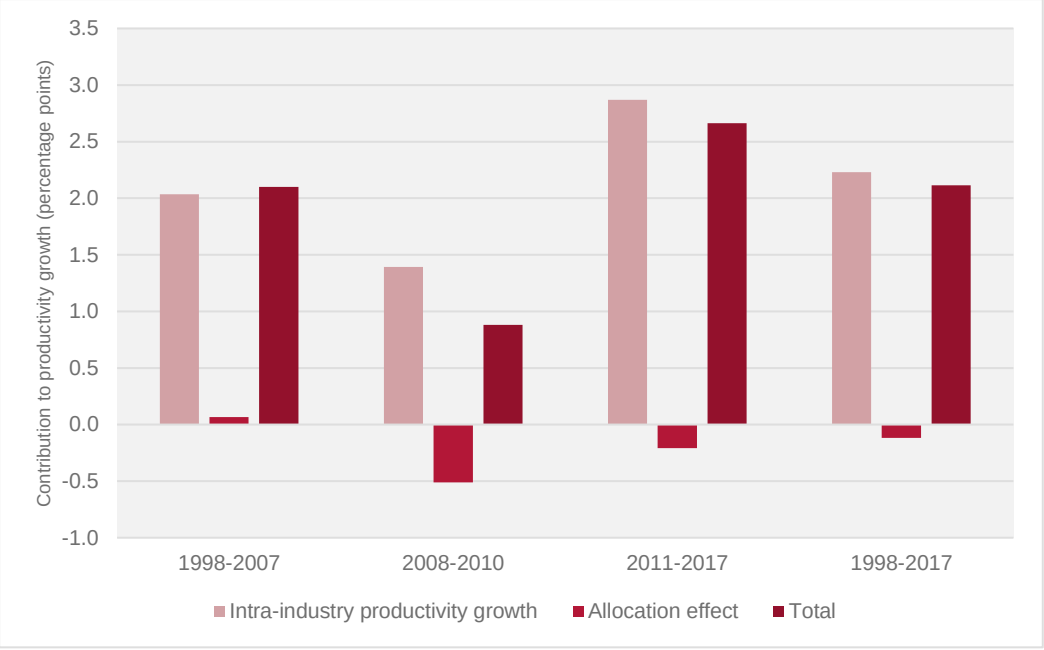
3. How do sectoral dynamics explain recent trends in aggregate productivity growth?

Overall labour productivity growth can be explained by an intra-industry productivity growth effect (or 'within' effect), which captures the productivity growth of each industrial sector and its relative weight in the overall economy; and by an allocation effect (or 'between-industries' effect), which captures the impacts on aggregate productivity growth because of the expansion or contraction of sectors with different levels of productivity.

In order to understand how different sectors have contributed to either aggregate productivity growth or slowdown, labour productivity (measured as output per worker) growth rates by sector were decomposed into these components using the Generalised Exactly Additive Decomposition (GEAD) methodology, as described in Tang and Wang.[5] Appendix II explains this decomposition in more detail.

Aggregate productivity in Germany is mainly explained by intra-industry productivity growth, while structural changes have led to negative contributions to aggregate productivity, as Figure 4 shows (-0.1 in 1998–2017). Allocation effects were particularly large during the financial crisis (2008–10), representing 58% of the productivity growth experienced in that period (0.9%).

FIGURE 4: DECOMPOSITION OF GERMANY'S AGGREGATE PRODUCTIVITY GROWTH (1998–2017)



Source: OECD (2020). Structural Analysis Database (STAN).

The decomposition was also conducted excluding sectors that involve a large non-market component (real estate, public administration and defence, education, human health activities, and residential care and social work activities). Table 9 presents the results of this decomposition for the 1998–2017 period. Key highlights include larger aggregate intra-industry productivity growth effects (2.31 percentage points) and less negative allocation effects (-0.03 percentage

[5] Tang, J. and Wang, W. (2004). Sources of aggregate labour productivity growth in Canada and the United States. *Canadian Journal of Economics*, Volume 37, Number 2.

points). Larger intra-industry productivity growth effects are mainly explained by larger contributions from the manufacturing sector, while the changes in allocation effects are explained by larger and positive allocation effects from professional, scientific and technical activities; administrative and support service activities; and public administration and defence.

As discussed in Section 2, the economic sectors that made the largest contributions to Germany's aggregate labour productivity growth include: manufacturing (particularly the manufacture of transport equipment); real estate activities; wholesale and retail trade; administrative and support service activities; and human health activities.

The contribution of manufacturing to aggregate productivity growth is explained by its large size (22.8% output and 17.2% employment shares in 2017) and its high productivity growth (3.0%, on average, in 1998–2017). Manufacturing sub-sectors that experienced the fastest productivity growth in 1998–2017 include (in brackets, annual average growth): the manufacture of transport equipment (5.3%); the manufacture of machinery and equipment (3.1%); the manufacture of computer, electronic and optical products (3.1%); and the manufacture of textiles, wearing apparel, leather and related products (3.1%) (Table 2).

A variety of factors help to explain the remarkable performance of Germany's manufacturing sector, including: a skilled workforce, a strong innovation ecosystem and a competitive export position supported by the euro. Germany's dual system of vocational education and training, which combines practical and theoretical elements, is a key source of high-skilled manufacturing workers.[6] Small and medium-sized (SMEs) companies benefit from this, as well as from the innovation services provided by the Fraunhofer Society and other public applied research organisations.[7]

Medium-sized German companies participate more in medium and high manufacturing than in other advanced economies; and more than a thousand of them are considered hidden champions, that is, publicly less well known international market leaders.[8]

The adoption of the euro as a currency has allowed Germany to maintain a strong competitive position for its exports. Evidence suggests that the evolution of the relative price of tradables in Germany has played an important role in its exporting success. When the euro was introduced in 1999, Germany had a current deficit in its balance of payments amounting to around 1.4% of GDP; by 2016 that balance had improved, reaching a surplus of 8.5% of GDP.[9]

Within manufacturing, transport equipment is the manufacturing sub-sector with the largest contribution to aggregate productivity growth, at 9% in 1998–2017. Automotive is the largest industry in Germany, accounting for around 20% of the total German industry revenue in 2021.[10] Germany's automotive sector is the country's most innovative industry, accounting for 35% of total German business R&D expenditure of around EUR72 billion in 2018. Germany has the highest concentration of all European automotive original equipment manufacturers (OEM) and

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[6] Audretsch, D. (2018). Why is Germany so Strong in Manufacturing? Insight into manufacturing policy.
[7] Comin, Diego; Licht, Georg; Pellens, Maikel; Schubert, Torben (2019): Do companies benefit from public research organizations? The impact of the Fraunhofer Society in Germany, ZEW Discussion Papers, No. 19-006, ZEW - Leibniz-Zentrum für Europäische Wirtschaftsforschung, Mannheim.
[8] Simmon, H. (2017). Why Germany Still Has So Many Middle-Class Manufacturing Jobs. *Harvard Business Review*.
[9] Micossi, S., D'Onofrio, A. and Peirce, F. (2018). On German external imbalances. Policy Insights. Centre for European Policy Studies.
[10] Germany Trade and Invest (2022). Automotive Industry.

tier supplier R&D centres. Small and medium-sized companies play a key role in Germany's automotive industry, and around 85% of the industry suppliers are medium-sized companies.[11]

During the financial crisis of 2008, computer, electronic and optical products made up the manufacturing sub-sector that was most affected, showing a contraction in productivity growth of 5.8% in 2008–10. In comparison, food products, beverages and tobacco showed the strongest performance, with an average annual growth of 7.8% between 2008 and 2010 (Table 2).

Unlike other economies examined in this report, in the decade after the financial crisis of 2008 (2011–17) most of the economic sectors in Germany sustained productivity growth rates similar to, or larger than, those observed in the decade before the crisis (1997–2007). Exceptions include: electricity, gas, steam and air conditioning supply; mining and quarrying; transportation and storage; and financial and insurance activities. These sectors observed declines in their productivity growth ranging from 1.7 to 7.1 percentage points (Table 1).

Computer, electronic and optical products returned to positive productivity growth rates in the post-crisis period (2.5%) but smaller than those observed in the decade before the crisis (6.2%). Other manufacturing sub-sectors that experienced a slowdown in their productivity growth in 2011–17 include: basic metals and fabricated metal products, except machinery and equipment; machinery and equipment; and chemical, rubber, plastics, fuel products and other non-metallic mineral products (Table 2).

Although manufacturing continues to be a key driver of Germany's productivity growth, it experienced a significant contraction in the last two decades, particularly between 1998 and 2010. Manufacturing employment shares contracted 2.1 percentage points in 1998–2007 and suffered a further reduction of 0.9 percentage points in 2008–10. Manufacturing relative output prices also contracted, 1.3 percentage points in 1998–2007 and 1.9 in 2008–10 (Table 3 and Table 4).

The shrinking of the manufacturing sector in Germany slowed down aggregate productivity growth by -0.14 percentage points, on average, in 1998–2017 (allocation effect, Table 5). The manufacturing sub-sectors that contributed the most to this include: chemical, rubber, plastics, fuel products and other non-metallic mineral products (-0.03 percentage points); wood and paper products, and printing (-0.03 percentage points); and the manufacture of electrical equipment (-0.02 percentage points) (Table 7).

As the manufacturing sector contracted, services increased their participation in the economy. Service activities that saw among the largest improvements in their contributions to aggregate productivity growth between the pre-crisis and post-crisis periods include: human health activities (0.08 percentage points); wholesale and retail trade (0.07 percentage points); residential care and social work activities (0.05 percentage points); and professional, scientific and technical activities (0.05 percentage points) (Figure 5).

Productivity increases in wholesale and retail trade are likely to be linked to the adoption of digital technologies in this sector, particularly those related to e-commerce and the emergence of new German wholesale players.[12]

[11] Germany Trade and Invest (2020). The Automotive Industry in Germany. *Industry overview*. Issue 2020/2021.
[12] Dachs, B. et al. (2016). EU wholesale trade: Analysis of the sector and value chains.

TABLE 1: GERMANY: PRODUCTIVITY LEVELS AND GROWTH RATES BY SECTOR, 1998–2020

Economic sector	Output per hour							
	1998–2007		2008–2010		2011–2017		1998–2017	
	Average absolute value (euros[1/])	Average annual growth	Average absolute value (euros[1/])	Average annual growth	Average absolute value (euros[1/])	Average annual growth	Average absolute value (euros[1/])	Average annual growth
Agriculture, forestry and fishing	14.1	5.4%	15.7	-9.5%	20.2	8.7%	16.5	4.3%
Mining and quarrying	28.5	6.2%	46.9	3.6%	51.5	1.8%	39.3	4.3%
Manufacturing	39.8	3.2%	45.1	2.8%	53.9	2.9%	45.5	3.0%
Electricity, gas, steam and air conditioning supply	84.5	6.4%	139.5	7.4%	126.8	-0.6%	107.6	4.1%
Water supply; sewerage, waste management and remediation activities	48.4	3.3%	59.5	-0.1%	67.2	3.3%	56.7	2.8%
Construction	21.2	-0.1%	23.6	5.8%	29.3	4.0%	24.4	2.3%
Wholesale and retail trade; repair of motor vehicles and motorcycles	25.0	2.6%	27.7	1.5%	31.8	3.8%	27.8	2.9%
Transportation and storage	29.8	3.8%	35.2	0.4%	37.4	1.2%	33.3	2.4%
Accommodation and food service activities	13.2	2.2%	13.4	-3.8%	16.7	6.0%	14.5	2.7%
Information and communication	58.3	2.2%	59.5	-2.9%	66.8	2.5%	61.4	1.5%
Financial and insurance activities	48.4	4.1%	56.6	2.4%	66.5	2.4%	56.0	3.2%
Real estate activities	359.1	1.4%	435.5	2.9%	490.3	2.5%	416.5	2.0%
Professional, scientific and technical activities	45.1	-1.5%	38.8	-3.0%	40.6	2.3%	42.6	-0.4%
Administrative and support service activities	29.0	0.1%	29.1	0.2%	32.3	2.5%	30.2	1.0%
Public administration and defence; compulsory social security	30.7	2.1%	35.5	3.6%	42.8	3.3%	35.6	2.7%
Education	30.9	0.6%	32.3	1.5%	36.4	2.6%	33.0	1.4%
Human health activities	26.8	0.8%	29.8	1.8%	33.4	3.1%	29.5	1.8%
Residential care and social work activities	13.8	1.7%	14.8	0.7%	16.9	3.0%	15.0	2.0%
Arts, entertainment and recreation	32.4	0.7%	33.4	0.0%	37.3	3.6%	34.3	1.6%
Other service activities	27.1	1.2%	29.0	-0.3%	31.7	2.2%	29.0	1.3%
Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	10.5	2.1%	11.2	0.6%	12.5	2.3%	11.3	1.9%
Whole economy	34.6	2.1%	38.3	0.9%	43.4	2.7%	38.2	2.1%

Note: [1/] Chained prices of the previous year.

Source: OECD (2020). Structural Analysis Database (STAN).

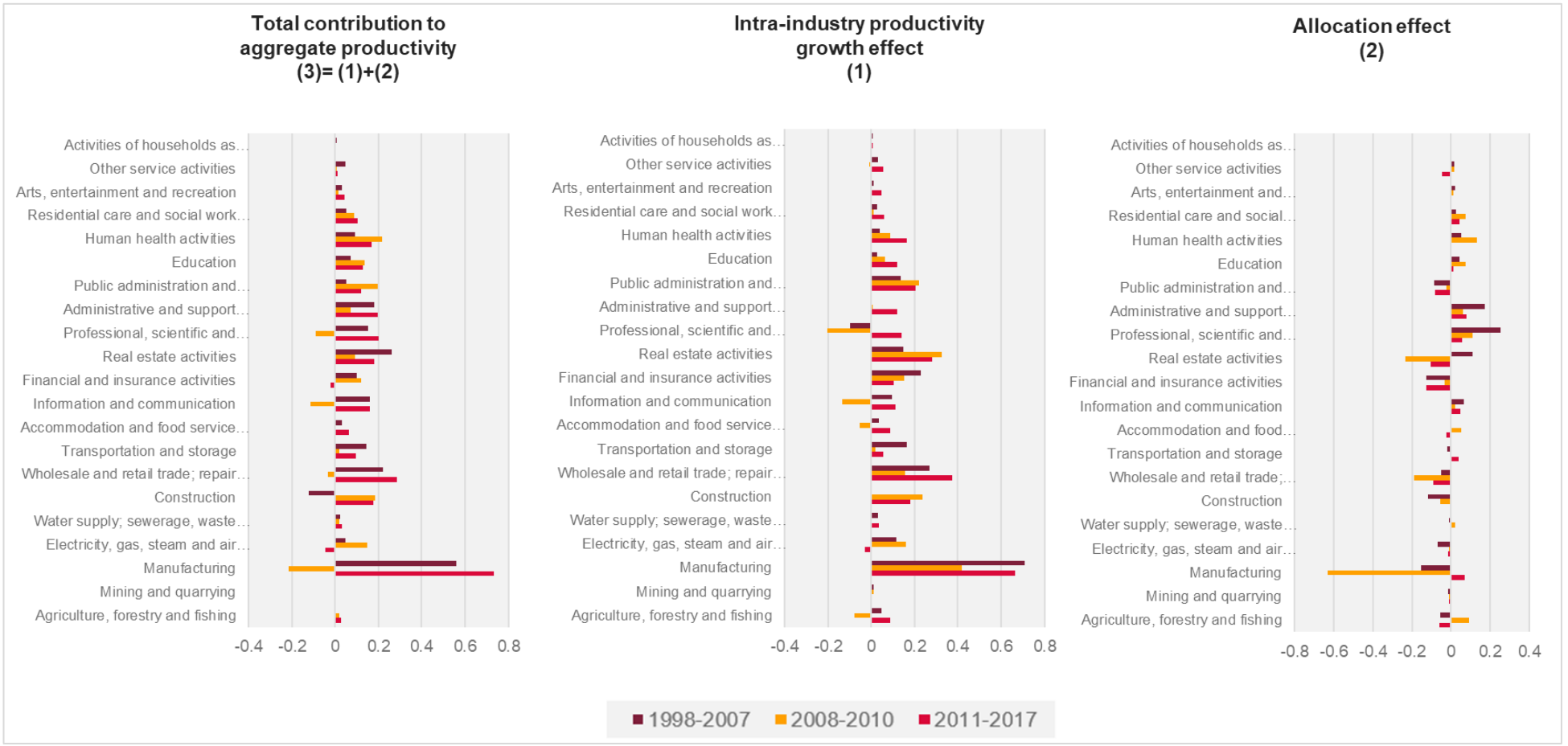
TABLE 2: GERMANY: PRODUCTIVITY LEVELS AND GROWTH BY MANUFACTURING SUB-SECTORS, 1998–2017

Manufacturing sub-sector	Output per hour							
	1998–2007		2008–2010		2011–2017		1998–2017	
	Average absolute value (euros[1/])	Average annual growth	Average absolute value (euros[1/])	Average annual growth	Average absolute value (euros[1/])	Average annual growth	Average absolute value (euros[1/])	Average annual growth
Manufacture of food products, beverages and tobacco	26.5	0.2%	27.9	7.8%	31.2	1.1%	28.4	1.6%
Manufacture of textiles, wearing apparel, leather and related products	25.1	3.1%	29.6	2.9%	34.8	3.2%	29.2	3.1%
Manufacture of wood and paper products, and printing	31.8	2.1%	33.6	1.4%	36.9	2.1%	33.9	2.0%
Manufacture of chemical, rubber, plastics, fuel products and other non-metallic mineral products	50.7	2.5%	58.0	4.8%	64.7	1.4%	56.7	2.5%
Manufacture of basic metals and fabricated metal products, except machinery and equipment	33.1	3.4%	37.9	0.3%	42.2	1.9%	37.0	2.4%
Manufacture of computer, electronic and optical products	63.4	6.2%	66.7	-5.8%	73.1	2.5%	67.3	3.1%
Manufacture of electrical equipment	42.5	1.8%	49.6	6.3%	56.9	2.1%	48.6	2.6%
Manufacture of machinery and equipment n.e.c.	40.9	3.8%	46.7	1.8%	54.1	2.7%	46.4	3.1%
Manufacture of transport equipment	51.0	4.6%	61.4	6.5%	89.1	5.9%	65.9	5.3%
Manufacture of furniture; other manufacturing; repair and installation of machinery and equipment	29.0	3.4%	32.6	1.0%	38.3	2.7%	32.8	2.8%
Total manufacturing	39.8	3.2%	45.1	2.8%	53.9	2.9%	45.5	3.0%

Note: [1/] Chained prices of the previous year.

Source: OECD (2020). Structural Analysis Database (STAN).

FIGURE 5: SECTORAL CONTRIBUTION TO GERMANY'S AGGREGATE PRODUCTIVITY GROWTH, SELECTED SECTORS 1998–2017



Source: OECD (2020). Structural Analysis Database (STAN).

TABLE 3: GERMANY: SECTORAL CONTRIBUTIONS TO OVERALL PRODUCTIVITY GROWTH,1998–2007

Economic sector	Output shares		Employment shares		Structural change (1998–2007, percentage points)			Contribution to productivity growth (1998–2007, average, percentage points)			Labour productivity growth (1998–2007)
	1998	2007	1998	2007	Output	Employment	Relative output prices	Intra-industry productivity growth effect (1)	Allocation effect (2)	Total (3) = (1) + (2)	
Agriculture, forestry and fishing	1.1%	0.9%	2.0%	1.6%	-0.2	-0.4	-10.7	0.05	-0.05	-0.01	5.39%
Mining and quarrying	0.3%	0.2%	0.4%	0.2%	-0.1	-0.2	-2.3	0.01	-0.02	0.00	6.22%
Manufacturing	22.5%	23.2%	20.2%	18.1%	0.7	-2.1	-1.3	0.71	-0.15	0.56	3.20%
Electricity, gas, steam and air conditioning supply	1.9%	2.0%	0.8%	0.6%	0.1	-0.2	-1.2	0.12	-0.07	0.05	6.43%
Water supply; sewerage, waste management and remediation activities	1.0%	1.0%	0.7%	0.6%	0.0	0.0	-3.3	0.03	-0.01	0.02	3.34%
Construction	5.7%	3.9%	7.8%	5.7%	-1.8	-2.1	6.8	0.00	-0.12	-0.12	-0.05%
Wholesale and retail trade; repair of motor vehicles and motorcycles	10.4%	10.2%	15.1%	14.5%	-0.3	-0.6	1.7	0.27	-0.05	0.22	2.61%
Transportation and storage	4.0%	4.6%	4.8%	4.9%	0.6	0.1	-2.0	0.16	-0.02	0.14	3.85%
Accommodation and food service activities	1.5%	1.5%	3.5%	3.9%	-0.1	0.4	-4.6	0.03	0.00	0.03	2.25%
Information and communication	4.5%	4.8%	2.5%	3.0%	0.2	0.4	-5.3	0.09	0.07	0.16	2.17%
Financial and insurance activities	4.6%	4.8%	3.3%	3.1%	0.2	-0.2	-3.3	0.23	-0.13	0.10	4.08%
Real estate activities	10.9%	11.4%	1.1%	1.2%	0.4	0.1	5.0	0.15	0.11	0.26	1.37%
Professional, scientific and technical activities	6.5%	6.6%	4.1%	5.7%	0.1	1.6	1.8	-0.10	0.25	0.15	-1.49%
Administrative and support service activities	3.7%	4.5%	4.3%	6.4%	0.8	2.1	0.1	0.00	0.17	0.18	0.13%
Public administration and defence; compulsory social security	6.6%	5.9%	7.8%	6.8%	-0.7	-1.0	0.5	0.14	-0.09	0.05	2.10%
Education	4.3%	4.2%	4.9%	5.3%	-0.2	0.5	2.2	0.03	0.05	0.07	0.59%
Human health activities	4.7%	4.6%	6.1%	6.5%	-0.1	0.4	-3.6	0.04	0.05	0.09	0.81%
Residential care and social work activities	1.5%	1.7%	4.0%	4.7%	0.2	0.6	-0.5	0.03	0.02	0.05	1.74%
Arts, entertainment and recreation	1.3%	1.3%	1.2%	1.5%	0.0	0.3	2.1	0.01	0.02	0.03	0.75%
Other service activities	2.6%	2.6%	3.4%	3.6%	0.0	0.2	-0.4	0.03	0.01	0.05	1.22%
Activities of households	0.3%	0.3%	2.1%	2.2%	0.0	0.1	-1.2	0.01	0.00	0.01	2.05%
Whole economy	100.0%	100.0%	100.0%	100.0%	N/A	N/A	N/A	2.03	0.06	2.10	2.10%

Note: N/A, not applicable.

Source: OECD (2020). Structural Analysis Database (STAN).

TABLE 4: GERMANY: SECTORAL CONTRIBUTIONS TO OVERALL PRODUCTIVITY GROWTH, 2008–2010

Economic sector	Output shares		Employment shares		Structural change (2008–10, percentage points)			Contribution to productivity growth (2008–10, average, percentage points)			Labour productivity growth (2008–10)
	2008	2010	2008	2010	Output	Employment	Relative output prices	Intra-industry productivity growth effect (1)	Allocation effect (2)	Total (3) = (1) + (2)	
Agriculture, forestry and fishing	0.9%	0.9%	1.6%	1.6%	0.0	0.0	44.5	-0.08	0.09	0.02	-9.51%
Mining and quarrying	0.3%	0.2%	0.2%	0.2%	-0.1	0.0	-17.3	0.01	-0.01	0.00	3.55%
Manufacturing	22.3%	21.9%	18.3%	17.4%	-0.4	-0.9	-1.9	0.42	-0.63	-0.21	2.76%
Electricity, gas, steam and air conditioning supply	2.3%	2.4%	0.6%	0.6%	0.1	0.0	-13.6	0.16	-0.01	0.15	7.37%
Water supply; sewerage, waste management and remediation activities	1.0%	1.0%	0.6%	0.6%	0.0	0.0	11.4	0.00	0.02	0.02	-0.07%
Construction	4.0%	4.3%	5.6%	5.7%	0.3	0.0	-3.3	0.24	-0.05	0.18	5.82%
Wholesale and retail trade; repair of motor vehicles and motorcycles	10.4%	9.8%	14.4%	14.2%	-0.5	-0.2	-4.2	0.16	-0.19	-0.03	1.51%
Transportation and storage	4.6%	4.5%	4.9%	4.8%	-0.1	-0.1	2.4	0.02	0.00	0.02	0.40%
Accommodation and food service activities	1.4%	1.4%	3.9%	4.1%	0.0	0.2	7.3	-0.06	0.05	0.00	-3.84%
Information and communication	4.6%	4.3%	3.0%	2.8%	-0.3	-0.1	3.2	-0.14	0.02	-0.11	-2.89%
Financial and insurance activities	4.3%	5.0%	3.0%	3.0%	0.7	0.0	5.6	0.15	-0.03	0.12	2.36%
Real estate activities	11.6%	11.4%	1.2%	1.1%	-0.2	0.0	-0.6	0.32	-0.23	0.09	2.88%
Professional, scientific and technical activities	6.7%	6.2%	5.8%	5.9%	-0.6	0.1	0.3	-0.20	0.11	-0.09	-2.99%
Administrative and support service activities	4.6%	4.6%	6.5%	6.8%	0.0	0.3	0.1	0.01	0.06	0.07	0.21%
Public administration and defence; compulsory social security	6.0%	6.4%	6.7%	6.7%	0.3	0.0	-1.2	0.22	-0.02	0.20	3.60%
Education	4.2%	4.5%	5.4%	5.6%	0.3	0.2	1.0	0.06	0.07	0.14	1.52%
Human health activities	4.7%	5.1%	6.5%	6.8%	0.4	0.2	5.4	0.09	0.13	0.22	1.81%
Residential care and social work activities	1.7%	1.9%	4.8%	5.1%	0.2	0.4	1.4	0.01	0.08	0.09	0.69%
Arts, entertainment and recreation	1.3%	1.3%	1.5%	1.5%	0.0	0.0	0.2	0.00	0.01	0.01	0.04%
Other service activities	2.7%	2.6%	3.7%	3.7%	-0.1	0.0	1.2	-0.01	0.02	0.01	-0.28%
Activities of households	0.3%	0.3%	2.1%	1.9%	0.0	-0.2	1.1	0.00	0.00	0.00	0.57%
Whole economy	100.0%	100.0%	100.0%	100.0%	N/A	N/A	N/A	1.39	-0.51	0.88	0.88%

Note: N/A, not applicable.

Source: OECD (2020). Structural Analysis Database (STAN).

TABLE 5: GERMANY: SECTORAL CONTRIBUTIONS TO OVERALL PRODUCTIVITY GROWTH, 2011–2017

Economic sector	Output shares		Employment shares		Structural change (2011–17, percentage points)			Contribution to productivity growth (2011–17, average, percentage points)			Labour productivity growth (2011–17)
	2011	2017	2011	2017	Output	Employment	Relative output prices	Intra-industry productivity growth effect (1)	Allocation effect (2)	Total (3) = (1) + (2)	
Agriculture, forestry and fishing	1.0%	0.9%	1.6%	1.4%	-0.1	-0.2	2.1	0.09	-0.06	0.03	8.73%
Mining and quarrying	0.2%	0.1%	0.2%	0.1%	-0.1	0.0	-9.6	0.00	-0.01	-0.01	1.83%
Manufacturing	22.5%	22.8%	17.5%	17.2%	0.3	-0.4	-0.1	0.66	0.07	0.73	2.95%
Electricity, gas, steam and air conditioning supply	2.0%	1.7%	0.6%	0.6%	-0.2	0.0	-5.2	-0.03	-0.01	-0.04	-0.64%
Water supply; sewerage, waste management and remediation activities	1.1%	1.1%	0.6%	0.6%	0.0	0.0	0.9	0.03	0.00	0.03	3.25%
Construction	4.4%	4.7%	5.7%	5.6%	0.3	-0.1	2.0	0.18	-0.01	0.18	4.02%
Wholesale and retail trade; repair of motor vehicles and motorcycles	9.9%	10.0%	14.1%	13.4%	0.1	-0.7	0.1	0.37	-0.09	0.28	3.83%
Transportation and storage	4.4%	4.4%	4.9%	5.1%	0.0	0.2	2.4	0.06	0.04	0.10	1.23%
Accommodation and food service activities	1.4%	1.6%	4.1%	4.2%	0.2	0.1	2.3	0.09	-0.02	0.07	6.04%
Information and communication	4.5%	4.6%	2.8%	2.9%	0.1	0.1	1.9	0.11	0.05	0.16	2.53%
Financial and insurance activities	4.8%	4.0%	2.9%	2.6%	-0.8	-0.3	-2.7	0.10	-0.12	-0.02	2.35%
Real estate activities	11.5%	10.6%	1.1%	1.1%	-0.9	0.0	0.4	0.28	-0.10	0.18	2.52%
Professional, scientific and technical activities	6.0%	6.4%	6.0%	6.4%	0.4	0.4	-0.2	0.14	0.06	0.20	2.26%
Administrative and support service activities	4.6%	5.1%	7.0%	7.4%	0.4	0.5	0.9	0.12	0.08	0.20	2.49%
Public administration and defence; compulsory social security	6.2%	6.1%	6.3%	5.9%	-0.1	-0.4	-0.1	0.20	-0.08	0.12	3.28%
Education	4.4%	4.6%	5.6%	5.6%	0.1	0.1	1.5	0.12	0.01	0.13	2.62%
Human health activities	5.1%	5.3%	6.8%	7.2%	0.3	0.4	-3.9	0.17	0.00	0.17	3.14%
Residential care and social work activities	1.9%	2.2%	5.2%	5.9%	0.3	0.7	0.3	0.06	0.04	0.10	3.03%
Arts, entertainment and recreation	1.3%	1.4%	1.5%	1.5%	0.0	0.0	-0.3	0.05	-0.01	0.04	3.55%
Other service activities	2.5%	2.2%	3.6%	3.3%	-0.3	-0.3	-0.4	0.05	-0.04	0.01	2.20%
Activities of households	0.3%	0.2%	1.9%	1.9%	0.0	0.0	0.9	0.01	0.00	0.00	2.33%
Whole economy	100.0%	100.0%	100.0%	100.0%	N/A	N/A	N/A	2.87	-0.21	2.66	2.66%

Note: N/A, not applicable.

Source: OECD (2020). Structural Analysis Database (STAN).

TABLE 6: GERMANY: SECTORAL CONTRIBUTIONS TO OVERALL PRODUCTIVITY GROWTH, 1998–2017

Economic sector	Output shares		Employment shares		Structural change (1998–2017, percentage points)			Contribution to productivity growth (1998–2017, average, percentage points)			Labour productivity growth (1998–2017)
	1998	2017	1998	2017	Output	Employment	Relative output prices	Intra-industry productivity growth effect (1)	Allocation effect (2)	Total (3) = (1) + (2)	
Agriculture, forestry and fishing	1.1%	0.9%	2.0%	1.4%	-0.2	-0.6	26.75	0.04	-0.03	0.01	4.32%
Mining and quarrying	0.3%	0.1%	0.4%	0.1%	-0.1	-0.2	6.69	0.01	-0.01	0.00	4.28%
Manufacturing	22.5%	22.8%	20.2%	17.2%	0.3	-3.0	-3.58	0.65	-0.14	0.50	3.05%
Electricity, gas, steam and air conditioning supply	1.9%	1.7%	0.8%	0.6%	-0.1	-0.2	0.85	0.07	-0.04	0.03	4.10%
Water supply; sewerage, waste management and remediation activities	1.0%	1.1%	0.7%	0.6%	0.1	0.0	1.43	0.03	0.00	0.03	2.80%
Construction	5.7%	4.7%	7.8%	5.6%	-0.9	-2.2	4.83	0.10	-0.07	0.03	2.25%
Wholesale and retail trade; repair of motor vehicles and motorcycles	10.4%	10.0%	15.1%	13.4%	-0.4	-1.7	-1.00	0.29	-0.08	0.20	2.87%
Transportation and storage	4.0%	4.4%	4.8%	5.1%	0.3	0.3	0.03	0.10	0.00	0.11	2.41%
Accommodation and food service activities	1.5%	1.6%	3.5%	4.2%	0.1	0.7	-1.70	0.04	0.00	0.04	2.66%
Information and communication	4.5%	4.6%	2.5%	2.9%	0.0	0.4	0.53	0.07	0.05	0.12	1.53%
Financial and insurance activities	4.6%	4.0%	3.3%	2.6%	-0.5	-0.7	-0.11	0.17	-0.11	0.06	3.22%
Real estate activities	10.9%	10.6%	1.1%	1.1%	-0.4	0.0	3.46	0.22	-0.01	0.21	2.00%
Professional, scientific and technical activities	6.5%	6.4%	4.1%	6.4%	-0.1	2.3	0.48	-0.03	0.16	0.13	-0.40%
Administrative and support service activities	3.7%	5.1%	4.3%	7.4%	1.4	3.1	1.13	0.04	0.12	0.17	0.97%
Public administration and defence; compulsory social security	6.6%	6.1%	7.8%	5.9%	-0.6	-1.9	1.45	0.17	-0.08	0.10	2.74%
Education	4.3%	4.6%	4.9%	5.6%	0.2	0.8	1.92	0.06	0.04	0.10	1.44%
Human health activities	4.7%	5.3%	6.1%	7.2%	0.7	1.1	-5.52	0.09	0.05	0.14	1.78%
Residential care and social work activities	1.5%	2.2%	4.0%	5.9%	0.7	1.9	1.94	0.04	0.04	0.08	2.04%
Arts, entertainment and recreation	1.3%	1.4%	1.2%	1.5%	0.1	0.3	0.35	0.02	0.01	0.03	1.62%
Other service activities	2.6%	2.2%	3.4%	3.3%	-0.4	-0.1	0.58	0.03	-0.01	0.03	1.34%
Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.3%	0.2%	2.1%	1.9%	0.0	-0.2	0.63	0.01	0.00	0.00	1.93%
Whole economy	100.0%	100.0%	100.0%	100.0%	N/A	N/A	N/A	2.23	-0.12	2.11	2.11%

Note: N/A, not applicable.

Source: OECD (2020). Structural Analysis Database (STAN).

TABLE 7: GERMANY: CONTRIBUTIONS OF MANUFACTURING SUB-SECTORS TO OVERALL PRODUCTIVITY GROWTH, 1998–2017

Manufacturing sub-sector	1998–2007 (average, percentage points)			2008–2010 (average, percentage points)			2011–2017 (average, percentage points)			1998–2017 (average, percentage points)		
	Intra-industry productivity growth effect	Allocation effect	Total	Intra-industry productivity growth effect	Allocation effect	Total	Intra-industry productivity growth effect	Allocation effect	Total	Intra-industry productivity growth effect	Allocation effect	Total
Food products, beverages and tobacco	0.00	0.01	0.01	0.12	-0.12	0.01	0.02	0.02	0.04	0.03	-0.01	0.02
Textiles, wearing apparel, leather and related products	0.01	-0.02	-0.01	0.01	-0.02	-0.01	0.01	-0.01	0.00	0.01	-0.02	-0.01
Wood and paper products, and printing	0.03	-0.04	-0.01	0.01	-0.05	-0.04	0.02	-0.02	0.00	0.02	-0.03	-0.01
Chemical, rubber, plastics, fuel products and other non-metallic mineral products	0.11	-0.04	0.07	0.20	-0.16	0.04	0.06	0.03	0.09	0.11	-0.03	0.07
Basic metals and fabricated metal products, except machinery and equipment	0.10	0.01	0.11	-0.02	-0.13	-0.15	0.05	0.02	0.07	0.06	-0.01	0.05
Manufacture of computer, electronic and optical products	0.08	-0.03	0.06	-0.10	0.01	-0.09	0.03	0.02	0.05	0.04	-0.01	0.03
Manufacture of electrical equipment	0.03	-0.01	0.02	0.10	-0.04	0.06	0.03	-0.01	0.02	0.04	-0.02	0.02
Manufacture of machinery and equipment n.e.c.	0.12	0.00	0.12	0.01	-0.08	-0.07	0.09	0.04	0.13	0.09	0.00	0.09
Transport equipment	0.17	-0.01	0.16	0.14	-0.11	0.03	0.28	0.03	0.31	0.20	-0.01	0.19
Furniture; other manufacturing; repair and installation of machinery and equipment	0.05	-0.01	0.03	0.01	0.01	0.02	0.04	0.00	0.03	0.04	-0.01	0.03
Total manufacturing	0.71	-0.15	0.56	0.42	-0.63	-0.21	0.66	0.07	0.73	0.65	-0.14	0.50

Source: OECD (2020). Structural Analysis Database (STAN).

TABLE 8: GERMANY: CHANGES IN RELATIVE SIZE OF MANUFACTURING SUB-SECTORS, 1998–2017

Manufacturing sub-sector	Change, 1998–2007, percentage points			Change, 2008–2010, percentage points			Change, 2011–2017, percentage points			Change, 1998–2017, percentage points		
	Output shares	Employment shares	Relative output prices	Output shares	Employment shares	Relative output prices	Output shares	Employment shares	Relative output prices	Output shares	Employment shares	Relative output prices
Food products, beverages and tobacco	-0.3	-0.1	-2.7	0.0	0.0	-22.5	0.0	-0.1	-2.2	-0.3	-0.1	1.2
Textiles, wearing apparel, leather and related products	-0.2	-0.3	-1.2	0.0	0.0	1.4	0.0	-0.1	-0.9	-0.3	-0.5	-4.6
Wood and paper products, and printing	-0.3	-0.4	0.6	-0.1	-0.1	0.2	-0.1	-0.1	-4.4	-0.6	-0.7	-2.8
Chemical, rubber, plastics, fuel products and other non-metallic mineral products	-0.2	-0.4	-3.4	0.1	-0.1	-1.5	-0.1	0.0	-0.7	-0.4	-0.6	2.2
Basic metals and fabricated metal products, except machinery and equipment	0.3	-0.2	2.6	-0.5	-0.2	-4.1	-0.2	-0.1	-0.5	-0.2	-0.3	0.7
Manufacture of computer, electronic and optical products	0.3	-0.1	-8.0	-0.1	-0.1	13.7	0.1	0.0	9.2	0.1	-0.1	6.0
Manufacture of electrical equipment	-0.1	-0.1	2.6	0.1	0.0	-3.5	-0.2	-0.1	-0.5	-0.2	-0.3	-0.9
Manufacture of machinery and equipment n.e.c.	0.4	-0.1	1.6	-0.4	-0.1	-3.1	0.0	0.0	-0.4	0.3	-0.1	-3.4
Transport equipment	0.6	-0.1	-2.8	0.4	-0.1	3.6	0.9	0.1	-0.3	1.8	-0.1	-5.5
Furniture; other manufacturing; repair and installation of machinery and equipment	0.0	-0.2	1.7	0.1	0.0	-4.7	-0.1	-0.1	0.1	0.0	-0.3	0.1
Total manufacturing	0.7	-2.1	-1.3	-0.4	-0.9	-1.9	0.3	-0.4	-0.1	0.3	-3.1	-0.6

Source: OECD (2020). Structural Analysis Database (STAN).

TABLE 9: GERMANY: PRODUCTIVITY GROWTH DECOMPOSITION OF 'MARKET SECTORS', 1998–2017

Economic sector	All sectors			'Market' sectors		
	Contribution to productivity growth (1998–2017, average, percentage points)			Contribution to productivity growth (1998–2017, average, percentage points)		
	Intra-industry productivity growth effect (1)	Allocation effect (2)	Total (3) = (1) + (2)	Intra-industry productivity growth effect (1)	Allocation effect (2)	Total (3) = (1) + (2)
Agriculture, forestry and fishing	0.04	-0.03	0.01	0.06	-0.04	0.02
Mining and quarrying	0.01	-0.01	0.00	0.01	-0.02	0.00
Manufacturing	0.65	-0.14	0.50	0.92	-0.15	0.77
Electricity, gas, steam and air conditioning supply	0.07	-0.04	0.03	0.10	-0.05	0.05
Water supply; sewerage, waste management and remediation activities	0.03	0.00	0.03	0.04	0.00	0.04
Construction	0.10	-0.07	0.03	0.14	-0.08	0.05
Wholesale and retail trade; repair of motor vehicles and motorcycles	0.29	-0.08	0.20	0.41	-0.09	0.31
Transportation and storage	0.10	0.00	0.11	0.15	0.02	0.16
Accommodation and food service activities	0.04	0.00	0.04	0.06	0.00	0.06
Information and communication	0.07	0.05	0.12	0.09	0.09	0.18
Financial and insurance activities	0.17	-0.11	0.06	0.24	-0.14	0.10
Real estate activities	0.22	-0.01	0.21			
Professional, scientific and technical activities	-0.03	0.16	0.13	-0.04	0.25	0.20
Administrative and support service activities	0.04	0.12	0.17	0.06	0.19	0.25
Public administration and defence; compulsory social security	0.17	-0.08	0.10	N/A	N/A	N/A
Education	0.06	0.04	0.10	N/A	N/A	N/A
Human health activities	0.09	0.05	0.14	N/A	N/A	N/A
Residential care and social work activities	0.04	0.04	0.08	N/A	N/A	N/A
Arts, entertainment and recreation	0.02	0.01	0.03	0.03	0.02	0.05
Other service activities	0.03	-0.01	0.03	0.05	0.00	0.05
Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.01	0.00	0.00	0.01	0.00	0.01
Whole economy	2.23	-0.12	2.11	2.31	-0.03	2.29

Note: N/A, not applicable.

Source: OECD (2020). Structural Analysis Database (STAN).

Appendix I. Definitions of variables and data sources

Variable	Measure, units	Source
Labour (hours)	Hours worked – hours, millions	OECD (2020). Structural Analysis Database (STAN)
Labour (people)	Number of persons engaged (total employment) – persons, thousands	
Output (real values)	Value added, chained prices of the previous year – euros, millions	
Output (nominal values)	Value added, current prices – euros, millions	

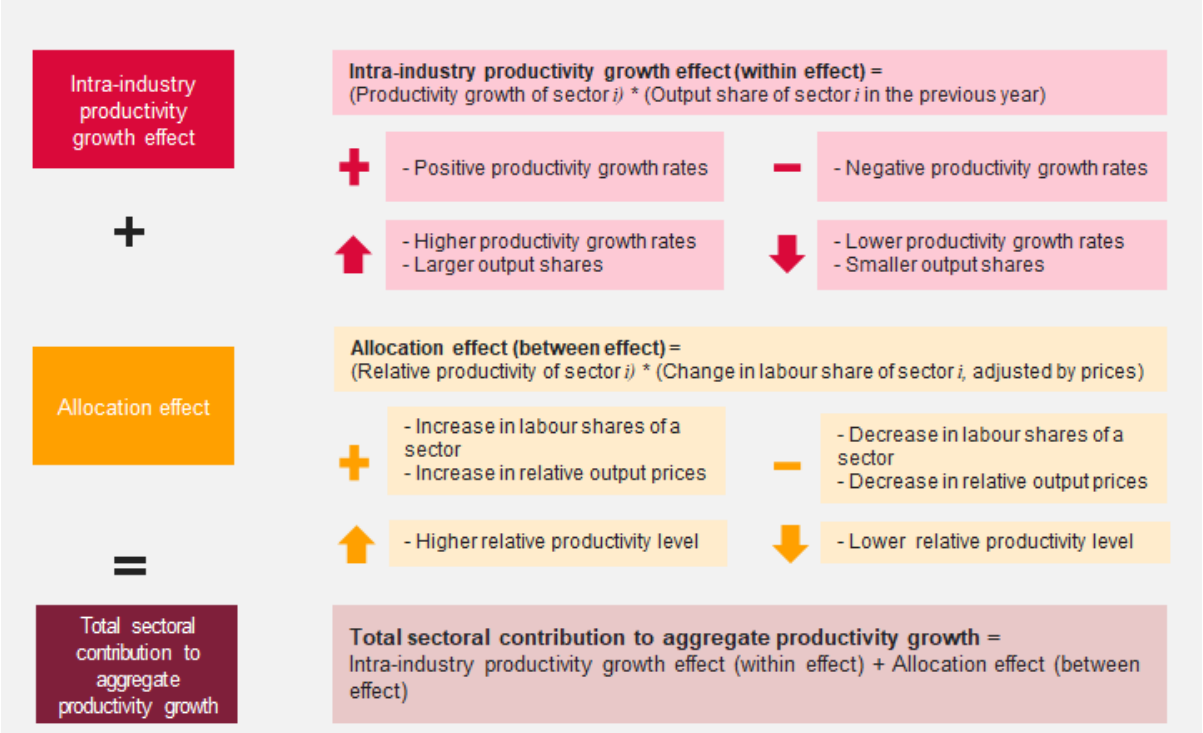
Appendix II. Decomposition of productivity growth

Economic sectors contribute disparately to aggregate productivity growth, depending on their productivity gains over time, as well as their weight in the total economy and relative productivity differences.

In order to understand the extent and nature of these contributions, we decompose the economy-wide labour productivity growth rates into sectoral contribution effects, as described in Tang and Wang:[13] (i) an intra-industry effect that captures the productivity growth of each economic sector, given the relative importance in the economy (within effect); and (ii) an allocation effect (between-industries effect) that captures the effects of changes in the relative size of sectors.

The *intra-industry productivity growth effect* of a given sector i takes positive (negative) values whenever the sector shows positive (negative) productivity growth. Its magnitude depends on the productivity growth rate and how large the sector is in relation to other sectors in the economy. Assuming that a sector i shows a productivity level that is above the national average, then the *allocation effect* will take positive (negative) values if the sector increases (decreases) in size. The relative size is determined by changes in labour shares and the relative output prices of sector i. By changes in relative output prices, we mean how much output prices in sector i change in relation with changes in the output prices of the whole economy.

FIGURE A.1: DECOMPOSITION OF SECTORAL CONTRIBUTION TO AGGREGATE PRODUCTIVITY GROWTH



Source: Authors, based on Tang and Wang (2004).

[13] Tang, J. and Wang, W. (2004). Sources of aggregate labour productivity growth in Canada and the United States. *Canadian Journal of Economics*, Volume 37, Number 2.

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