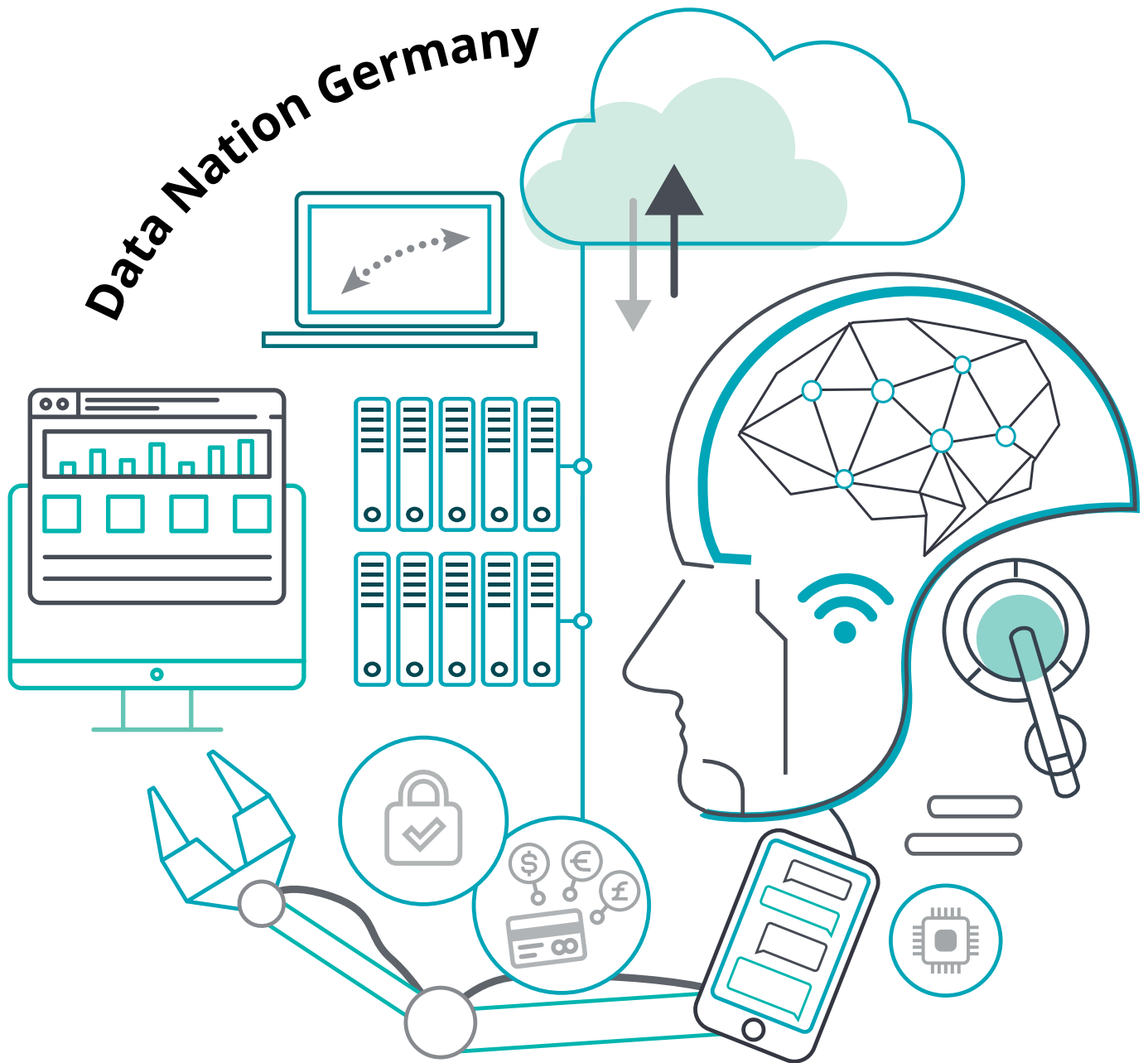


The German Technology Sector From Hardware to Software & Services

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Data Nation Germany



Executive Summary

The German technology sector is going through a remarkable evolutionary process, the essential feature of which is the contrasting development of the two large sector segments of “Hardware” and “Software and Services”. The segments differ significantly in their developmental dynamics: While the Hardware sales revenues have been stagnant for years, Software and Services have become the fundamental growth drivers for the entire technology sector.

The results of the present study reveal that:

- Sales revenues of the German technology industry will have grown by the year 2022 by more than 20 percent to almost 280 billion euros. Hence, the tech sector will show a growth rate that is stronger by seven percentage points than the nominal gross domestic product over the same period.
- Fueled by new megatrends, the investments in digital growth fields in the area of convergence between the technology sector and other sectors will continue to increase in the months ahead. There are three relevant drivers: The Internet of Things and 5G, Analytics and Artificial Intelligence and new “as-a-Service” business models (XaaS).
- Within the technology sector, there is a distinct global division of labor. Germany's contribution consists primarily of software and services for the digitalization of companies and processes as well as of high-revenue special hardware.
- Today, the tech sector is already closely integrated with other sectors. There are particularly close links with the mechanical engineering sector where German companies have a strong history of technological expertise. Thus, significant future opportunities lie in the field of Industry 4.0.

Introduction

Technology companies are innovation drivers for Germany as a business location as well as business enablers and process designers for new digital offerings. In addition, the tech sector is a key economic driver. In Germany, the sector stands for more than 100,000 companies, more than one million jobs, and sales revenues in excess of 230 billion euros, which means that this sector already accounts for nearly seven percent of the German economic output.

During the last years, the German technology sector held its ground in a somewhat ambivalent market environment: On the one hand, digitalization offered huge opportunities; on the other hand, the sector faced increasingly global competition. This has led to a sometimes painful, but ultimately successful evolutionary process, at the end of which there is a focus on specialized, high-margin supplies and an increased focus on the sector segment of "Software and Services".

How is the German technology sector positioned today? How strong are the links to other sectors? What is the position of Germany as a supplier of technological components and services in the global context? Which are the source and destination countries with which there are particularly intense flows of goods and services? And which are the relevant drivers for the further development of the technology sector?

The present analysis delivers the right answers on the basis of a detailed macro-economic consideration of the underlying figures and the input-output analysis of Deloitte Economic Consulting.

Technology: definition of an sector

For the technology sector, there is no generally accepted or universal industry definition. Instead, the definition is sometimes more restrictive and sometimes wider. As a result, the data on market size vary in the relevant sources significantly depending on the underlying definition.

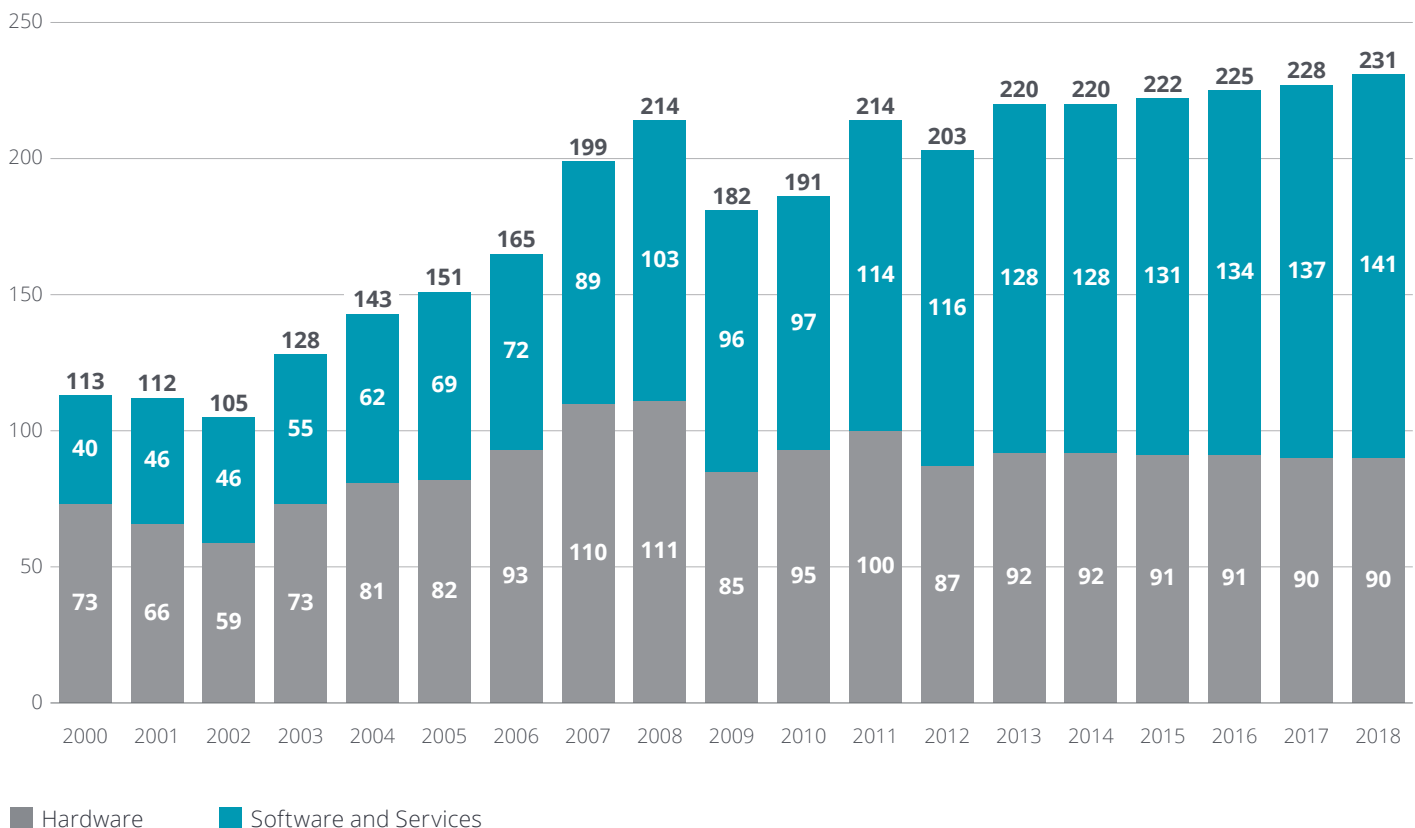
The following analysis and the figures reported are based on the segments of “Hardware” (Code 26) and “Software and Services” (Codes 62 and 63) acc. to ISIC, Rev.4 Classification (International Standard Industrial Classification of All Economic Activities). Hence, the major sector segments covered include, among others, computer hardware, semiconductors, communication equipment, consumer electronics, IT services as well as data processing and hosting.

Looking Back: Software and Services as Growth Drivers

In the past years, the German technology sector was characterized by exceptionally strong dynamics. Since the millennium, the sector has gone through considerable periods of growth, intervals of stagnation and a radical shift of powers within the relevant

sector segments. Figure 1 illustrates the quantitative development of the German technology sector and shows the historical development trend in the major segments of "Software and Services" and "Hardware".

Fig. 1 – Annual Technology Sector Sales Revenues* in Germany by Segment in Billion Euros (2000–2018)



* Market perspective, without exports of German technology companies
Sources: Deloitte, World Input-Output Database, OECD, Oxford Economics

A glance at the past years shows: The German technology market has more than doubled (+104 %) since the year 2000. However, the growth trend was by no means steady. Rather, the positive development is not least the result of the extremely strong increase in the years between 2002 and 2008. The compound annual growth rate (CAGR) in this period was a remarkable 12.6 %. Since then, this rapid trend has come to a halt; instead, the sector sales revenues in the last years have remained at a level offering at best a very moderate growth.

The German technology market has more than doubled since 2000.

When searching for the causes of the dynamic and partially almost erratic sector development, looking at the two sector segments is useful and shows: Major growth drivers of the last two decades are Software and Services, whose sales revenues have increased on average by 7.3 percent p.a. since 2000, whereas for Hardware the annual growth was only at 1.2 percent. This means that the weightings of the segments have reversed in the past two decades: At the beginning of the period under review, Hardware accounted for two thirds of the technology sector sales revenues in Germany; meanwhile, Software and Services are leading with almost the same share.

The Software and Services segment has shown continuous development over the entire period. Even in the years of the financial crisis, the sales revenues remained largely stable, whereas the Hardware segment faced significant declines during that period. Moreover, the moderate growth rates of the technology sector in the recent past was also exclusively generated by

Software and Services. The reasons for this strength lie in the unstoppable digitalization, which has not only led to a noticeably increased demand for the different variations of software; the increasingly large number and complexity of digital solutions have also strongly pushed the demand for IT services.

On the other hand, the Hardware segment has reacted significantly more sharply to economic cycles and has been facing diverse restraining factors: A sustainable decline in prices of numerous hardware categories, the loss of importance of classic consumer electronics as well as locational cost disadvantages in the area of production, which has been shifted more and more to the Asian region. As a result, the Hardware growth rate has developed to a very limited extent and could hardly benefit in terms of sales from the digital megatrends of the past years.

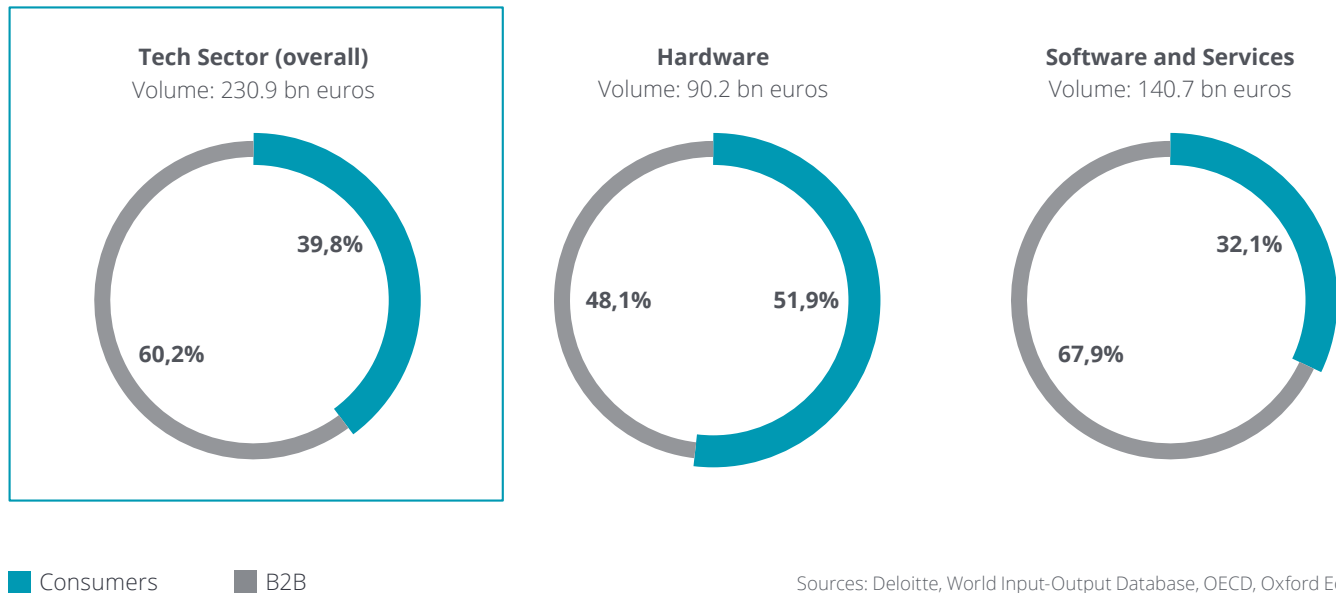
Sector Convergence: Technology as Innovation Driver

Nowadays, technology is a key element of business models also outside the actual tech sector. This is particularly evident when considering the numerous digital growth areas, which in the past years have evolved in the intersection of technology and other industries. For Industry 4.0, Connected Car, BioTech, FinTech, Insure-Tech, E-/M-Health or Smart City, the expertise of technology companies is an indispensable element. It is not just in this area that the entire technology sector indirectly benefits as a supplier of digital input services. Thus, the business-to-business (B2B) sales of the technology sector with a share of more than 60 percent are significantly above the revenues that are directly achieved from sales to consumers (see Fig. 2).





Fig. 2 – Share of the Sector Sales Revenues by Origin (2018)



A closer look reveals significant differences within the two technology sector segments. For instance, the B2B revenue share of Software and Services accounts for more than two thirds. It is here where input services for other sectors are strongly reflected. In contrast, sales to consumers prevail in the Hardware segment. The reason for this is the strong consumer business with smartphones, PCs and consumer electronics. However, the B2B share with regard to hardware sales should not be neglected and is almost equal with about 48 percent.

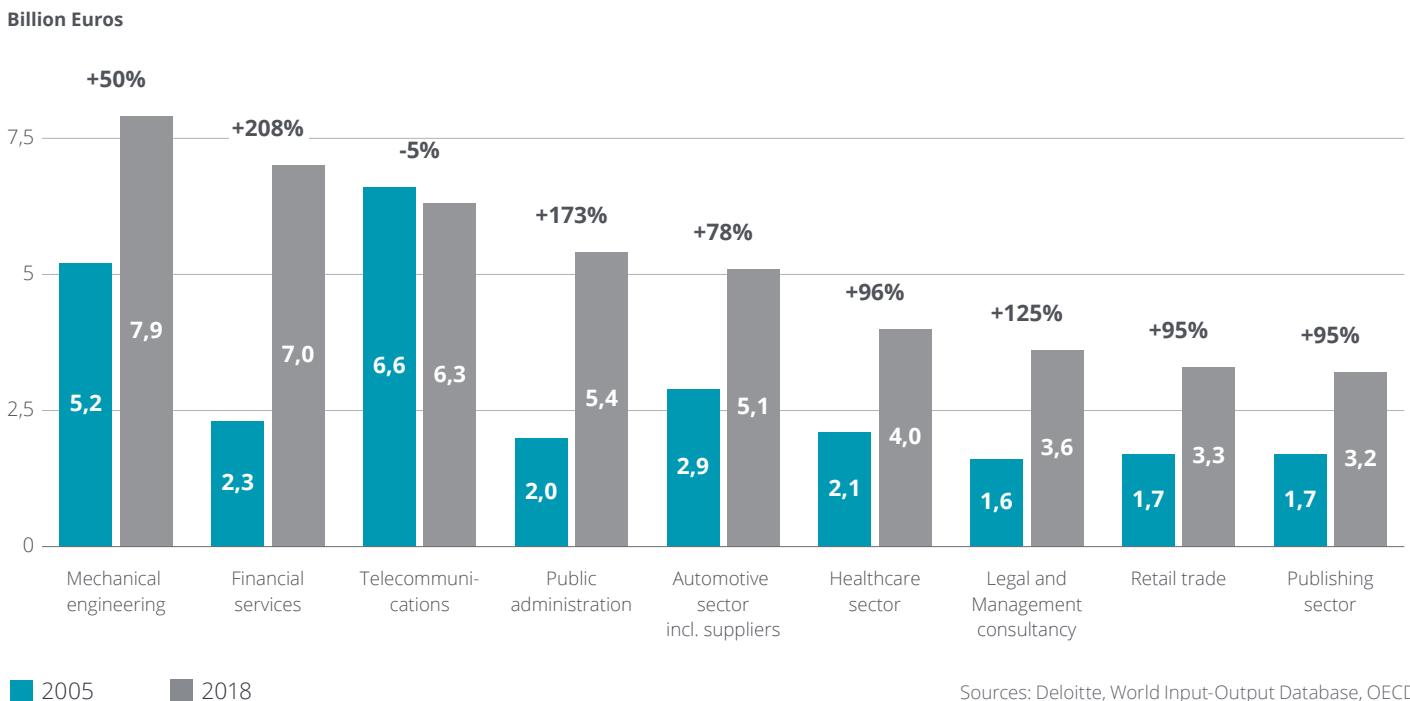
The high B2B revenue share is a strong indicator for the integration of the tech sector with other sectors.

Close Integration with the mechanical engineering sector

The high B2B share in sales is a strong indicator for the integration of the tech sector with other sectors. And where are the links especially close? Figure 3 breaks down the B2B sales revenues of the tech sector by sectors and contrasts these revenues with the figures from the year 2005. Here

it becomes evident that the tech sector especially converges with the mechanical engineering sector, the financial services industry, the telecommunications sector and the public administration sector. And in almost all sectors, some considerable growths have been recorded in recent years.

Fig. 3 – B2B Gross Sales Revenues of the Tech Sector with Selected German Sectors in Billion Euros (2005, 2018)



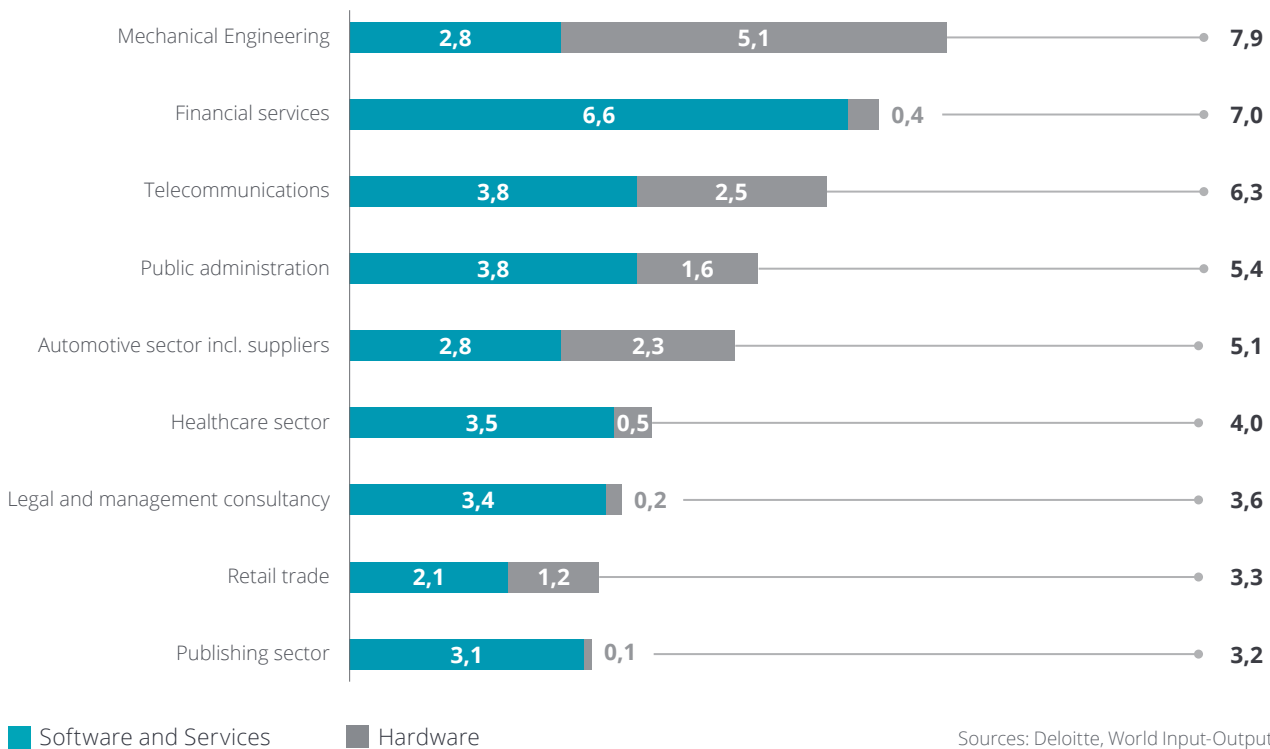
A key cause of the strong increase in the B2B sales revenues since 2005 has been the increasing digitalization of processes, which often covers entire business models. In other words: The technology sector is a major business enabler for the digitalization of other sectors. It is particularly with financial services providers and the public administration that technology companies today generate a multiple of their sales revenues from 2005. An exception is the telecommunications sector. Already in 2005, tech companies delivered network infrastructure, software and IT services to telco providers to a large extent. Like no

other sector, the telecommunications sector was digitalized at an early stage and even then was dependent on high-performance hardware. The sales level, which was already high in 2005, and the decline in prices of hardware in the end even led to a slight decline in the B2B revenues that technology companies generate with the telco sector. Added to this was the general pressure on telecommunications rates and the related stagnation of the market, which the network operators could also not compensate by a large-scale growth of B2B services or other OTT services.

Software and Services more frequently requested

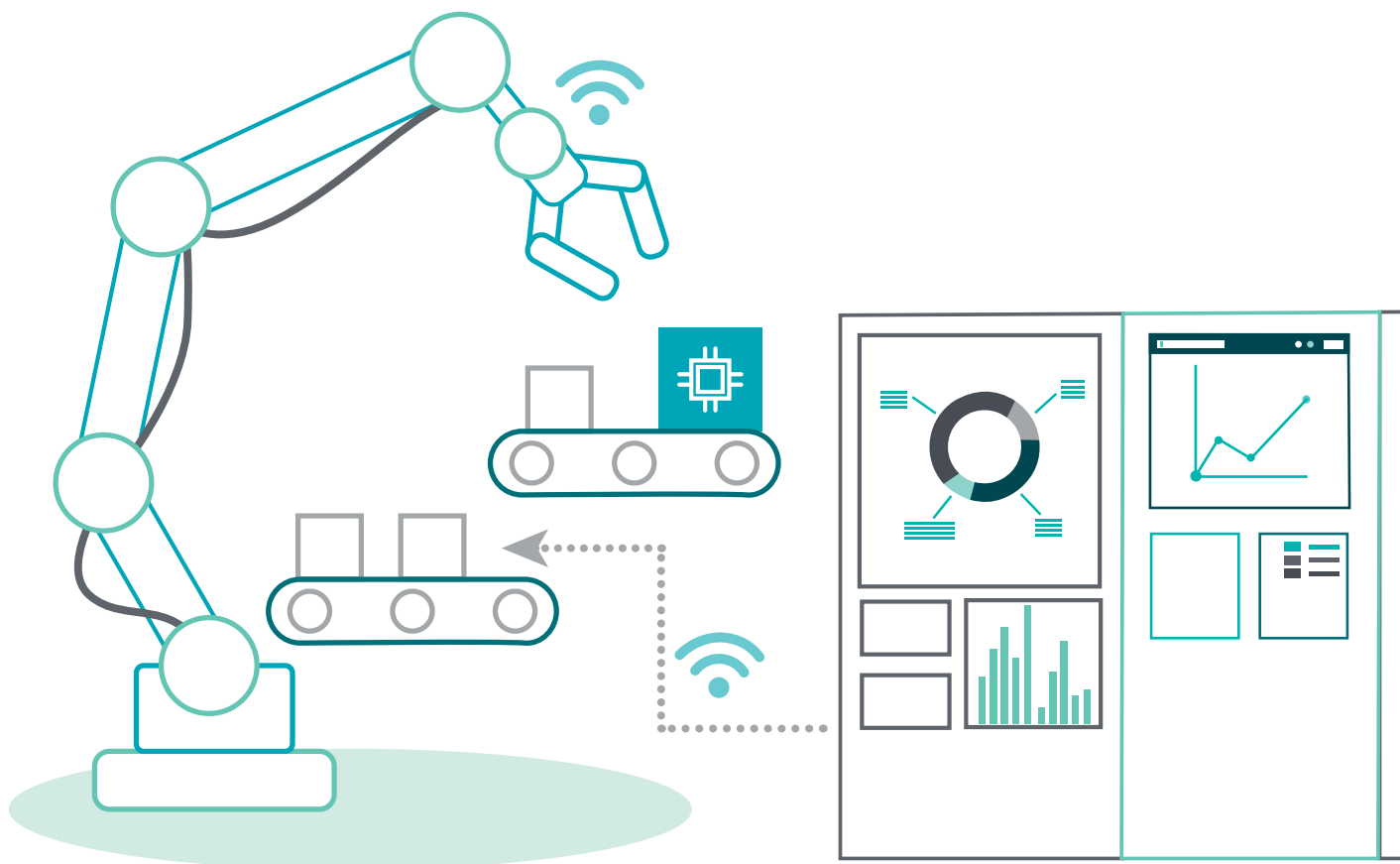
Figure 4 shows the B2B sales revenues of the technology sectors from another perspective, which focuses on the breakdown by Hardware and Software and Services. The figures show: The demand for technology offerings varies from sector to sector and is greatly dependent on their respective features and requirements.

Fig. 4 – B2B Gross Sales Revenues of the Sectors with Selected German Sectors in Billion Euros (2018)



In the manufacturing sector, the hardware shares tend to be higher. The mechanical engineering sector is the only sector to which technology companies supply even more hardware components than Software and Services. An orientation towards Industry 4.0 drives the demand, for example, for sensors, cameras, and robots, which stimulates the hardware share. The automotive sector also has a comparatively strong demand for hardware, which, however, is considerably lower than the demand in the mechanical engineering sector. The development of autonomous vehicles and the increasing importance of in-vehicle connectivity and infotainment will push the “Software and Services” share in the automotive sector in the foreseeable future.

By contrast, regarding financial services, the “Software and Services” sales revenues are predominant. The payment transactions, which meanwhile are handled mostly electronically, and the wide distribution of online and mobile banking require appropriate software solutions and consultancy services. Due to the high complexity of digital offerings in the financial services industry, high sales revenues will continue to be generated with Software and Services. The situation is similar in the healthcare sector, where the sales revenues from Software and Services are clearly predominant and where the foreseeable increase in digital healthcare services will also reinforce the existing trend.



Trade Flows: Global Interdependencies

The figures presented above illustrate the close interaction of the technology sector with other national sectors. In addition, there are strong global interrelations, which is evident from an overview of the international trade flows. In the technology sector, Germany imports goods and services with a value of about 107 billion euros; in return, corresponding exports constitute a value of 105 billion euros. Thus, the technology trade balance of Germany as the global export champion is slightly negative against the overall trend.

A more differentiated picture follows from a separate analysis of the segments of Hardware and Software and Services, which shows significant differences between the two segments. For instance, the volume of hardware imports totals 83 billion euros, which corresponds to an import quota of more than 90 percent. This quota only amounts to 17 percent with Software and Services, where the volume of imports totals 24 billion euros.



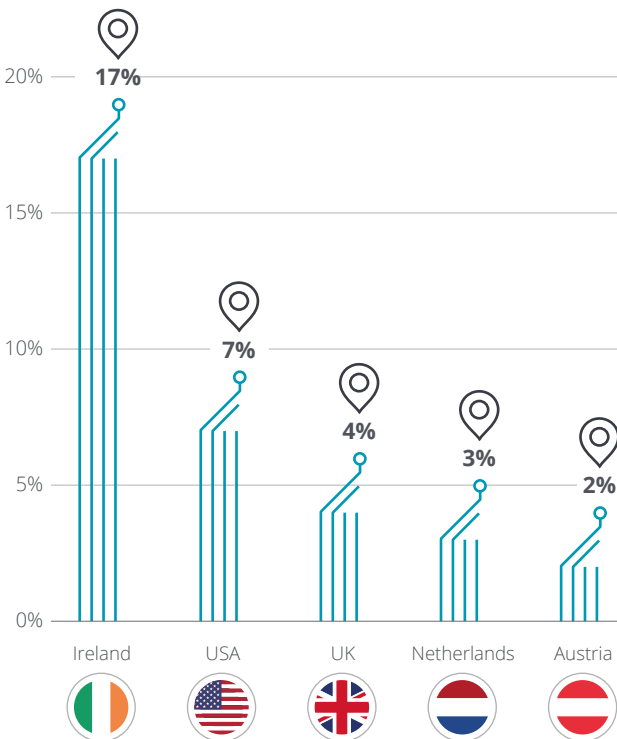
China and Ireland are leading in imports

The top 5 countries of origin of the technology imports are shown in Figure 5, where the prominent position of Ireland in Software and Service imports and the strong position of China in the Hardware segment is striking.

Fig. 5 – Top 5 Countries in Tech Imports (Share in Total Technology Imports)

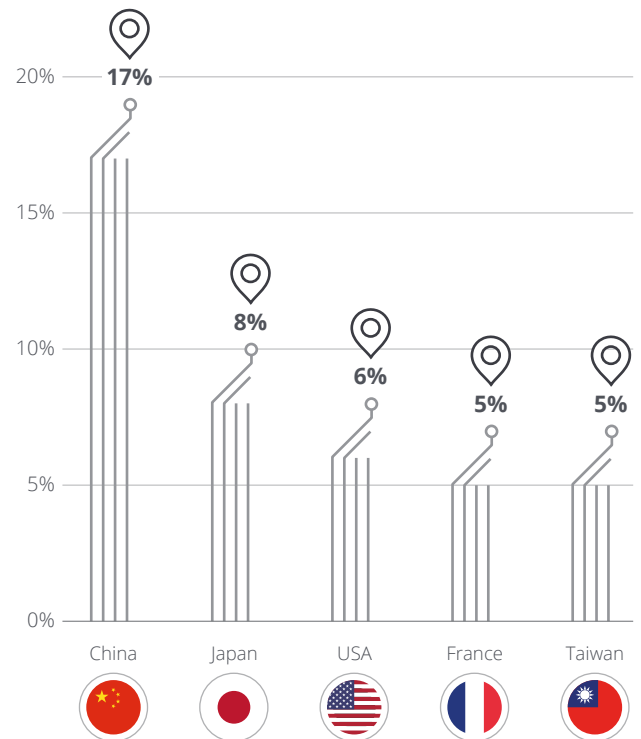
Software and Services

Import volume: €24 bn



Hardware

Import volume: €83 bn



Sources: Deloitte, World Input-Output Database, OECD

The role of China in the hardware segment is hardly surprising, as the country has been rated as the “technology workbench” and most important manufacturing site of hardware for years. In contrast, the position of Ireland requires at least some explanation: Numerous US-based technology groups and the large digital platform operators manage their European activities from Ireland. Half of the companies operating in Ireland with annual sales of more than 100 million euros have their international headquarters in the

U.S.A. Nevertheless, the billions from the German trade with online advertising, for instance, are initially transferred to Ireland. Behind the main trading partners Ireland and China, the regional distribution of the import flows appears to be very fragmented.

The German technology sector has a fairly broad global basis; there are no further significant dependencies on imports from individual countries. It is also worth noting that the import countries do not overlap

between the segments, so that currently there is no country from which Germany equally imports both Hardware and Software and Services.

Numerous destination countries for German Tech Exports

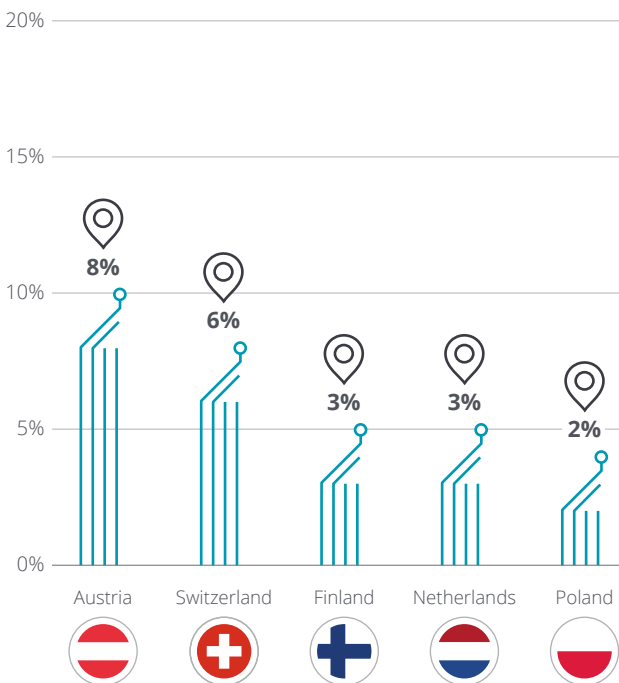
The export figures also illustrate the strong anchorage of the German tech sector in the global market context. German companies export Software and Services with a value of 27 billion euros;

in the Hardware segment, the export volume even amounts to 78 billion euros. The analysis of the German technology exports to destination countries shows a fragmented picture as is the case with the imports (see Fig. 6).

Abb. 6 – Top 5 Countries of Tech Exports (Share in Total Technology Exports)

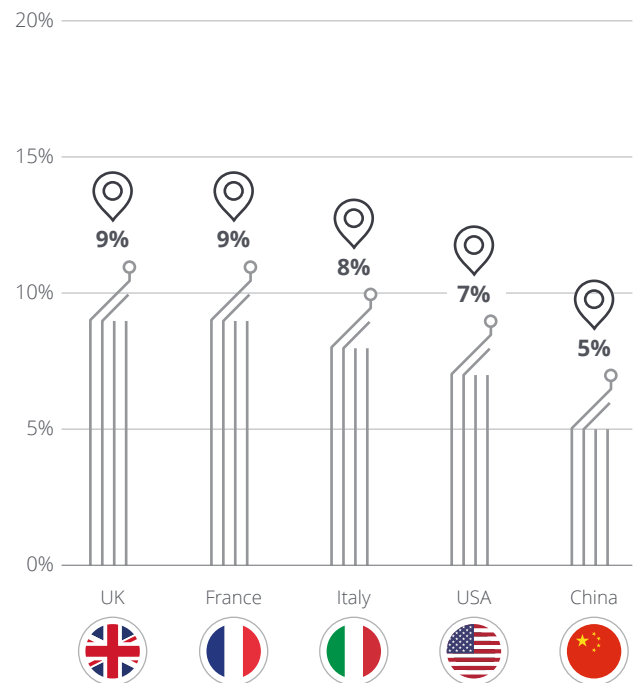
Software and Services

Export volume: €27 bn



Hardware

Export volume: €78 bn



Sources: Deloitte, World Input-Output Database, OECD

With the exports, there is also no overlap between the segments of Hardware and Software and Services in the Top-5 recipient countries. In contrast to the imports, there also no individual destination countries for German technology exports to be emphasized. Due to the geographical proximity and the lack of language barriers, Software and Services are first and foremost supplied to the German-speaking neighbors, i.e. Austria and Switzerland, whereas the destinations of hardware exports are often the large European markets of Great Britain, France and Italy.

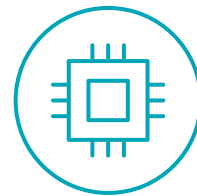
In all, a focused view on the German technology trade flows shows two significant peculiarities:

1. There are no risky dependencies on individual trading partners; the volume of the Chinese technology imports might at best cause concern to critical market observers.
2. The Hardware segments shows the now distinct global division of labor. The import quota for hardware sold in Germany is about 80 percent;

nevertheless, German companies export high-tech equipment in a nearly identical volume. While the domestic demand for highly competitive and low-margin consumer technology is met almost completely by imports, German technology companies primarily export high-revenue special hardware in the B2B segment.

Tech Megatrends Guaranteeing Further Dynamics

In the years after the millennium, the digitalization in the German technology sector triggered an enormous boom. Although some stagnation was evident in the last years, there are indications that the tech sector is awaiting a new boost to growth. While 20 years ago digitalization was the single trigger, today several technology megatrends have to be active. Together, they provide a crucial impetus to enable digital growth segments such as Industry 4.0, Connected Car, BioTech/FinTech, InsureTech, E-/M-Health or Smart City to exploit their huge potential:



Internet of Things and 5G

According to Deloitte's calculations, the number of IoT endpoints will rise to more than 20 billion globally by the year 2020, whereof 750 million are allotted to Germany. Virtually all such objects are of high relevance to the digital growth segments and thus are within the area of convergence between the technology sector and other sectors. Moreover, 5G, i.e. the next generation of mobile communications, is becoming a business enabler for even more sophisticated IoT services such as autonomous driving or telemedicine. Industry 4.0 also benefits from 5G due to the necessity of real-time control and management of networked machines. The implementation of these IoT services of the next generation requires new hardware, software and service expertise, which is contributed by the technology sector to a very high degree.



Analytics and Artificial Intelligence

The interaction of millionfold connectivity and new network infrastructures generates huge additional amounts of data. A potentially huge treasure of data will be generated by various applications, including the generation of location data from connected cars. The exploitation of this treasure also requires crucial technology expertise, in particular in the fields of Analytics and Artificial Intelligence (AI). In the months and years to come, German tech companies will benefit from the new opportunities, where potential for strong growth exists above all in the sector segment of "Software and Services".

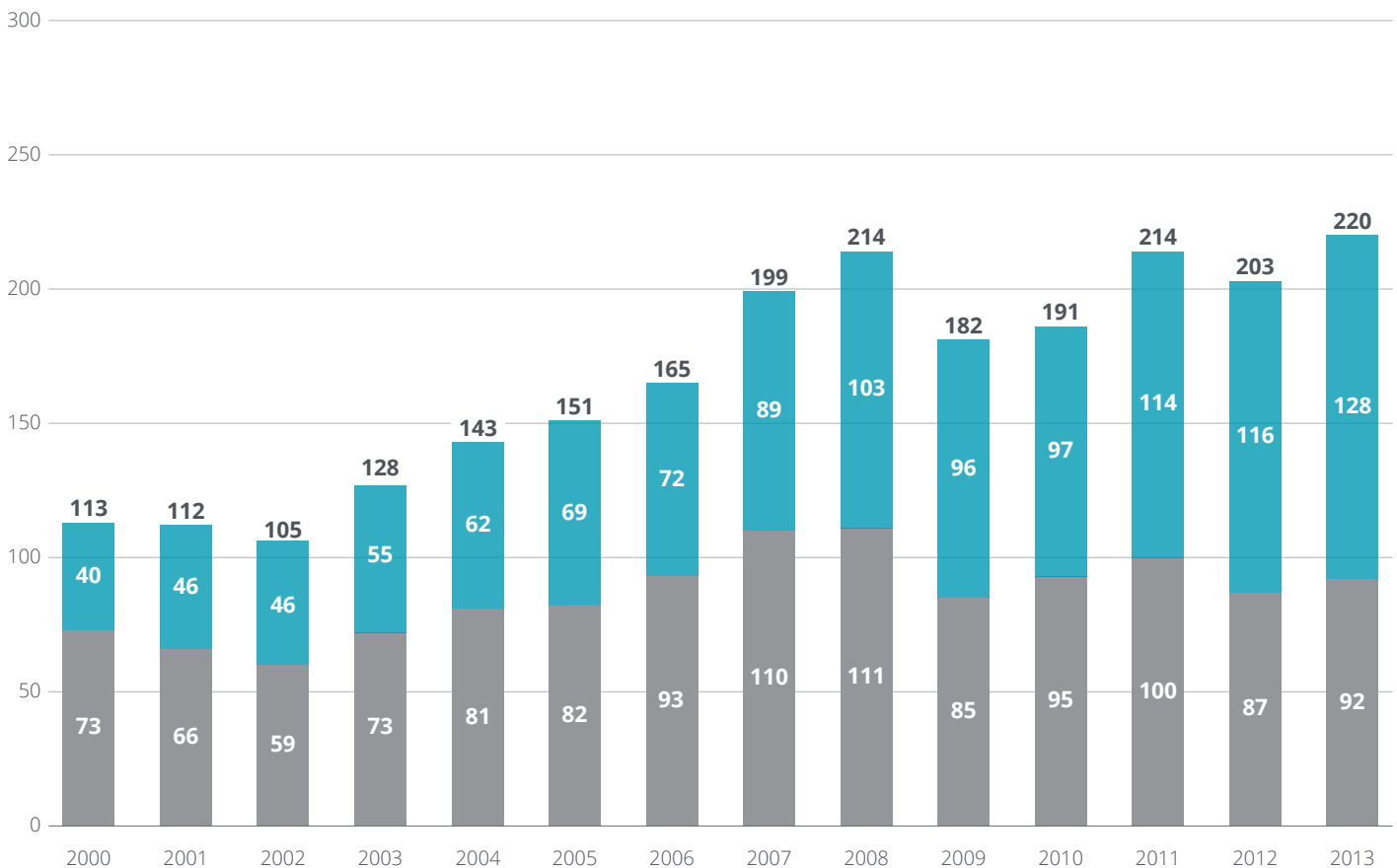


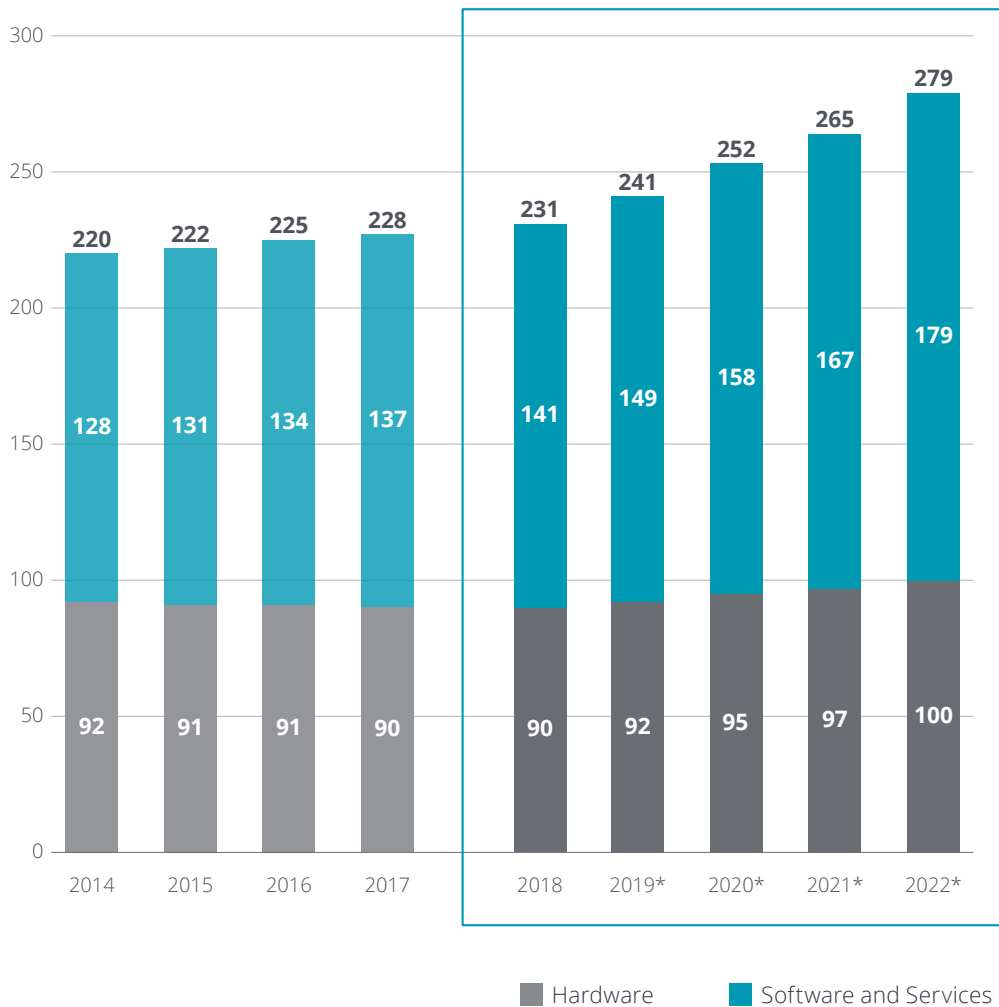
XaaS

Numerous business models are going through a radical process of change. Providers increasingly focus on the offering of pre-specified and guaranteed services, instead of one-off sales of corresponding products. It is especially in the technology sector that "as-a-service" business models (XaaS) have been established. Tech companies have an edge in knowledge and experience in this field from which they will benefit enormously in the foreseeable future, as in the years to come XaaS will continue to gain in importance and become an important factor for the establishment of innovative technologies. For instance, "AI-as-a-service" will make a major contribution to the spread of artificial intelligence and will make AI also accessible to small and mid-size companies.

Looking Ahead: Tech Sector Awaiting a New Boost to Growth

Fig. 7 – Annual Technology Sector Revenues* by Segments in Billion Euros (2000–2022E)





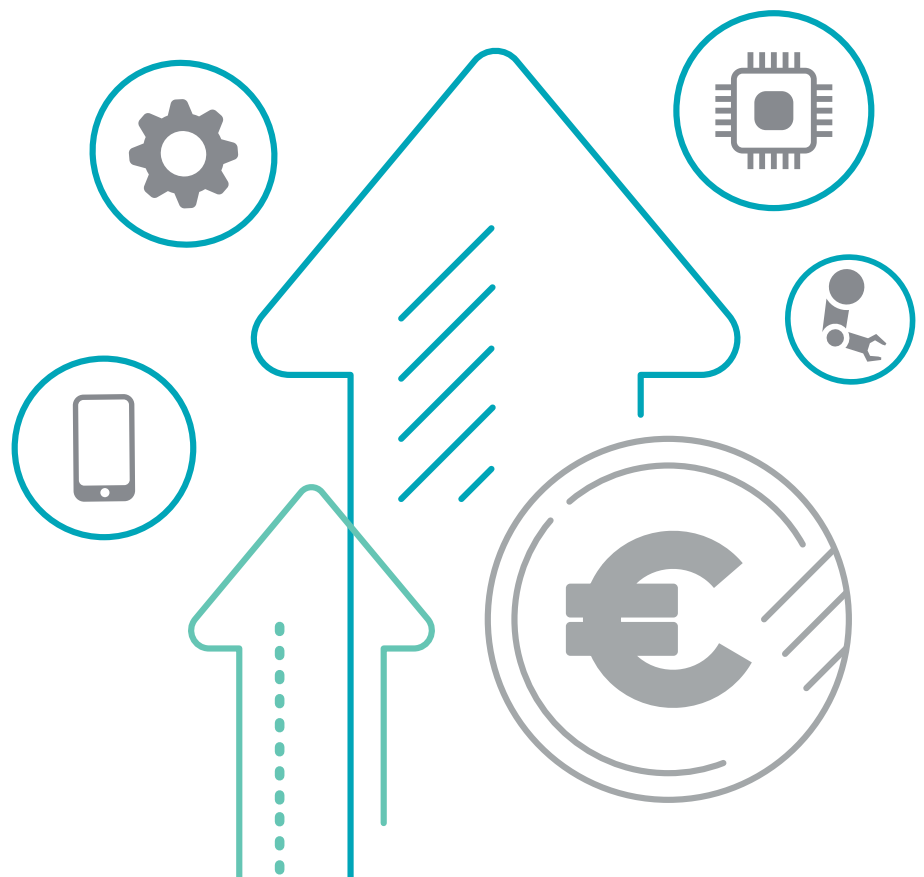
* Market perspective, without exports of German technology companies
 Sources: Deloitte, World Input-Output Database, OECD, Oxford Economics

The German technology sector is awaiting a further growth phase. This is evident from the analyses by Deloitte Research, which combine the growth trends of the past with the forecasts by Oxford Economics for the years to come. Thus, it is not only the direct revenues generated from sales to customers that will rise. Indirect effects through the growth of other sectors and the related demand for Hardware and Software and Services (B2B relations) will also have a positive impact (see Fig. 7).

Until 2022, an annual compound growth of the German technology sectors of about five percent is expected – even despite the currently rather subdued macroeconomic forecasts. The positive trend is largely supported by an increasing integration of the technology sector with other sectors (digitalization) and the strength in the Software and Services segment, where growth will be more than twice as strong than in the Hardware segment.

The interaction of IoT and 5G, Analytics and AI as well as XaaS produces an immediate effect and fuels the sales in the German tech sector. A close connection with these megatrends is established by the strong cross-sector commitment in fields such as Industry 4.0, Connected Car, BioTech, FinTech and digital health services. In these fields, the German technology sector is not only a supplier of products and services, but also a major alliance and cooperation partner. In this way, the technology sector in Germany will generate sales revenues of almost 280 billion euros in 2022.

Until 2022, an annual compound growth of five percent is expected for the tech sector.



Five levers for reinforcing the German tech sector

The positive prospects for German tech companies give them the opportunity to position themselves as relevant long-term players in the global technology market in the years to come. The development of appropriate strategies can be supported by using five levers for reinforcing the German technology sector, which directly follow from our analysis of the economic key data:

1. Continue to focus on Software and Services. In the recent past, this sector segment already showed a significantly stronger growth. This trend will continue in the next years. An important role in this connection is played by the increasing importance of XaaS offerings. Moreover, there are new promising opportunities in the advancement of innovative future-oriented topics such as Industry 4.0 or Connected Car due to the pronounced service expertise of German technology companies in the field of the digitalization of processes and business models.
2. Focus on the B2B business; exercise restraint with consumer and commodity hardware. With B2C products such as TV sets or PCs, the cost disadvantages of Germany as a business location usually cannot be compensated by the contribution margins of related products. Hence, the strategic focus with hardware should clearly be on the B2B segment.
3. Keep up the level of activity for Analytics and AI. Data and their evaluation will continue to gain in importance in the next years and become the basis of sophisticated technology business models. Due to their analytics and AI expertise, tech companies will become indispensable partners across all sectors in the development of innovative, data-driven solutions.
4. Reinforce the high-margin special hardware business. With the focus on the aforesaid future-oriented topics, German tech companies can further underpin their position in specialized areas of the hardware market. Here, they benefit both from the high growth momentum in the new areas and the traditional German strength in the B2B business.
5. Further expand the close ties to the mechanical engineering sector and the financial services industry. Cooperations can be established to jointly advance digital business models in the area of convergence between the technology sector and the partner sectors. A particular potential is promised by the fields of Industry 4.0, FinTech and InsureTech. Technology companies are already in an excellent starting position due to the close integration with the mechanical engineering sector and the financial services industry.

Annex:

Basis of Our Analyses

The data used for our analyses is based until the year 2014 on statistics of the World Input-Output Database. This is a joint European project of various universities and economic research institutions, such as University of Groningen, the ZEW or the Conference Board Europe. The World Input-Output Database maps global links between sectors and countries and shows the share of input services of the technology sector in the value creation of another sector. The current integration of the technology sector with other sectors is thereby evident. Moreover, the comparison of periods illustrates the sectors where the technology sector has gained in importance (industry convergence).

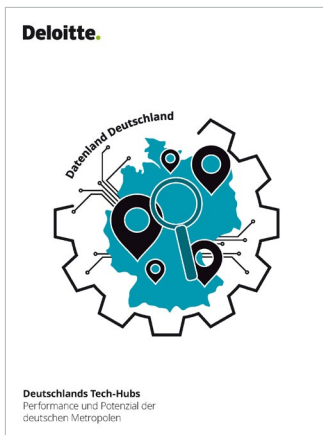
In addition, the input-output data and its past growth and convergence trends was combined with the latest growth figures of the OECD and the sector forecasts of the Global Economics Database from Oxford Economics. Hence, the development of

the German technology sector could be updated on the basis of the tech sector's own growth and the growth until 2022 triggered by integration with other sectors.

The stated sector revenues exclusively relate to sales generated in Germany with technology. The exports of German tech companies as outlined in this study are not considered in this market analysis. The breakdown of the imports and exports by Hardware and Software and Services is based on an update of the historical data. The prices used for calculation relate to prices applicable in the respective year.

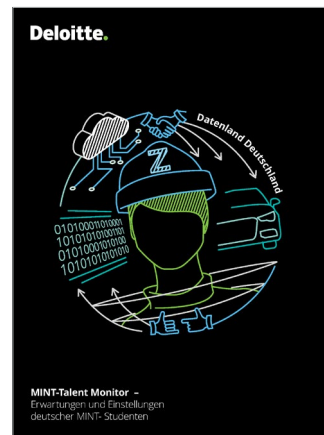
The development of the German technology sector was forecast until 2022 based on its growth and affinity with other sectors.

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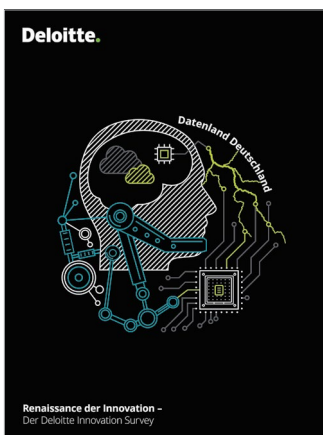
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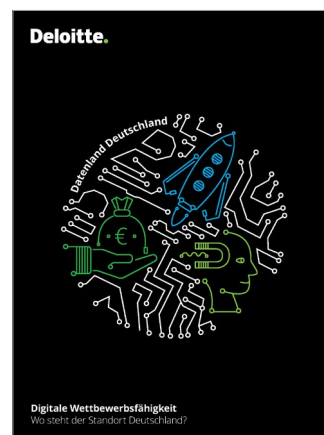
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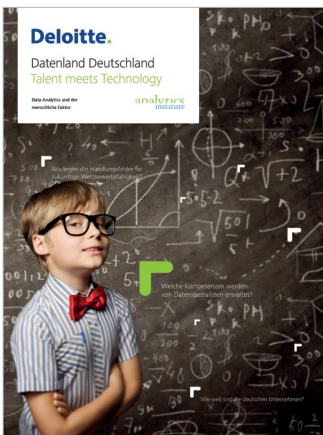


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