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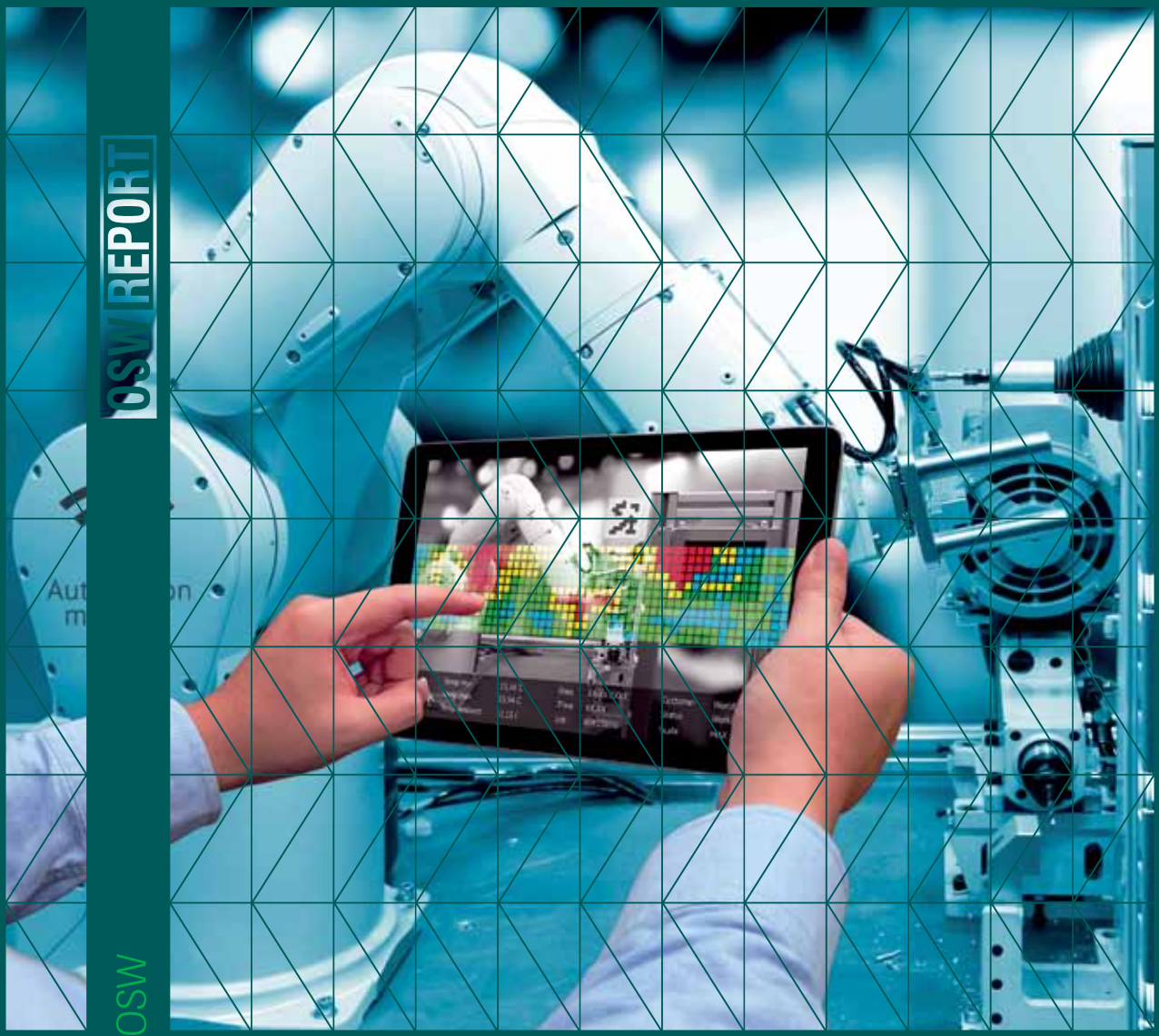

OSW

INDUSTRY 4.0
GERMANY'S NEW INDUSTRIAL POLICY

Konrad Popławski, Rafał Bajczuk

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FIGURES
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PUBLISHER
Ośrodek Studiów Wschodnich im. Marka Karpia
Centre for Eastern Studies

ul. Koszykowa 6a, Warsaw, Poland
Phone + 48 /22/ 525 80 00
Fax: + 48 /22/ 525 80 40
osw.waw.pl

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INTRODUCTION

The Fourth Industrial Revolution is characterised by the extensive use of the internet and the computerisation & roboticisation of all spheres of the economy. Its symbols today are smartphones and electric cars, but in the near future we will witness the creation and use of smart cities, smart electrical grids and smart factories. Today's industry is changing at an unprecedented rate. The earlier industrial revolutions, i.e. periods of fundamental changes in the modes of production and communication, proceeded at a much slower pace than those we are observing today. The first industrial revolution utilised coal and steam to mechanise production and transport. The second disseminated the means of mass production by the use of electricity and the internal combustion engine. The third, digital revolution, which began in the middle of the last century, automated industrial production and globalised communication. The German economy, which reached a very high level of sophistication in the industries of the first and second industrial revolutions – in heavy industry, electronics and the automotive branch – did not benefit so greatly from the digital revolution.

The Fourth Industrial Revolution is radically changing the nature of the economy and society as it embraces most traditional industries. Machinery and vehicles, increasingly saturated with electronics, must be able to communicate and collaborate with other devices. Specialised software is evolving to read and interpret human speech. Technological advances have changed the logic of operation in the economic sectors in which Germany has had a dominant market position for decades. The solution may not lie in further process innovations, in which the German small- and medium-sized enterprises have hitherto specialised by continuing their decades-long family traditions. In order to maintain a market position, it is no longer enough to design a slightly more efficient, higher-quality version of the previous model of the product; rather, it is necessary to add completely new features and technologies. Success in the automotive industry no longer depends on producing reliable high-quality cars, but on devising a method for producing vehicles capable of driving autonomously and cooperating with other equipment (such as city GPS systems), and which should also be ecologically friendly (for example, powered by electric engines). The technological breakthrough related to the fourth industrial revolution is bringing about significant transformations of markets, something which threatens the strong position of German companies, especially in the production of machinery, equipment and vehicles[1].

[1] 'Industrie 4.0 Digitale Wirtschaft und Impulse für Wachstum, Beschäftigung und Innovations', Federal Ministry of Economy and Energy, April 2015, https://www.bmwi.de/

These technological changes are occurring at a time when the ability of German society to absorb innovation is decreasing. The demographic crisis has led to a systematic shrinking of the number of German companies. As they retire, many of their owners are having trouble finding successors, and the difficulties which businesses have in gaining access to skilled workers are increasing. The traditional infrastructure is aging, and the development of the digital infrastructure is proceeding slowly. Moreover the banks, which are accustomed to working with the traditional industries, are reluctant to finance risky ventures in the field of new technologies.

This report, which considers the whole context of these technological changes, is intended to contribute to the discussion of the situation in which German industry finds itself in the face of the ever closer integration of industrial production with digital technologies, and is focused on the German state's response to the challenges of the digitisation of industry. The report has been prepared on the basis of German government documents, academic publications, studies by associations of experts and industries, and data from the Federal Statistical Office of Germany & international organisations. An important addition to the collected materials comes from interviews with German experts from public institutions, industry associations and non-governmental organisations who have been dealing with the subject of industrial policy.

The very definition of the term 'industrial policy' is ambiguous, because in an era of ever closer integration of industrial production and digital technology, it is difficult to draw a precise boundary between industrial and non-industrial sectors. This publication adopts a broad definition of 'industrial policy' as any action taken by the state which is aimed, in a direct or indirect way, at improving the situation or prospects for the development of companies related to industry. German state initiatives in this area include the creation of favourable legal, infrastructural, social and financial conditions to maintain the important role of industry in the economy and its high competitiveness on foreign markets[2].

The report discusses the role of industry in the German economy, the position of German industry in global trade, and also outlines the unique features

Redaktion/DE/Publikationen/Industrie/industrie-4-0-und-digitale-wirtschaft.pdf?__blob=publicationFile&v=3, p. 3.

[2] A specifically German feature is the fact that these activities are not usually referred to as 'industrial policy', but rather in terms such as 'environmental policy', 'the policy of improving the attractiveness of the investment (*Standortpolitik*)' or 'the policy of innovation'.

of the German economic model which favours the development of industry. It presents the main problems facing Germany with the coming of the Fourth Industrial Revolution, and also describes the attempts to overcome them within the concept of 'Industry 4.0', which is the cornerstone of the country's new industrial policy. This analysis covers the organisation of German industrial policy, discussing the main institutions involved in it, as well as the scope of its support from public funding. The Annex presents the main stages in the laying of the foundations of German industrial policy. The last chapter includes four case studies as a contribution to the analysis: the influence of the German state on the structure of the economy, the means to maintain its end-state branches[3] (the shipbuilding industry is the example here), to reinforce the position of the stronger industries (the automotive industry), and to develop new technologies (the renewable energy industry).

[3] The term 'end-stage industry' includes companies that have little chance of dynamic development, and whose survival would be in jeopardy without financial assistance from the state.

THE MAIN THESES

- The financial and economic crisis of 2008 exposed the weaknesses of the service-based economies while boosting those with a strong industrial base, such as Germany. The manufacturing branches generate 23% added value to the GDP of Germany, provide 34% of the jobs, and pay wages which are 21% above the average in the German economy. 90% of private-sector expenditure on research and development is generated by firms associated with industry. Thanks to the structure of the economy, Germany has been able to maintain stable economic growth, low unemployment and the sustainability of its public finances, and to achieve a high level of trade surplus.

- Germany has been able to create a balanced structure of its economy, in which a strong small- and medium-sized enterprise sector (SMEs) exists side by side with many global-level German industrial companies. In this structure, the state plays the role of moderator, regulator and enforcer of regulations, taking care to maintain social sustainability. The key determinants of economic success, and an objective of the state's industrial policy, include supporting exports and maintaining a high level of trade surplus. This assumption has proved successful over the last two decades, as one of the main engines of growth for German industry has been foreign expansion. The industrialisation of developing countries in Central Europe, Asia and Latin America has increased global demand for industrial goods.

- The Fourth Industrial Revolution, characterised by the widespread use of the internet and digital technologies in all spheres of the economy, is bringing about a transformation of the markets, and is threatening the hitherto strong position of German companies, especially in the production of machinery, equipment and cars. The important problems for Germany associated with this trend include: an insufficient number of qualified employees, an underdeveloped digital infrastructure, weakening entrepreneurship, and difficulty in maintaining a high level of education. The rapid aging of German society is leading to lower human capital resources, a reduction in the number of companies, and a disinclination to adapt to new technologies. Moreover the banks, which are used to working with traditional industries, are unwilling to finance risky enterprises in new areas of the economy.

- Another challenge for Germany is the entrance into the automotive sector of new, innovative leaders such as Tesla, and IT giants such as Apple, Google

and China's Baidu, which have ambitious plans to create autonomous self-driving cars fully integrated with digital technologies. Moreover, Germany's machine industry fears the rapid progress of competition from China, which is rapidly catching up and also has large financial resources to implement innovations and buy foreign technology. If German companies do not meet the challenge of producing a new generation of vehicles, equipment and machinery which is heavily saturated with digital technology, they could lose their role as market leaders and become subcontractors of components at a lower level of the value chain.

- The German state's response to the challenges of the fourth industrial revolution is the concept of 'Industry 4.0', that is, the construction not only of smart devices, but also of entire production plants capable of autonomously coordinating the processes among themselves. German companies need to gain a dominant position on the market for smart devices and autonomous vehicles, urban mobility systems (e.g. sharing or renting cars), and the sales of complex systems for energy production from renewable sources and increasing energy efficiency. This requires a radical change in the existing business models of German manufacturers; they must increase their competence in producing software, saturate their products with digital technologies, and guarantee their access to the appropriate IT infrastructure & the necessary data. The government's priority lies in conducting a comprehensive process of digitisation by accelerating the expansion of digital infrastructure, improving the digital skills of SMEs, and developing e-government services. It is necessary to create favourable legal framework and networks of financial instruments which will encourage companies to invest in innovative and risky business ventures.

- The priority of German industrial policy is to radically increase spending on innovation. In 2015, national spending on science reached 3% of GDP for the first time. The budget of the Ministry of Science has increased by leaps and bounds, by almost 142% (up to €17 billion) in the years 2005–2017. The system of innovation in Germany is focused on supporting research enterprises, in contrast to those focused on supporting public research units. Non-university scientific institutions form the bedrock of this research, especially for smaller businesses.

- The German government assumes that electronic data will be the most important 'raw material' of the twenty-first century, and that the development of German industry could be hindered by a lack of digital sovereignty.

This term is used in Germany to define the ability of individuals, companies and institutions to move freely and conduct their business in cyberspace. In the area of industry, one problem for Germany is the expansion in this field of non-European IT companies (especially from the US), which are the main providers of software for smart equipment. Other potential areas of conflict between Germany and the US are regulatory questions in the field of digitisation, as well as the dispute over the market shares of American IT businesses. These currently control 89% of the global search engine market, 98% of the operating systems for smartphones, 89% of mobile application distribution channels, 43% of the messaging market, and generate 90% of revenues from e-commerce. That is why Germany needs to set international norms and standards that will force global manufacturers to develop software within a standardised framework and reduce their market dominance. German institutions are conducting advanced analytical research on future markets, so they will be ready to compete – either at the EU level or on the global stage – for the most favourable legal framework for the development of the German digital economy.

- In the field of digitisation, Germany is facing the problem of how to find a balance between the development of the market and the expansion of German law into new areas of cyberspace, which includes important areas of social life. On the one hand, Germany wishes to be a pioneer in the digital economy, which requires low bureaucratic and regulatory barriers in order to ensure the greatest possible flexibility for companies with ideas for new business models which do not suit the existing legal framework. On the other hand, Germany is concerned that a lack of activity by the state in devising new laws concerning the digital economy could disrupt the country's socio-economic model. One example of this is the spread of false information (a.k.a. fake news) in modern social networking (for example, concerning the migration crisis), which could destabilise the political scene in the country.

- Industrial policy in Germany is evolving towards supporting the competitiveness of certain industries. An example of Germany's new approach is its strategy for energy transformation. The framework includes a setting in the long-term perspective (guaranteed production tariffs for renewable energy sources for a 20-year period, and also setting targets to increase the share of renewable energy sources in the energy mix by 2050) for developing renewable energy technologies & energy efficiency in such a way that they become a new export commodity for Germany. The main objective has

been to change the structure of the energy market by focusing on support for renewable energy resources at the expense of plants operating on nuclear power, and later carbon fuels as well. One unexpected result of the energy transformation was the breaking of the oligopoly of the four largest energy companies (E.ON, RWE, Vattenfall and EnBW) in favour of smaller, often local manufacturers and providers of electricity. Also, conditions were created for cooperation between public institutions, research centres, enterprises and representatives of civil society. In 2015, Germany was the second largest exporter of products in this sector (13.5% of the global market) behind China (16.2%). In particular, technologies related to wind turbines and energy efficiency may be developed by the mechanical engineering sector, which is very strong in Germany.

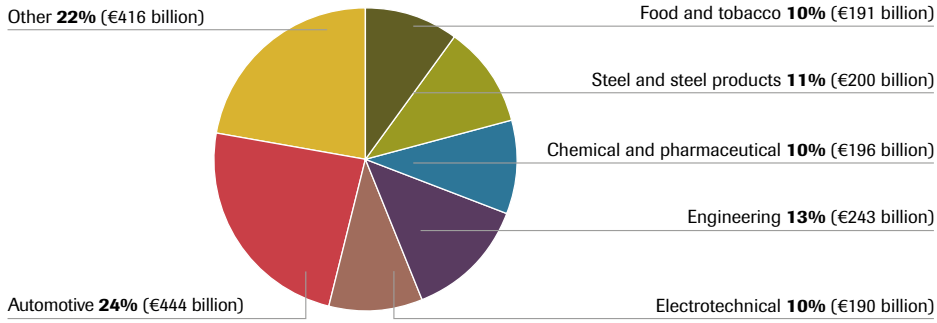
- Germany's industrial policy will not cease providing subsidies and other forms of support, especially for industries with structural problems. According to the government, the share of grants declined from 1.1% to 0.8% of GDP in the years 2005–2017. However, if we take into account the tax benefits and privileges, the amount of support for the economy actually rises to 3.5% of GDP. Tax incentives are most often targeted at the end-stage industries, whereas the direct subsidies reach those industries which need funds to adapt to the market situation. Even very strong sectors, such as the automotive branch, can count on considerable financial aid, often in the form of subsidies to improve environmental performance or boost innovation.

I. INDUSTRY AND INDUSTRIAL POLICY IN GERMANY

1. The importance of industry for the German economy

Industry is the factor which guarantees Germany can maintain its economic growth, prosperity and jobs. The manufacturing branches generate 23% of added value in Germany's GDP, and ensure that wages in this sector are about 21% higher than the average in the German economy[4]. Industrial enterprises employ about 8 million people; but if we add the branches dependent on contracts with the industrial enterprises, this number rises to 15 million[5].

Figure 1. Turnover of the main industrial branches (in € billions) and their share in the turnover of all industry (in %), 2016

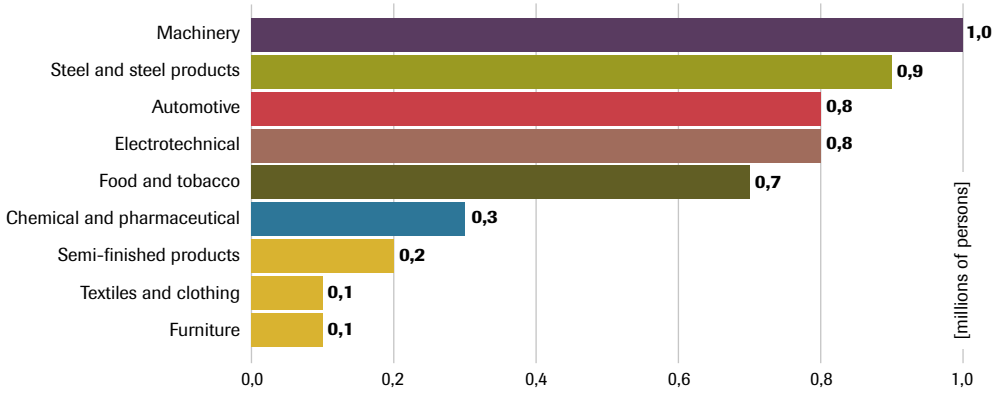


Source: Federal Statistical Office

[4] 'Verdienst auf einen Blick', Federal Statistical Office 2017, https://www.destatis.de/DE/Themen/Arbeit/Verdienste/Verdienste-Verdienstunterschiede/_inhalt.html

[5] 'Unsere Industrie Innovativ. Intelligent. International', Federal Ministry of Economy and Energy 2016, https://www.bmwi.de/Redaktion/DE/Publikationen/Industrie/unsere-industrie.pdf?__blob=publicationFile&v=6

Figure 2. Employment in major industries in Germany (in millions of persons), 2016



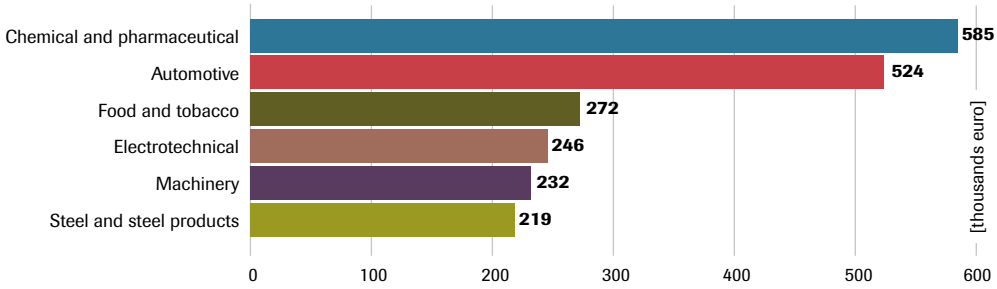
Source: Federal Statistical Office

Of all the manufacturing branches, the highest turnover (€444 billion, representing 24% of German industry's total turnover) is generated by the automotive sector. Vehicle and parts manufacturers taken together only come third in terms of the number of jobs they create (800,000), although their indirect influence on the German economy is greater because they create demand for goods from the machine-building, chemical and electrical branches.

In second place in terms of turnover comes the machine-building industry, which generates 13% of turnover of all industries and employs the most workers, more than 1 million. Next in the table come the steel industry[6] (11% of turnover, 900,000 jobs), chemical and pharmaceutical (10%, 300,000), food and tobacco (10%, 700,000) and electrical engineering (10%, 800,000).

[6] The steel industry includes producers of raw steel, but also of steel products. Hence the number is higher than the number of German workers in steel foundries, who number about 87,000.

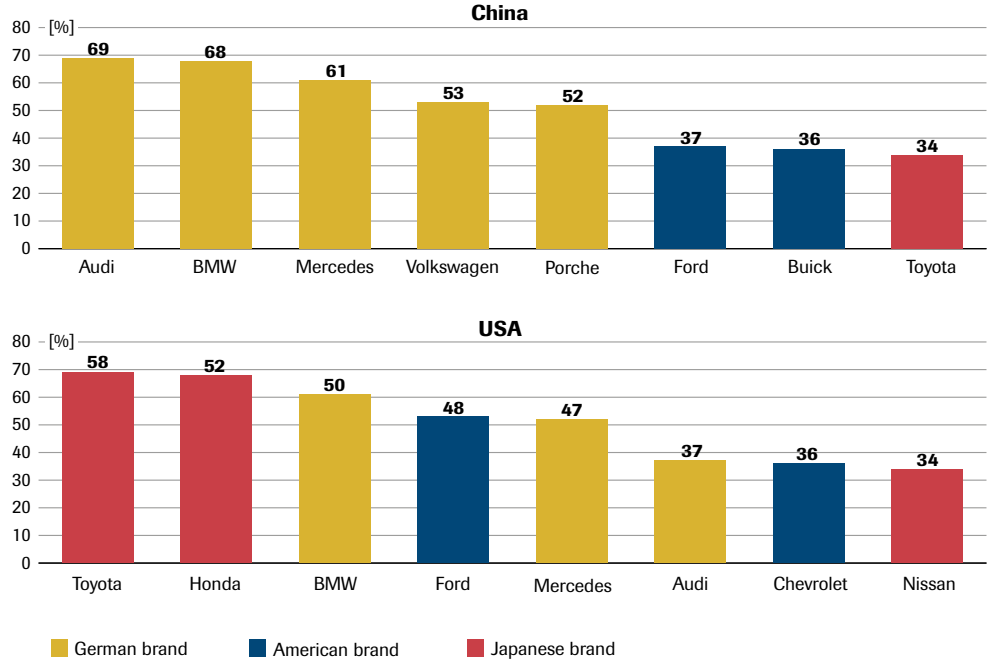
Figure 3. Revenues of selected industries per 1 employee (€ thousands), 2016



Source: Federal Statistical Office

The situation is different when the industries are classified in terms of revenue generated per employee. At the top of this list is the chemical and pharmaceutical industry, which brings a turnover of €585,000 per employee. Slightly lower revenue per employee (€524,000) is generated by the automotive industry, followed by the food and tobacco, electrical engineering, machine and steel branches.

Figure 4. The most trusted car brand among consumers in China and the US



Source: 'Raport: Image deutscher nach Marken VW scandal', https://www.globe-one.com/wp-content/uploads/2018/06/Globeone_Image-deutscher-Marken-nach-VW-Skandal_deutsch.pdf

The special role which the automotive industry plays in the German economy is confirmed by its results on the global markets. From the results of surveys conducted by Globe One in 2015 among consumers in the United States and China, it appears that the five automotive brands most trusted by respondents in China come from Germany (Audi, BMW, Mercedes, Volkswagen and Porsche), whereas American respondents choose two German (Mercedes and BMW) brands. German automotive brands are primarily associated with very good quality, prestige, reliability and environmental performance. It follows that German automotive brands enjoy a high reputation on two important markets. In recent years China has been among the fastest growing automotive markets in the world. In contrast, the US example shows that Germany could increase production on the very competitive markets of countries which themselves have strong automotive sectors.

Although the revenues generated *per capita* in the electrical industry, machinery and steel products are lower than those in the automotive industry, the role of these sectors in the German economy is also extremely important. It is mainly companies from these sectors which belong to the category referred to as the 'hidden champions', the existence of which is an element distinguishing Germany from other highly developed economies. These are often family-run small- and medium-sized enterprises, unknown to the wider public, which have very strong global positions on particular niche markets[7]. These companies are characterised by three features: a large share of exports in their sales, the production of highly specialised products, and considerable flexibility in adapting to customer needs[8]. No other country has so many leaders in market niches as Germany. Thanks to many years of hard work on process innovations, they have achieved high level of quality for their products, which are unique on the global scale. The strategy of these companies gives them genuinely high profitability and market stability, but it is also a barrier to their achieving the position of global-level corporations.

2. German industry against the background of global competition

The period after the global financial crisis was a time when countries with strong industrial bases were appreciated. The failure to maintain manufacturing production and the focus on services led to social tensions in many developed countries. Many workers see themselves as the losers of globalisation, as many of them have lost jobs as a result of the relocation of production plants to

[7] H. Simon, *Hidden Champions: Aufbruch nach Globalia*, Campus, Frankfurt 2012, pp. 83–84.

[8] 'Innovationsindikator 2015', ACATECH and the German Industry Association, https://www.acatech.de/wp-content/uploads/2018/03/Innovationsindikator_2015_Web.pdf, p. 7.

developing countries. The negative effects of this trend were not balanced out by the rapid development of the financial sector, which created jobs for people with completely different qualifications. Governments are also coming under increasing pressure from new social and political anti-globalisation movements, which are increasingly popular in structurally weak regions and are increasing their influence over major policy decisions. At the centre of controversial events in Anglo-Saxon countries, such as the decision by the UK to leave the EU and the election of Donald Trump as President of the United States, are disputes over the role of industry in the economy.

Against this background, Germany has stood out as being able to resist the trend of de-industrialisation and maintain the important role of manufacturing sectors in its economy, which represent a success against the background of a declining share of industrial production in the most highly developed countries[9]. Before 2009, Anglo-Saxon economists in particular had perceived the German economy as being inefficient, outdated, and incapable of innovation or moving onto the path of rapid economic growth[10]. Since the outbreak of the global financial crisis, however, the German economy has gained a reputation as one of the strongest in the world, due to the rapid pace at which it lifted itself out of recession, the labour market's resilience, and the ability to develop the world's highest trade surplus. During this time, the thesis regained popularity that a healthy industry boosts the circulation to other areas of economic activity, because it is part of the traditional economy, based on real production granting stable economic growth. The unilateral support for service-based economies and the IT sector, and a disregard for those with a strong industrial base, has turned out to be unjustified. In Germany 85% of expenditure on research and development is funded by industry[11]. Good results for industries such as the automotive,

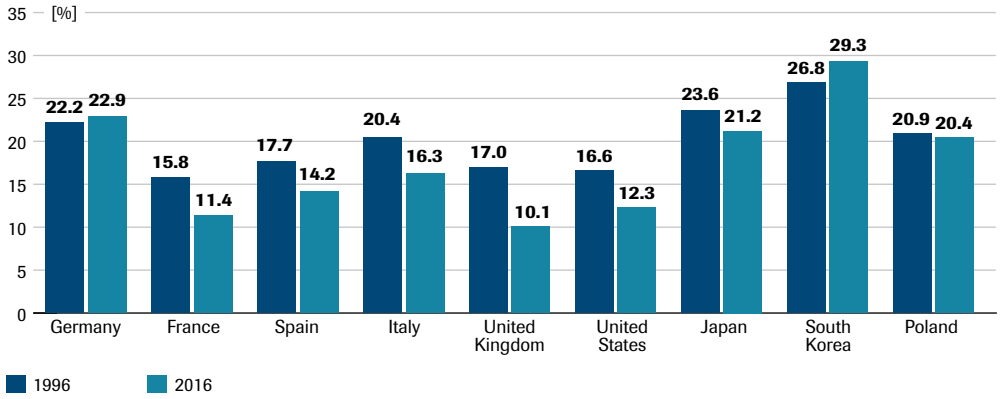
[9] German society has not always showed full openness to the needs of German industry, as demonstrated by the considerable public resistance to the signing of the Transatlantic Partnership in the field of trade and EU investment with the US. Germany had the opportunity to be the biggest beneficiary of this agreement, but public opinion was concerned that the agreement would lead to a deterioration of food standards in Germany, and could also limit the sovereignty of German courts. The agreement provided for the settlement of disputes between US investors and European countries within the framework of transnational investment tribunals, which could *de facto* have limited the powers of state institutions. K. Popławski, 'Germany's stance on the TTIP. Background, interests and concerns', *OSW Studies*, 24 March 2015: https://www.osw.waw.pl/en/publikacje/osw-studies/2015-03-24/germanys-stance-ttip-background-interests-and-concerns

[10] T. Schulz, 'How the German economy became a model', *Der Spiegel*, 21 May 2012, http://www.spiegel.de/international/business/the-us-discovers-germany-as-an-economic-role-model-a-822167.html

[11] 'Wirtschaftspolitische der Positionen 2015 IHK-Organisation', German Chamber of Commerce, Berlin 2015, p. 42.

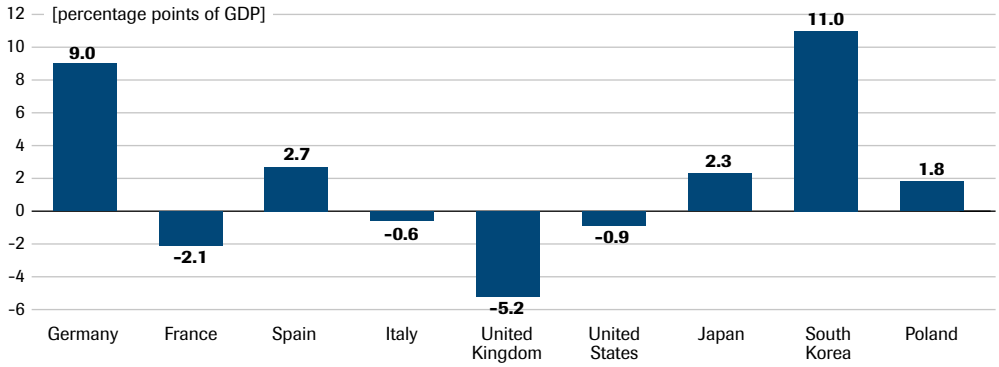
machine-building, chemical and electrical engineering branches have allowed Germany to remain at the forefront of the biggest goods exporters in the world[12]. The strong position of German industry has also strengthened the country's position as the leader of the European Union. According to Eurostat, in 2016 Germany made up 21% of the EU's added value to GDP, and in the case of industrial production, its share in added value rose to 30%.

Figure 5. The share of manufacturing sectors in the creation of value added to GDP in selected countries in 1996 and 2016* (in %)



Source: Organisation for Economic Cooperation and Development (OECD)
* Data for the United States comes from 2015, as no later information is available.

Figure 6. Changes in current account balance in the period 1996–2016 (in percentage points)



Source: Organisation for Economic Cooperation and Development (OECD)

[12] In 2003–2008 Germany was the largest exporter of goods in the world. Since 2009, Germany has been overtaken by China, and by the United States since 2010.

In the period 1996–2016, only two of the most developed countries shown in the chart were able to defend themselves against a decline in the share of industry in creating value added to their GDPs: South Korea and Germany. South Korea increased this percentage by 2.5 percentage points, to 29.3%, and Germany increased it by 0.7 percentage points, to 22.9%. In most other countries there has been a serious decline, as in Spain (by 4.5 percentage points, p.p.), Italy (3.9 p.p.), France (4.3 p.p.), the US (by 4.3 p.p.) and the UK (6.9 p.p.). To a lesser extent, the share of value added to GDP generated by industry also fell in other countries: Japan (2.4 p.p.) and Poland (0.5 p.p.). The decrease in the role of industry has had serious consequences for the stability of these countries' economies. Many of the countries experiencing the trend of deindustrialisation have seen deterioration in their trade balances in the period 1996–2016. This trend was observed in France (a reduction in the current account balance of 2.1 p.p.), Italy (-0.6 p.p.), the UK (-5.2 p.p.) and the US (-0.9 p.p.); meanwhile, countries with a stable or rising share of industrial production recorded improvements in their current account balances. This was particularly evident in the cases of Germany (+9 p.p.) and South Korea (+11 p.p.).

The high technological level and price competitiveness of German industry contributed to the stable development of the economy, low unemployment and balanced public finances, especially when the myth of lavish profits flowing from a self-propelling market of innovative financial instruments collapsed[13]. Service sectors such as finance and tourism often do not guarantee income in periods of global economic slowdown. The link between the rise in industrial production and the increase of the economy's trading surplus also results from the fact that 76% of turnover in international trade is generated by the trade in goods[14]. Services are still a type of product which is most often provided on the domestic market, which is why they play a less important role in international trade.

In the last decade, German industry has been supported by the situation on foreign markets. Rising incomes in emerging economies such as Brazil, China, India and Russia have led these countries onto the path of industrialisation by increasing investments in infrastructure and production capacity. This has benefited the German engineering, chemical and electrical engineering

[13] 'Germany's economic model: What Germany offers the world', *The Economist*, 14 April 2012, http://www.economist.com/node/21552567

[14] *Key Statistics and Trends in International Trade 2016*, UNCTAD, http://unctad.org/en/PublicationsLibrary/ditctab2016d3_en.pdf, p. 9.

companies. The boom in commodity markets has also favoured companies from Germany which supply the machinery and technology necessary to increase production[15]. Over time, the emerging economies have become richer and are beginning to develop strong middle and upper classes; consequently, demand on these emerging markets for the products of the German automotive sector has been rising. Moreover, the modernisation of the new EU countries, financed by the cohesion policy, guarantees Germany an attractive market to sell its investment goods.

Many German manufacturers of vehicles, machinery, tools and building materials have been gaining from the ongoing investments in the expansion of infrastructure and industry. In Germany there are strong links between the global corporations and the SME sector (including the so-called hidden champions). These links appear to be stable even in countries where the German economy is trying to expand. When German industrial companies started to invest in China, they brought their suppliers from Germany onto the Chinese market. Meanwhile, their foreign activity was funded by the German banks, which were able to offer a wide range of products well suited to the investors' needs.

3. The German model of industrial policy

In recent years, the actions Germany has taken within the framework of its industrial policy have been appreciated in the most developed countries. The consequences of the global financial crisis shook the faith that deepening globalisation benefits all countries and sectors of the population to a similar extent[16]. It is increasingly rare to hear mainstream economists question the view that the state should interfere in individual sectors of the economy. Many of them justify its right to go beyond the role adopted in the liberal economic model, to take care of institutions and ensure macroeconomic stability[17]. An example of the implementation of industrial policy mechanisms in the most

[15] K. Popławski, Chasing globalisation. Germany's economic relations with the BRIC countries. *OSW Report*, November 2013, https://www.osw.waw.pl/sites/default/files/raport_05_bric_ang.pdf

[16] Meeting of the OECD Council at Ministerial Level in Paris, OECD 2017, https://www.oecd.org/mcm/documents/C-MIN-2017-2-EN.pdf

[17] Cf. R. Wade, *After The Crisis: Industrial Policy & the Developmental State*, IMF 2010, https://www.imf.org/external/np/seminars/eng/2010/lic/pdf/WadeE.pdf, 'Commission calls for immediate action for a European Industrial Renaissance', *Europa.eu*, 22 January 2014, http://europa.eu/rapid/press-release_IP-14-42_en.htm

developed countries is the introduction of a variety of instruments to support innovation (start-ups) and the environment (renewable energy sources).

One of the more closely analysed models of industrial policy is the German model. During the post-war period Germany developed a number of unique solutions that laid the foundation for its economic success (for more on this subject see Appendix: Stages of development of industrial policy in Germany). The most important components of the German model include activity by the state, the strong position of the workers, and numerous privileges for SME enterprises.

The task of the German state's industrial policy is to provide a predictable political programme, ensuring that social interests are taken into account in the country's economic development, and promoting the international competitiveness of German companies[18]. Representatives of the public administration conduct a continuous dialogue with business. In a 'soft' way, the state coordinates the activities of companies, and seeks to act as a moderator in the discussion on the development of the German economy, balancing the interests of the various parties. Angela Merkel, despite her busy political calendar, makes an effort every year to participate in important economic events, especially those that are considered important from the perspective of the strategy for economic development. Special mention should be made of the national summits concerning future innovations, such as the national IT summits which have been held since 2006[19], the national education summits on mathematics, computer science, natural sciences and technology[20], and the CEBIT fair in Hanover.

By maintaining strong formal and informal relationships, the public institutions also receive feedback from the representatives of the companies and thanks to this they can monitor the risks for the economy more effectively: at the CEBIT in 2017, Merkel called for the preparation of a catalogue of business's expectations in matters concerning the regulation of the digital economy[21]. This dialogue is facilitated by the corporatist structure of the German

[18] The 2013 coalition agreement between the CDU/CSU and the SPD, https://www.cdu.de/sites/default/files/media/dokumente/koalitionsvertrag.pdf, p. 18.

[19] The National IT Summit, http://www.bmwi.de/DE/Themen/Digitale-Welt/nationaler-it-gipfel.html

[20] Website of the National Forum of Education in Mathematics, Computer Science, Engineering and Natural Sciences, http://www.nationalesmintforum.de/

[21] B. Gillmann, 'Merkel bittet Industrie um Hilfe', *Handelsblatt*, 13 April 2017, p. 12.

economy, in which the activities of companies are coordinated through a network of business associations. Because these organisations are grouped in hierarchical structures, they are treated by the government as the 'voices' of specific industries with clearly identified needs.

Another important element of Germany's industrial policy was the creation of a stable model of relations between employees and employers in the social market economy. Under the principle of workers' participation in decision making (*Mitbestimmung*), their representatives were granted the right to sit on the supervisory boards of the companies[22]. Works councils, consisting of employees' representatives, must be consulted on issues related to changes in employment and social affairs. The strong position of German workers means that German companies, even those with a global reach, must give priority to the interests of their plants located in Germany, even at the expense of their foreign affiliates. Research shows that this principle of co-decision points the companies towards making long-term profits, something which has prompted the British government, among others, to consider the possibility of implementing the German solutions in this field[23].

One particular feature of the German system is the creation for workers of a path by which they can simultaneously pursue theoretical education while learning practical skills in companies (*duale Ausbildung*) straight after they finish their basic education. This entitles the worker to sit a master's exam, and to obtain significantly higher qualifications and earnings. Moreover in Germany social benefits, including a fixed income, are guaranteed during the search for a new job, which favours the education of workers with high qualifications, even in very narrow professional niches.

Another characteristic feature of German industrial policy is that it is not targeted at large corporations alone. Germany early recognised the importance of the SME sector for the economy, and support for it has become one of the priorities of industrial policy. Policymakers have realised that the development of

[22] Pursuant to the law on the organisation of businesses, all companies employing over 500 people, with the exception of family businesses, were obliged to allocate one third of the seats on their supervisory boards to representatives of employees or works councils. Lower limits were set for smaller companies. The act is still in force today in a slightly different form (*Betriebsverfassungsgesetz* of 11 October 1952).

[23] N. Röper, 'Arbeitnehmer, die mitbestimmen, sind gut für die Wirtschaft', *Die Zeit*, 19 January 2017, http://www.zeit.de/karriere/2017-01/mitbestimmungsrecht-gewerkschaften-eugh-arbeitgeber-urteil-arbeitnehmer

the German economy may be hindered by problems with expanding the SME sector on foreign markets due to smaller capital resources, difficulties with the application of new technologies and management methods, and unfavourable political climate abroad, particularly on the markets of developing countries. The state's institutions see their role as offering political support to German companies, as well as in the creation of instruments to reduce the barriers protecting foreign markets.

In the face of increased competition on these markets, the state sees its task as promoting new technologies and management practices among the SMEs. For example, the German state institutions make efforts to inform the SME sector about the risks of the leakage or theft of technology caused by inadequate protection of sensitive data. Another important role is played by the policy of financing the SME sector from regional banks belonging to the federal state authorities (*Landesbanken*). Close cooperation allows financial institutions to offer financial products tailored to the needs of the SMEs. If the risks associated with the international expansion of companies become too high from the *Landesbanken* point of view, companies can apply for export and investment guarantees which are subsidised by the state.

Table 1. Components of industrial policy

Market industrial policy		
Sectoral industrial policy		
Subsidies for unprofitable industries	Periodic support for industries to assist their adaptation to market conditions or structural challenges	Creating conditions for the development of new industries Selective support for research and development

Source: Author's work, based on B. Rakow, Ökologische Industriepolitik in Deutschland und Europa: Eine Analyze des volkswirtschaftliche Konzeptes, Peter Lang, Frankfurt 2013, p. 87

The current industrial policy in Germany can be considered as an intermediate point between the liberal British model and the statist French model[24].

[24] Two models of industrial policy can be distinguished. One involves the creation of instruments of support for the economy as a whole, without distinguishing between the different sectors, which can be considered close to the British vision, as sanctioned by the Margaret Thatcher government. In that time, ambitious plans were carried out for the privatisation of many state-owned enterprises, including the railways, and subsidies for heavy industry were reduced. Another model of support is the sectoral industrial policy based on subsidis-

Germany prefers a horizontal approach, focusing on the development of instruments of support which are available to all sectors, through such measures as reducing taxation, making the labour market more flexible, and reducing the bureaucratic burden[25]. In Germany, there is a perception that subsidising unprofitable industries is most commonly linked (directly or indirectly) to the use of protectionist measures, which raises concerns in other countries that tension in international trade will be generated. Also at the EU level, Germany has (next to the UK) been a staunch supporter of liberalising markets and reducing protectionism. Germany has also thus been sceptical of industrial policy, because it could limit the room for German exporters to expand.

Germany allows the use of certain elements of sectoral industrial policies, such as restructuring sectors with problems (for more on this see Chapter IV, p. 2), supporting research and development in some industries (see Chapter IV, p. 3), and facilitating the development of new sectors, such as renewable energy sources (see Chapter IV, p. 4).

ing unprofitable industries, helping them to adapt, and fostering innovation to improve individual industries. This approach is close to the French model, which is characterised by the implementation of large projects and the creation of national champions, as well as the use of instruments to protect specific sectors.

[25] K. Aiginger, 'Industrial Policy for a sustainable growth path', *Policy Paper*, no. 13, https://www.oecd.org/eco/Industrial-Policy-for-a-sustainable-growth-path.pdf, pp. 7–8.

II. INDUSTRIAL POLICY 4.0

The trend of digitisation, which is one of the essential elements of the Fourth Industrial Revolution, presents not only opportunities but also many risks for the German economy. The role of the state's institutions is to prepare a response to the challenges of technological innovations, and this is why they have been developing the Industry 4.0 concept. Its main objectives include activities in four areas: digitisation, innovation, education and the international stage.

1. Germany's problems with the Fourth Industrial Revolution

From Germany's perspective, the Fourth Industrial Revolution raises three challenges. Firstly, German producers must be able to abandon their existing business models and join the pioneers of change. Only in this way will they be able to respond flexibly and quickly to market changes, including the emergence of completely new competitors on their markets. Second, manufacturers of machinery and equipment, especially SMEs, need to focus on increasing their competence in producing software and acquiring the skills of equipping their products with digital technologies, and also to gain access to the appropriate IT infrastructure and the necessary data. Thirdly, Germany must defend itself against domination by the foreign manufacturers of software used in German products, which will reduce the value added achieved by German manufacturers. The development of Industry 4.0 in Germany may be hindered by the problem of digital sovereignty. This term is used in Germany to define the great extent to which German companies are dependent on foreign suppliers of the software which is essential in the production of machines capable of intercommunication. The challenge for German companies is to master the ability to create software with high utility values, so they do not become dependent on external software developers which could become serious competitors over time.

The German state, as it realises the scale of the challenge, is seeking ways to adapt its domestic industry to the transforming global economy. Public institutions want to ensure coordination between enterprises, research institutes and workers' & social organisations to adapt the German economy to the fourth industrial revolution. The intention is for Germany to become a country that offers cutting-edge digital services to its citizens via a modern infrastructure for data transmission, as well as a state which is not merely a subject of these changes, but also an active initiator and co-creator of them. The state's institutions want to manage the processes of modernising industry in such a way that they do not undermine the foundations of the social

market economy, and that the internet does not become an area which lies outside the writ of German law.

Since 2013 the German government has been developing the concept of Industry 4.0, which is a response to the opportunities and risks associated with the Fourth Industrial Revolution. Germany sees its best opportunities for expansion in the areas of automation, information technology, and the digitisation of industrial production processes. The advantages of Industry 4.0 may include an increase in the capacity and efficiency of factories, an expanded range of products and services, and the creation of entirely new business models[26]. The intention is for German manufacturers to specialise in providing customers with advanced and comprehensive solutions, and not just individual products. Thus, companies from Germany will be able not only to provide buses or subway cars for cities, but also to sell whole systems to improve mobility, along with entire ranges of German products. Making this possible will require close coordination among German companies, in order to develop common technology standards which will make it possible to design equipment operating within a single system.

One of the most important goals of the German government in the Industry 4.0 project is to coordinate the work of large enterprises and SMEs, thus creating a platform to bring the interested parties together, increase the funding opportunities for related initiatives, and develop regulations allowing the development of new innovative products and services. Many public institutions have been conducting research to identify the opportunities and risks associated with the development of Industry 4.0. These reports often discuss specific issues, including the state of research in this field[27], prospects for developing the education of employees in SMEs[28], and the development of Industry 4.0 in a global context[29]. This knowledge should enable them

[26] W. Wahlster (ed.), *Industrie 4.0 im globalen Kontext: Strategien der Zusammenarbeit mit internationalen Partnern*, Munich 2016, p. 20.

[27] *Forschungsagenda Industrie 4.0 – Aktualisierung des Forschungsbedarfs*, Federal Ministry of Economy and Energy, 2016, https://www.plattform-i40.de/I40/Navigation/DE/Home/home.html

[28] *Industrie 4.0-Wegweiser zur Qualifizierung und Weiterbildung für kleine und mittelständische Unternehmen*, Federal Ministry of Economy and Energy, 2016, http://www.plattform-i40.de/I40/Redaktion/DE/Downloads/Publikation/wegweiser-qualifizierung.pdf?__blob=publicationFile&v=3

[29] H. Kagermann, R. Anderl, J. Gausemeier, G. Schuh, W. Wahlster, *ACATECH Studie: Industrie 4.0 im globalen Kontext: Strategien der Zusammenarbeit mit internationalen Partnern*, 2016, http://www.plattform-i40.de/I40/Redaktion/DE/Downloads/Publikation/industrie-40-im-globalen-kontext.pdf?__blob=publicationFile&v=1

to make informed choices about the path of future development. The German government has also focused on creating a platform connecting actors with the potential to jointly shape Industry 4.0, in particular representatives of businesses, trade unions and science. Cooperation between these groups should allow the development of new standards and certificates, intensify research, improve digital security, and help with the proposals of new regulations for the development of digitisation.

2. Supporting digitisation

In the current conditions of the dynamic development of new technologies, one prerequisite for maintaining the high competitiveness of the German economy is its comprehensive digitisation. Chancellor Angela Merkel has stressed in her speeches that "data will be the raw material of the twenty-first century"[30]. Hence, the ability to use and rapidly process data will be decisive for the country's position in international economic relations. Digitisation may pose a threat to Germany's existing model of the social market economy. US companies currently control 89% of the global search-engine market, 98% of the operating systems for smartphones, 89% of distribution channels for mobile applications, 43% of the online messaging market, and generate 90% of revenues from e-commerce[31]. At the same time, the largest internet companies are using their current position to enter additional market segments such as transportation, medical services, paying bills and online shopping.

Germany has its advantages regarding competition with other highly developed countries in the field of digitisation: a large domestic market and good conditions for access to foreign markets, high demand for IT products, a relatively high level of innovation among its traditional industries, as well as effective cooperation between the IT sector and other branches[32]. German companies recognise that digitisation is becoming a major priority for the government. According to an analysis by Germany's digital association Bitkom, the

[30] 'Merkel: Rohstoffe sind die Daten des 21. Jahrhunderts', *FAZ*, 3 December 2016, http://www.faz.net/aktuell/wirtschaft/cebit/vor-der-cebit-merkel-daten-sind-die-rohstoffe-des-21-Jahrhunderts-14120493.html

[31] R. Berger, *Fair Play in der digitalen Welt. Wie Europa für Plattformen den richtigen Rahmen setzt*, 15 October 2016, https://www.rolandberger.com/de/Publications/pub_fair_play_in_the_digital_arena.html, pp. 17 and 47.

[32] 'Merkel: Daten sind die Rohstoffe des 21. Jahrhunderts', *FAZ*, 12.03.2016, https://www.faz.net/aktuell/wirtschaft/cebit/vor-der-cebit-merkel-daten-sind-die-rohstoffe-des-21-jahrhunderts-14120493.html

government implemented 80% of its digitisation plan in the period 2013–2017. Particular achievements in recent times have included the introduction of a law on access to data (Open Data), improvements to digital security, and the establishment of 11 centres for digital skills, which are intended to support small- and medium-sized enterprises in the process of digitisation.

Despite this progress, however, Germany is clearly behind the world leaders in many areas of digitisation. Currently Germany ranks only 28th among OECD countries in terms of the availability of a fibre optic network for its citizens. According to the EC, Germany is 20th in the EU in terms of offering e-government services and, according to the ranking by the Global Open Data Index, it is only 27th in the world in terms of sharing public data for commercial purposes.

Some of these deficits are due to negligence and a lack of coordination between public institutions. The business community emphasises that the state is being held back by the federal state structure in accelerating the digitisation process, because there is a high level of reluctance to cooperate between the municipalities, the *Bundesländer* and the federation, as well as disputes between ministries over competences[33]. The situation is not being made any easier by the problems with coordinating the government's work in this field. In recent years, responsibility for digitisation has been divided among different ministries, with the vast majority of competences being assigned to the Federal Ministry of Transport, which was not prepared for these tasks. The new coalition has not listened to appeals from the business community to create a separate Federal Ministry of Digitisation. Although the structure for coordinating issues related to digitisation has been ineffective, however, additional decision-making units have been created. Shortly after the swearing-in of the government in March 2018, a post of Secretary of State for Digitisation was established as part of the Chancellor's Office, which was filled by Dorothee Bär (CSU). But Chancellor Merkel did not want to transfer control of that area to the CSU, and a month later she created a department for political planning, innovation and digital policy within the Federal Chancellery, which she entrusted to one of her closest collaborators, Eva Christiansen[34].

[33] D. Heide, Ch. Kerkmann, 'Die verpasste Chance', *Handelsblatt*, 14 June 2017, p. 18.

[34] M. Hecking, 'Diese Frau entscheidet über Deutschlands digitale Zukunft', *Manager Magazine*, 26 April 2018, http://www.manager-magazin.de/politik/deutschland/merkel-vertraute-eva-christiansen-leitet-digitalressort-a-1204765.html

The government's main objectives for its digitisation policy include:

- guaranteeing access to broadband internet with a capacity of at least 50 Mbit/s (this is a big challenge, considering that currently the average transfer rate in Germany is only 10.7 Mbit/s);
- subsidising the development of the internet in structurally weak regions;
- supporting small- and medium-sized ICT-sector companies in their foreign expansion;
- creating competence centres to deal with the promotion of new companies, technologies and best practices in the IT field;
- increasing the number of start-ups from 10,000 to 15,000 annually, and offering them access to capital in order to finance riskier projects;
- protecting new innovative companies from the monopolistic practices of the dominant internet companies;
- supporting the use of new IT technologies in the development of energy networks, in particular introducing renewable energy sources and improving the energy efficiency of the economy;
- more emphasis on the development of e-government, and making it independent of the IT tools developed by global corporations;
- increasing the security of communication used by state bodies;
- extending the scope of access to scientific publications on the internet;
- becoming involved in changing EU rules in such a way that the protection of personal data adequately defends the rights of German citizens and the competitiveness of German companies which store significant amounts of sensitive data online;
- combatting cybercrime which results in economic losses and threats to personal freedom[35].

A major challenge for the German government is encouraging traditional industrial firms and the IT industry to cooperate in developing joint products. This is necessary because the greatest opportunities for an innovative German economy are opening up in areas such as the production of self-driving vehicles, the so-called internet of things, new sales channels, logistics, and Industry 4.0[36], all of which require expertise from both areas.

[35] Digitale Agenda 2014–2017, the Federal Ministry of Economy and Energy, August 2014, https://www.bmwi.de/Redaktion/EN/Downloads/digital-agenda-2014-2017.pdf?__blob=publicationFile&v=1

[36] Digitale Strategies 2025 the Federal Ministry of Economy and Energy, March 2016, http://www.bmwi.de/BMWi/Redaktion/PDF/Publikationen/digitale-strategie-2025,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf, p. 8.

Other barriers to the digitisation process include the resistance of small- and medium-sized enterprises to the implementation of new technologies, and the low level of security of the data stored. Many SMEs do not have sufficient resources and skills to protect themselves against industrial espionage or hacker attacks, meaning that German technology is leaked to foreign competitors[37]. The German government has been subsidising projects to raise the IT level of those industries which are least advanced in this respect, such as craft businesses.

The government is currently setting targets and coordinating cooperation between the political, economic, scientific and social spheres. One example of this is the organisation of round-table meetings between representatives of the national government, the *Bundesländer*, the municipalities and telecom operators to develop the best procedures for expanding the national fibre-optic infrastructure. To increase the potential of German companies, the government has adopted a law on open access to data (*Open-Data-Gesetz*), which is intended to make the data resources collected by the German public administration freely available for commercial use[38]. This is aimed at enabling the creation of a market valued at up to €131 billion; the benefits may include better traffic management, the prevention of traffic jams, and the reduction of energy consumption.

The German government faces the challenge of how to devise regulations for the digital market which would protect German companies from the dominance of non-European IT companies, while not blocking opportunities for new business models to develop[39]. Greater powers to detect abuses are to be given to the Office for Cartels, whose intended function is to ensure that German law on the internet is respected. The SPD and the Greens have already submitted formal requests for the government to examine the activities of internet service platforms such as Uber and AirBnB in terms of their compliance with the law[40].

The Federal Ministry of Economy and Energy is implementing provisions extending the definition of the market in German law to include areas not directly related to trading by means of payment in order for its antitrust regulations to be able to cover search engines, especially Google. The Ministry of Justice

[37] W. Wahlster (ed.), Industrie 4.0 globalen them Kontext, *op. cit.*, p. 21.

[38] D. Heide, D. Neuerer, 'Staat will Daten vergolden', *Handelsblatt*, 17 November 2016, p. 6.

[39] D. Heide, 'Mehr Transparenz in der virtuellen Welt', *Handelsblatt*, 20 March 2017, p. 9.

[40] D. Heide, 'Digitalisierung: Regeln für das Tauschgeschäft', *Handelsblatt*, 18 January 2017, p. 8.

has also drawn attention to the monopoly position of some IT companies on the online search market, which the European Commission is to examine in terms of antitrust law[41]. The Minister of Justice has introduced a bill requiring social networking sites to remove false information or posts disseminating hatred within 24 hours of notification under a penalty of €50 million for corporations and up to €5 million euros for the employees responsible[42]. The official justification for this move was to discipline social networking sites into improving their filtering processes before the elections to the Bundestag. However, it has also been pointed out that, for example, Facebook has a dominant position on the online advertising market in Germany, which has hit German press titles trying to move their business online.

The position of the government, which is trying to implement the law conducive to technological progress, has often been met with scepticism or reluctance by German consumers. In 2017 the Federal Infrastructure Ministry proposed the establishment of a law under which users would be responsible for accidents involving self-driving cars, despite the fact that 73% of Germans have stated that the blame for such situations should be borne by the software's creator[43]. Meeting the will of the people, however, would hamper the development of this technology, which will be vital for the German automotive industry.

3. Stimulating entrepreneurship and innovation

The demographic crisis is increasingly restricting entrepreneurship in Germany, which could jeopardise the international position of the German economy in the future. Already, the number of newly established companies is decreasing, and many business owners, even those with an established market position, are having difficulty finding successors. In recent years, Germany has been struggling with the problem of more companies being closed than being established, due to factors including the demographic crisis. Almost half of new companies (in recent years this figure has fallen within the range of 44 to 47%) are being founded by people of immigrant origin. At the same time, the number of German companies being dissolved in 2012–2015 exceeded the number of businesses

41 'Facebook in Haftung nehmen', *Handelsblatt*, 5 October 2016, pp. 4–5.

42 G. Chazan, 'Germany cracks down on social media over fake news', *Financial Times*, https://www.ft.com/content/c10aa4f8-08a5-11e7-97d1-5e720a26771b

43 D. Neuerer, 'Deutsche wollen Autobauer haftbar machen', *Handelsblatt*, 15 February 2017, http://www.handelsblatt.com/politik/deutschland/unfaelle-mit-autopilot-deutsche-wollen-autobauer-haftbar-machen/19394210.html

being founded by an average of 26,000 annually (about 0.7% of all companies). Yet this trend does not stop Germany from having the right conditions for business: a good infrastructure, a vast scope of protections for intellectual property rights, and the ability to obtain significant public funds and advisers to help set up businesses. Indeed, one of the factors which discourage the establishment of new companies is the favourable situation on the German labour market.

The government is trying various programmes to improve conditions for business in Germany. Its priorities in this area are:

- increasing the number of business start-ups and facilitating the financing of their investments;
- raising companies' technological levels;
- increasing opportunities for skilled workers to immigrate;
- guaranteeing stable legal frameworks for companies;
- supporting the development of small- and medium-sized enterprises;
- improving levels of education.

Chancellor Merkel has stressed that Germany has a lot of catching up to do in creating favourable conditions for the formation of start-ups, not only in comparison with the US, but also with Britain and France[44]. Many young entrepreneurs from Germany complain that the opportunities for raising capital for risky initiatives are much fewer than in the United States. Without progress in this area, many German innovators may decide to implement their ideas in the US. Although Berlin is considered the unofficial capital of European start-ups, in 2016 this type of company gathered much more money from the market for their activities in London and Paris[45]. In Germany around €3.1 billion was invested in such initiatives in 2015, while in the US in the same period the figure was €24.6 billion[46]. Almost a third of founders of start-ups in Germany would be willing to set up a new company in the United States, mainly due to the better financing conditions. Among the 146 global start-ups worth over US$1 billion, only seven are located in Germany. Representatives of such companies genuinely appreciate the conditions for obtaining capital in Germany for their start-ups; however, they have problems getting the funding to continue development. Currently, the annual shortfall is estimated at €500–600 million euros per year,

[44] B. Gillmann, 'Merkel bittet Industrie um Hilfe', *Handelsblatt*, 13 April 2017, p. 12.

[45] 'London und Paris überholen Berlin', NTV, 1 February 2017, https://www.n-tv.de/wirtschaft/London-und-Paris-ueberholen-Berlin-article19681373.html

[46] D. Heide, 'Der Traum vom deutschen Google', *Handelsblatt*, 14 October 2016, p. 8.

and in 2015–2016 annual investments in start-ups in Germany fell from €3.6 billion to €1.9 billion[47]. The government's KfW bank is trying to compensate for this problem; from 2020 it will raise its annual amount of support for start-ups from €100m to €200m. Additional support to the tune of €500 million will also be provided by the European Investment Fund. Moreover, the government has also introduced the option for owners of start-ups of tax deductions from the losses associated with their previous projects. A slightly different form of support is the INVEST Fund, created in 2017 by the Federal Ministry of Economy and Energy. It has at its disposal €300 million, from which investors can get grants for investment (up to 20% of its value) in high-innovation companies. In addition, tax on the sale of shares in high-innovation companies has been reduced.

An important goal for the government is to increase the innovativeness of small- and medium-sized enterprises, enabling them to strengthen their market position and increase employment. One of the key support programmes is KMU-Innovativ[48], implemented by the Federal Ministry of Education and Research, which aims to support SMEs in the fields of biotech, medicine, information and communications, research materials, photonics, production technology, resource efficiency, climate protection and civil security. Companies can count on assistance with consultation as well as financial grants. Since 2007, this programme has supported 2500 companies to the tune of €1 billion. Meanwhile, the Central Innovation Programme for SMEs (*Zentrales Innovationsprogramm-Mittelstand*) is a project of the Federal Ministry of Economy and Energy aimed at supporting innovation and competitiveness in small- and medium-sized enterprises[49] and their research units[50]. In this framework, one can apply for support for individual projects aimed at improving innovation[51],

47 M. Greive, 'Milliardenregen für die Gründer', *Handelsblatt*, 12 June 2017, http://www.handelsblatt.com/finanzen/banken-versicherungen/start-up-foerderung-milliardenregen-fuer-die-gruender/v_premium_not_allowed/19921630.html

48 *KMU-Innovativ für Vorfahrt Spitzenforschung im Mittelstand*, Federal Ministry of Education and Research, Berlin 2016, https://www.bmbf.de/pub/KMU_innovativ_Spitzenforschung.pdf

49 The SME sector is defined as companies employing up to 500 employees, with a turnover of €50 million and total assets of €43 million.

50 *Impulse für Innovationen Zentrales Innovationsprogramm Mittelstand*, Federal Ministry of Economy and Energy, 2015, https://www.bmwi.de/Redaktion/DE/Publikationen/Mittelstand/zentrales-innovationsprogramm-mittelstand-zim.pdf?__blob=publicationFile&v=18

51 These research projects must meet several criteria: their aim is to develop new products and services that exceed the level of technical solutions currently on the market; they must display significant, but predictable technical risks; they must create new market opportunities and jobs; and they must be impossible to finance without the help of the programme.

cooperation in implementing projects, or creating cooperation networks. One important advantage of this programme is that it reduces the formalities and bureaucratic procedures to a minimum, and examines each application within a two-month period. The total amount of support provided is around €350 million per year.

The German government is also taking action to limit the decline in the number of companies in Germany. Within the EXIST programme, higher education facilities can obtain resources to support students in the process of establishing companies, fund promising ventures, and provide the means to conduct conceptual work on new business projects (50–75% of the consultancy costs). Likewise, the German Accelerator programme allows students and graduates to establish companies in the IT sector, and supports them in their first years on the market. Also of interest are the activities of German institutions which lend assistance to business owners searching for successors. To do this, a special web platform has been set up wherein retiring business owners can search for successors. 12,000 companies have been assisted in this way. Another example was provided by the activities of the NRW-Invest agency in North Rhine-Westphalia, which has opened an office in Poland aimed at searching for successors to take over German companies.

4. Raising the level of education

Improving education is one of the key conditions for adapting to the Fourth Industrial Revolution. In its strategic documents the German government has been increasingly emphasising that in a globalised world competition between education systems will increase, and their quality will determine the economic future. Highly developed countries will find it difficult to maintain their position due to the rising levels of education and science in developing countries. Meanwhile, workers in Germany will find it difficult to compete in the world of the digital economy without proper training, especially since many small- and medium-sized companies are unwilling to increase the scope of their use of digital technologies. German entrepreneurs are also accustomed to existing rules governing how industries function, and may not have the skills to master new industrial technologies. In the face of these challenges, the government has been focusing on supporting the construction of networks and clusters of innovation, creating instruments facilitating collaboration between research industries and industrial services (such as transport and logistics), building up innovation partnerships (by bringing together representatives of management, unions, science and education, and the public), and initiating the process

of creating innovation through platforms (such as the National Platform for Electro-Mobility)[52].

Since coming to power Chancellor Merkel has laid great emphasis on increasing spending on education and science. The budget of the ministry responsible for these areas grew by leaps and bounds in the period 2005–2017, by almost 142% up to €17 billion, despite the fact that Germany reduced its overall budget expenditure during this period. In 2006–2017, the higher educational establishments considered to be the most promising could count on financing to the tune of €4.6 billion. This funding served three purposes: supporting young researchers, creating a network of units undertaking the highest-quality research, and the development of research at German universities. The government set a requirement that the results of research financed by the Federal Ministry of Education and Research should be shared on the open-access principle.[53] Scientists were also guaranteed the right to re-publish their work on the open-access principle within 12 months of its first publication (regardless of any prior agreement with the publishing house), if the research was at least 50% financed from public funds.

Germany does not have such attractive tax incentives for investment in science as some other highly developed economies. In particular small countries, such as Ireland and the Netherlands, have a system of tax exemptions which attract companies investing in research to them. Germany has often criticised these measures as a manifestation of aggressive tax competition, and is involved in working out a common definition of the tax base in the OECD in order to prevent abuses in this area, as well as the leakage of fiscal revenues from Germany. These attempts have ended in failure. The US has already implemented (and the United Kingdom is considering) the introduction of significant tax reductions for companies investing in research, which will exacerbate tax competition.[54] However, a potential side-effect of this solution may be the creation of new loopholes for global corporations to commit tax fraud.

[52] *Die neue Hightech-Strategie für Deutschland Innovations*, Federal Ministry of Education and Research, Berlin 2014, https://www.bmbf.de/pub_hts/HTS_Broschure_Web.pdf, p. 5.

[53] *Open Access in Deutschland: Die Strategie des Bundesministeriums für Bildung und Forschung*, Federal Ministry of Education and Research, Berlin 2016, https://www.bmbf.de/pub/Open_Access_in_Deutschland.pdf

[54] M. Greive, J. Hildebrand, 'Schäuble gibt Widerstand auf', *Handelsblatt*, 2 May 2017, p. 12.

An important role in raising the level of education is played by subsidising less privileged students. The federal government took full responsibility from the regional authorities for financing scholarships, which around 110,000 students received in 2016. Depending on their financial situation and stage of education, they can count on amounts of between €200 and €735 monthly support. The grant may also take the form of a partial exemption from tuition fees or an interest-free loan. The scholarships are open to persons who have not reached the age of 35: the aid may be granted not only to German citizens, but also to foreigners who are likely to remain in the country[55]. The German authorities also attach much importance to improving the students' social situation, which is aided by regular increases to scholarships, raising the thresholds for entitlement to scholarships, increasing social support for families, raising the tax-free threshold, expanding the opportunities of scholarships for foreigners, and simplifying procedures for applying for scholarships. Another important role in facilitating learning involves offering a greater range of childcare for the parents of young children[56].

5. Shaping the international legal framework

For years, the most important instrument for implementing German industrial policy in the field of international relations has been shaping the European legal framework in order to best suit the needs of German industry. In the 1960s, Germany was interested in liberalising the trade in industrial products within the European Economic Community in order to reduce barriers to the sale of its products on the markets of less competitive countries. In the 1970s, a period of significant currency fluctuations, German politicians brought about the establishment of the European Monetary System, which guaranteed the stability of the Deutsche Mark (German Mark) in trading with the countries of the European Economic Community. In the 1980s, Germany was one of the main advocates of abolishing non-tariff barriers, which hampered

[55] K. Dienelt, *BAföfG für Ausländer mit dauerhafter Bleibeperspektive in Deutschland*, https://www.migrationsrecht.net/nachrichten-auslaenderrecht-politik-gesetzgebung/791-bafmigration-integration-ausler-bleiberecht-22-bafovelle.html

[56] In its last few terms, the federal government has significantly supported the regions in constructing kindergartens and funding their operations. In the period 2008–2015, the number of places available for children aged 1-3 increased from 360,000 to 660,000, for reasons including the development of crèches. In addition, since 2013 parents of children aged 12 months or more have the right to obtain childcare; this was a way of putting pressure on the *Bundesländer* to increase funding to broaden the preschool offer. Another flagship project is the creation of 24-hour kindergartens, which will be particularly helpful for people working night shifts.

the development of trade within the EEC. The 1990s were a period when the German government was focused on developing the most favourable conditions for the functioning of the eurozone. The creation of a monetary union limited other countries' room to devalue their exchange rates to rebuild their competitiveness. After 2010, in the face of the euro crisis, Germany was able to push through an austerity policy which helped to limit the losses of German banks, whose portfolios contained valuable bonds from the monetary union's southern states. In addition, this offset the risk of burdening German taxpayers with the cost of bailing out those countries most affected by the consequences of the eurozone crisis.

Today Germany finds itself increasingly obliged to block changes in EU law to ensure that the new regulations do not weaken the institutions supporting its industry. One example of this was Germany's position regarding the establishment of a banking union[57]. The Berlin government agreed to the European Central Bank's supervision of banking institutions in the eurozone, provided that the German *Landesbanken* were excluded from this supervision[58]. Although they experienced numerous problems during the global financial crisis, and many of them had to be recapitalised with public funds, in Germany the opinion prevailed that the *Landesbanken* were able to provide industry with flexibility in financing their investments, thanks to their strong relationships with local businesses.

Another way in which the German government defended its industry from unfavourable legislative changes in the EU was Berlin's reactions to the European Commission's 2017 proposal to introduce a package deregulating the services market in the EU. Brussels saw the German regulation that a condition for operating a craft workshop is to have a master's degree as an obstacle to deepening the integration of the common market. Chancellor Merkel announced her strong opposition to this proposal, seeing it as an attack on the German system of chambers of commerce and business associations, which provide high-quality services and professional educations[59]. The German government was also one of the first EU countries to introduce a minimum wage for truck drivers,

[57] K. Popławski, 'The shape of the banking union confirms Berlin's privileged position in the eurozone', *OSW Commentary*, 10 January 2014, https://www.osw.waw.pl/en/publikacje/osw-commentary/2014-01-10/shape-banking-union-confirms-berlins-privileged-position

[58] W. Schäuble, *Umsetzung der Europäischen Bankenunion*, 6 November 2014, http://www.wolfgang-schaeuble.de/umsetzung-der-europaeischen-bankenunion/

[59] R. Berschens, T. Hoppe, F. Specht, 'Kampf um den Meisterbrief', *Handelsblatt*, 21 March 2017, p. 6.

which was a manifestation of the fight against 'social dumping'; aside from heeding public opinion, Berlin was also taking care to limit the expansion of transport companies from Central Europe. The EC criticised those activities as unlawful protectionism; however its actual, rather sluggish, reaction was limited primarily to holding talks with the government in Berlin[60]. Germany also received strong support from France after the election of President Emmanuel Macron. As a result, both countries have managed to push through restrictions in the provisions on posting workers between EU countries, which is likely to weaken the competitiveness from logistics and construction businesses from Central Europe.

The German government is increasingly involved in creating better conditions for the development of foreign trade, not only within Europe but also globally. Germany's involvement in setting the highest possible environmental standards (in particular through the introduction of requirements to increase the share of renewable energy in the energy balance, and its participation in global climate conferences) is expected to improve conditions for export by German companies in the fields of renewable energy and energy efficiency. Germany was one of the founders of the International Renewable Energy Agency (IRENA), whose headquarters is located in Bonn[61]. In turn, one intended aim of the Transatlantic Partnership in the field of Trade and Investment was the liberalisation of trade, of which German industries would be one of the biggest beneficiaries[62].

In Germany it is increasingly clear that potential areas of conflict with the US include regulatory issues within the field of digitisation, as well as disputes over the market share of American IT companies[63]. Therefore, an important task for the government is to strive to maintain its 'digital sovereignty', that is, the country's ability to maintain freedom of movement and operation on the

60 A. Meier, 'Westeuropäer gegen Sozialdumping', *Tagesspiegel,* 7 March 2017, http://www.tagesspiegel.de/politik/eu-streit-um-speditionsunternehmen-westeuropaeer-gegen-sozialdumping/19480534.html

61 'Deutschland ratifiziert als erstes Land Gründungsvertrag von IRENA', Federal Environment Ministry, https://www.bmu.de/pressemitteilung/deutschland-ratifiziert-als-erstes-land-gruendungsvertrag-von-irena/

62 K. Popławski, 'Germany's stance on the TTIP. Background, interests and concerns', *OSW Studies,* 24 March 2015, https://www.osw.waw.pl/en/publikacje/osw-studies/2015-03-24/germanys-stance-ttip-background-interests-and-concerns

63 'In Spite of It All, America', *New York Times,* 11 October 2017, https://www.nytimes.com/2017/10/11/world/europe/germany-united-states-trump-manifesto.html

internet. To achieve this, German citizens and institutions must be guaranteed the relevant powers to operate freely online and to a competitive market of internet providers, as well as the security of their data and their data transmission devices. Germany is therefore committed to the creation of international standards and regulations guaranteeing the preservation of digital sovereignty. In collaboration with companies and institutions, the government has been developing new digital standards in Germany, and has since been trying to transpose them into EU legislation, as part of the Industry 4.0 project among others. The Federal Ministry of Economy and Energy gives grants for the development of German technologies in the fields of so-called cloud computing, IT security and software development. Currently, it is also trying to establish new international standards regarding the security of data stored in the so-called cloud, as well as the legal framework for testing self-driving vehicles. Another important objective for Germany is the further liberalisation of the EU digital market, which requires the free exchange of digital goods and services between member states, guaranteeing the appropriate procurement procedures in the field of IT, as well as data security. The optimal scenario for Germany would be if the EU spent a greater portion of the funds available in the multiannual financial framework than it has done so far on the development of digitalisation and IT technology, and funded the expansion of digital infrastructure in the member states.

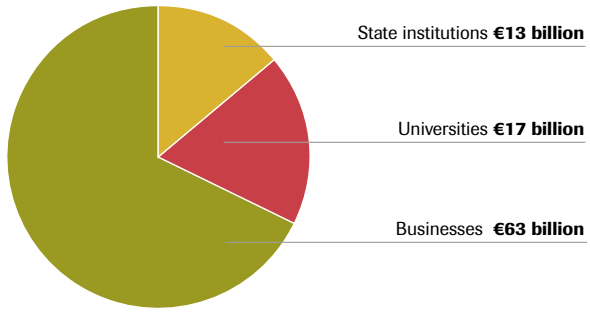
III. HOW SUPPORT FOR INDUSTRY IS ORGANISED

The two inseparable elements of industrial policy in Germany are the national innovation system and subsidies. Without the effectiveness of German institutions in these fields, the success which German industry enjoys today would be impossible.

1. Institutions responsible for implementing industrial policy

Despite difficulties in mastering the technology in the newest sectors of the economy, Germany is still one of the most innovative economies in the world in traditional sectors[64]. 90% of private sector expenditure on R&D is generated by industrial companies[65]. This is due largely to Germany's rich traditions of supporting industry through a system of institutions dealing with research and technical support for business. According to the OECD's methodology, the German innovation system is firm-centred, and its public research system is centred on public research institutions (as opposed to public research-centred innovation systems and higher-education institution-centred public research[66]).

Figure 7. Sources of spending on R&D (in billions of euros)



Source: Federal Ministry of Education and Scientific Research

Expenditure on research and development in Germany has been steadily rising, and in 2016 it amounted to €92 billion, of which business spent €63 billion,

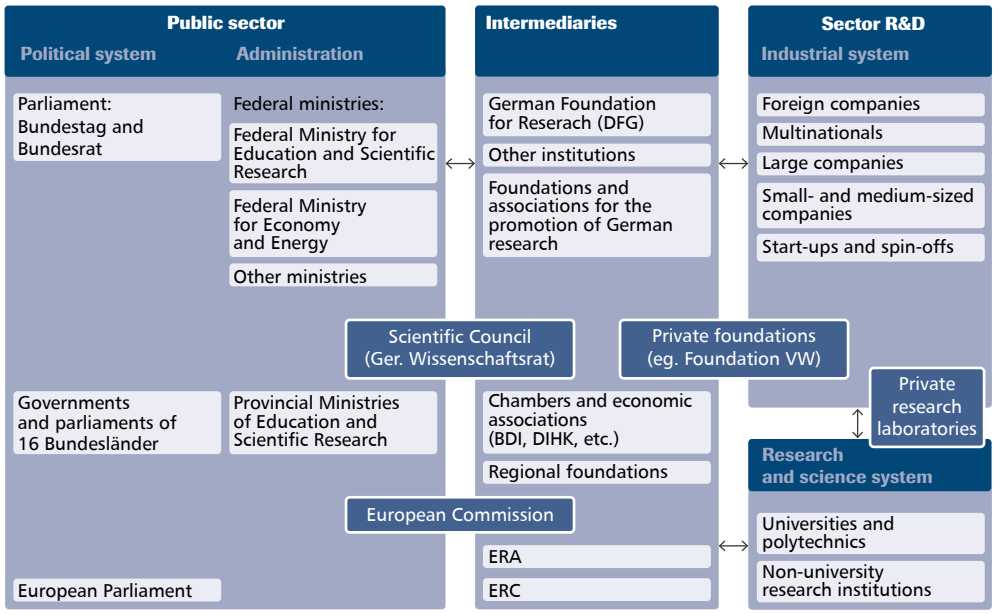
[64] In the innovation index of the European Commission, Germany came seventh in 2016, http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_en

[65] *Germany as a Competitive Industrial Nation: Building on Strengths–Overcoming Weaknesses–Securing the Future*, Federal Ministry of Economics and Technology, 2010, https://www.manufacturing-policy.eng.cam.ac.uk/documents-folder/policies/germany-in-focus-germany-as-a-competitive-industrial-nation-bmwi/at_download/file, p. 6.

[66] OECD Reviews of Innovation Policy: Sweden 2016, p. 91.

universities €17 billion, and the state €13 billion[67]. In 2014 603,900 people were employed in the R&D sector (out of 43.4 million workers in Germany); the number of employees in this sector has risen by 24% since 2000[68]. Support for innovation is a competence of both the federal and the provincial governments. Funds are earmarked for the short-term financing of specific research projects carried out by public and private institutions, as well as for the long-term financing of scientific and research institutions.

Figure 8. The German innovation system



Source: C. Hommes, A. Mattes, D. Triebe, *Research and Innovation Policy in the US and Germany: A Comparison*, Berlin 2011; and *New Challenges for Germany in the Innovation Competition–Final Report*, Karlsruhe, Atlanta 2008

The German innovation system is based on three pillars (see Figure 8):

1. The public sector: legislative and executive institutions (ministries) at the federal and regional level decide on the funding and define the strategies and directions for the development of the German economy.

[67] Forschung und Entwicklung, the Federal Statistical Office, https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bildung-Forschung-Kultur/Bildungsfinanzen-Ausbildungsfoerderung/Publikationen/Downloads-Bildungsfinanzen/bildungsausgaben-pdf-5217108.pdf?__blob=publicationFile&v=5

[68] *Forschung und Innovation: Die Trends 2016*, Federal Ministry of Education and Scientific Research, 6 January 2016, https://www.bmbf.de/de/deutschland-als-standort-fuer-forschung-und-innovation-2016-2845.html

2. Intermediaries: A significant part of public funding for innovation is managed by intermediaries, such as foundations or various types of government agencies. In addition, private foundations offer grants and funds for R&D.

3. The sector implementing R&D consists of enterprises, universities, non-university research institutions and state research institutions.

The most important institution coordinating expenditure on research and development is the Federal Ministry of Education and Scientific Research. For its part, the Federal Ministry of Economy and Energy primarily supports innovation among small- and medium-sized enterprises, and the transfer of technology from science to business. In addition, it is responsible for creating favourable structural conditions for research and innovation, by means including ensuring the supply of skilled labour, protecting intellectual property and financing the necessary technical infrastructure. For its part, the Federal Environment Ministry finances research projects on green technologies in the fields of transport, construction, energy and environmental protection.

The German *Länder* shape innovation policy through both the activities of the Ministry of Education and Scientific Research and other channels. Regional spending on research and development accounts for about 40% of all public expenditure in this sector. The role of auxiliary bodies, such as the Scientific Council (*Wissenschaftsrat*) and the Expert Commission for Research and Innovation (*Expertenkommission Forschung und Innovation*), is to make recommendations to the federal government and the *Länder* in matters of support for science and innovation.

The European Union plays an increasingly important role in the German plan for supporting innovation, particularly in view of the fact that the EU has allocated exceptionally large resources for research and innovation in its current budget planning. The European Commission co-finances research and development primarily through the European Research Council (ERC). In the budget for 2014–2020, the ERC has around €12.8 billion available for all EU countries. In turn, the European Research Area (ERA) aims to raise the effectiveness of research systems within the EU and the level of research cooperation between member states.

The intermediary institutions are involved in the administration of public and private spending assigned to research and development. As a rule, these institutions operate on the basis of public law or through a registered association

(*eingetragener Verein*). At the federal level, the largest of these intermediary institutions are:

- the German Foundation for Research (DFG, *Deutsche Forschungsgemeinschaft*). This is an independent foundation which received €2.99 billion from the federal government in 2016. The DFG funds both research projects & scholarships, and investments in research infrastructure. The Foundation funds research in all areas of science. In 2016, out of 14 areas of study, most funds were allocated for research in the field of medical sciences (around 25% of the budget).
- the German Academic Exchange Service (*Deutscher Akademischer Austauschdienst*). This association is primarily engaged in financing international scientific research exchanges and paying out scholarships.
- chambers and business associations such as the Federal Association of German Industry (*Bundesverband der deutschen Industrie*) and the German Chamber of Industry and Commerce (*Deutsche Industrie- und Handelskammertag*). This type of organisation offers its members financial support in applying for research grants, or cooperation in research and development, among other things. In addition to earmarking funds, they also offer know-how and act as mediators between business and the R&D sector.

An important role in financing research and innovation is also played by foundations which are financed or co-financed by individual companies. Some of them also receive money from the state budget. The largest of these are presented in the following table, together with their budgets and the areas of their research.

Table 2. The largest German non-governmental organisations financing research and innovation

Name of foundation	Annual spending on research and development	Areas of research
Federation of Industrial Research Associations (*Arbeitsgemeinschaft industrieller Forschungsvereinigungen*)	€535 million	Instruments of support for all research with applications in the economy, from basic research to individual products and processes. In 2017 around 30% of its funds were earmarked to support industrial research, and 70% for research for SMEs.

Name of foundation	Annual spending on research and development	Areas of research
Volkswagen Foundation	€150 million	The largest private foundation in Germany, which provides support to research institutions and individual researchers from all fields of science.
Bosch Foundation	€109 million	The Foundation supports activities in five key areas: – education – society – medicine – international cooperation – science (sustainable development, land management, women in science, cooperation among researchers).
Else Kröner-Fresenius Foundation	€46 million	Research projects in the field of medical science, and support for medical humanitarian projects.
Foundational Association for German Science (*Stifterverband für die deutsche Wissenschaft*)	€30.5 million	Support in the areas of: – education – learning – innovation. Around 30% of the budget goes to scholarships for professors.
Körber Foundation	€18 million	Support in the following areas of research: – demography and aging – education (support for education in the field of MINT) – communication – culture – science (financing conferences and awards) – democracy – history and politics – foreign policy

Source: Author's own research

At the European level, German companies and institutions involved in research and science may apply for European funds, either directly to the European Commission, or by applying for funding for specific activities through intermediaries such as the European Research Council (ERC) or the European Research Area programme (ERA).

One specifically German phenomenon is that of non-university research institutions, which consume a large part of R&D expenditure, and which also serve as the research base for German businesses, particularly smaller ones which do not maintain large R&D departments. In its report on organisations and institutions in the field of research and science, the Federal Ministry of Education and Scientific Research lists 636 such organisations[69]. The biggest of them are the Fraunhofer Society, the Max Planck Society, the Helmholtz Association of German Research Centres (*Helmholtz-Gemeinschaft*), and the Leibniz Association (*Leibniz-Gemeinschaft*). These non-university institutions often have offices and research centres outside Germany, most often in technically advanced countries like the US, Japan, South Korea, Israel and the Nordic countries. The Fraunhofer Society is the largest organisation for applied research in Europe, and the Helmholtz Association is the largest scientific organisation on the continent.

Table 3. Non-university research institutions in Germany

Name of institution	Number of employees*	Annual budget*	Areas of research
Fraunhofer Society	25,300, of whom 38% are academic staff and 27% are students and post-graduates	€2.3 billion	Applied science. Research in five areas: health, safety, communication, mobility, energy and environment, in 72 institutes.
Max Planck Society	22,900, of whom 61% are academics. 47% of its researchers are foreigners	€1.8 billion	Basic research in 84 institutes.
Helmholtz Association	38,700, of whom around 15,000 are employees and around 5000 are doctoral students	€4.5 billion	Technical and natural science, medical and biological science. Research is conducted in a network of 18 independent research institutions, including the German Aerospace Centre, the German Electron Synchrotron (DESY) and the Institute of Technology at Karslruhe.

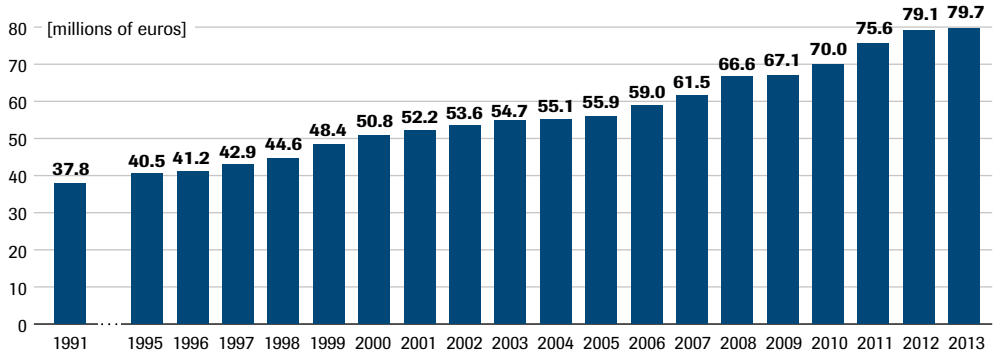
[69] *Bundesbericht Forschung und Innovation 2016–Ergänzungsband 2 Organisationen Einrichtungen und Forschung und Wissenschaft*, Ministry of Education and Scientific Research, 2016, p. 4.

Name of institution	Number of employees*	Annual budget*	Areas of research
Leibniz Association	19,100	€1.93 billion	Research in 5 areas: humanities, social and economic sciences, natural sciences, mathematics and engineering, environmental sciences.

* According to the latest available data. The oldest information comes from 2014

Source: *Bundesbericht Forschung und Innovation 2016–Ergänzungsband 2 Organisationen Einrichtungen und Forschung und Wissenschaft*, Federal Ministry of Education and Scientific Research, Berlin 2016

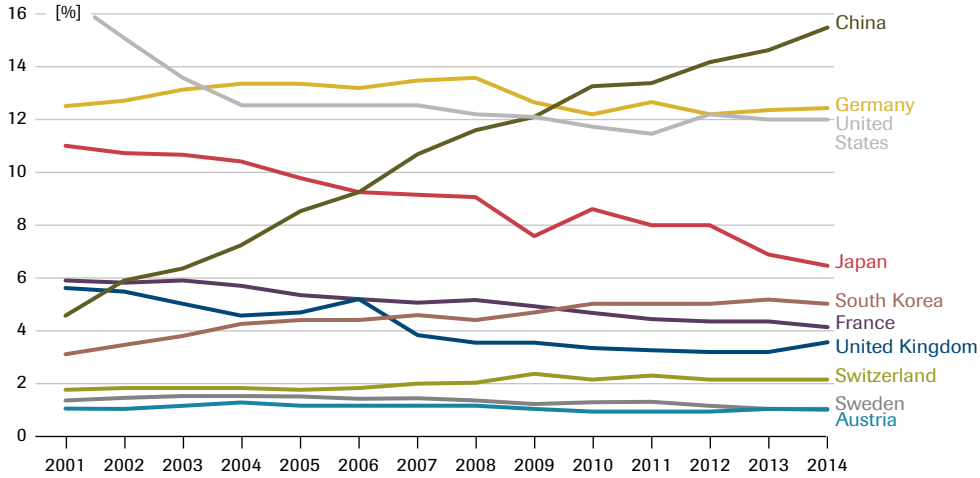
Figure 9. Development of gross expenditure on science and research in Germany, in millions of euros



Source: Federal Ministry of Education and Scientific Research, https://www.bmbf.de/de/deutschland-als-standort-fuer-forschung-und-innovation-2016-2845.html

In 2013, public and government expenditure on science and research amounted to €79.7 billion, placing Germany first in this category in the EU. Preliminary estimates put the increase in spending on science in 2014 at €583.9 billion. Around 70% of these funds (around €54 billion) go to private sector spending; the rest of the R&D expenditure goes to universities and public & private institutions. The number of people working in R&D is at its highest ever, and in 2014 amounted to 603,000 persons. Since 2000 that number has risen by over 20%.

Figure 10. Selected countries' share in the global trade in research-intensive goods (percent)



Source: Federal Ministry of Education and Scientific Research, https://www.bmbf.de/de/deutschland-als-standort-fuer-forschung-und-innovation-2016-2845.html

German companies have a big advantage over their EU competitors in terms of the global market share of research-intensive goods[70]. Since 2000, German companies have maintained a global market share of 12–13%, ahead of the US (around 12%), Japan (around 6%) and South Korea (around 5%). Only China has a better result in this indicator – a share of around 15% of the global market for research-intensive goods.

German efforts to support the R&D sector have had measurable effects. In the world ranking of the Global Competitiveness Index (GCI)[71], Germany ranks fourth out of the 140 countries classified. This ranking examines the competitiveness of economies based on 12 key indicators. Germany is sixth in the world in the rate of innovation.

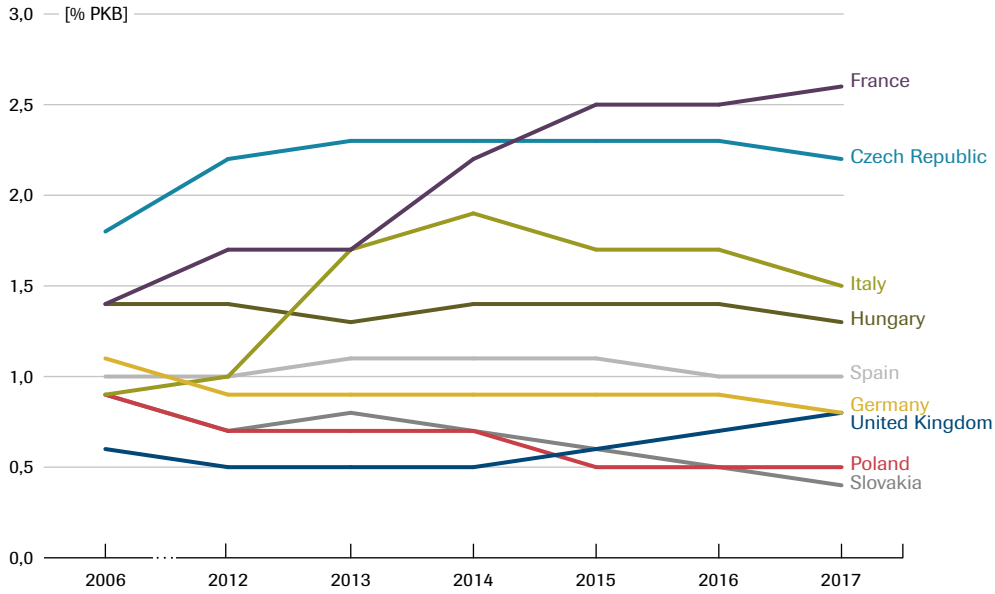
[70] According to the definition by the German Institute of Economy, research-intensive goods are industrial products on which during manufacturing companies spend between 2.5% to 7% of their annual R&D expenditure. Around two-thirds of German exports are products of this type. *Forschungsintensive Industrie*, 1 June 2018, https://www.diw.de/de/diw_01.c.412447.de/presse/diw_glossar/forschungsintensive_industrie.html

[71] World Economic Forum, http://reports.weforum.org/global-competitiveness-report-2015-2016/competitiveness-rankings/

2. The scope of subsidies within the framework of Germany's industrial policy

An important role in German industrial policy is played by subsidies and tax breaks. Although Germany's policy in this area has been the subject of strong criticism from the scientific community and non-governmental organisations, many private enterprises can still count on high levels of support from the state, even if they are in a good financial situation.

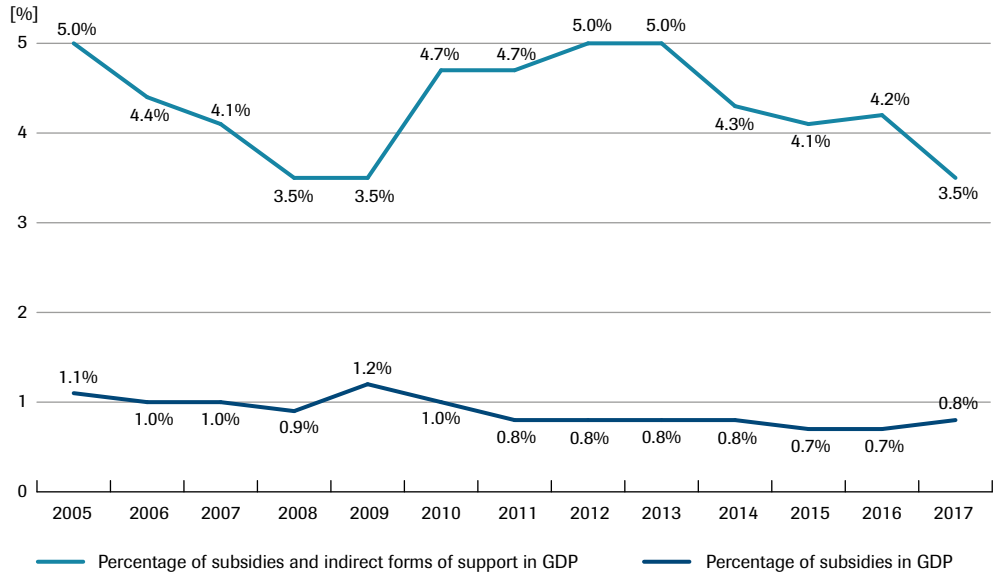
Figure 11. The value of subsidies in selected EU countries (% of GDP)



Source: Eurostat

Germany is at an average level, spending more on subsidies relative to GDP than do Poland or Slovakia, but less than the Czech Republic, France, Spain or Italy. In contrast to many countries, Germany has limited the scope of subsidies it provides in recent years. As a result, German expenditure in support of business is lower than in many other developed countries. This was caused by the country's good economic situation: in recent years German companies have not had problems with international expansion, have benefited from domestic consumption on the German market, and could also obtain cheap credit thanks to the extremely low cost of debt service. In the cases of France and Italy, levels of subsidies have risen because these governments have been protecting the industries most affected by the economic crisis.

Figure 12. Expenditure on subsidies relative to GDP in Germany



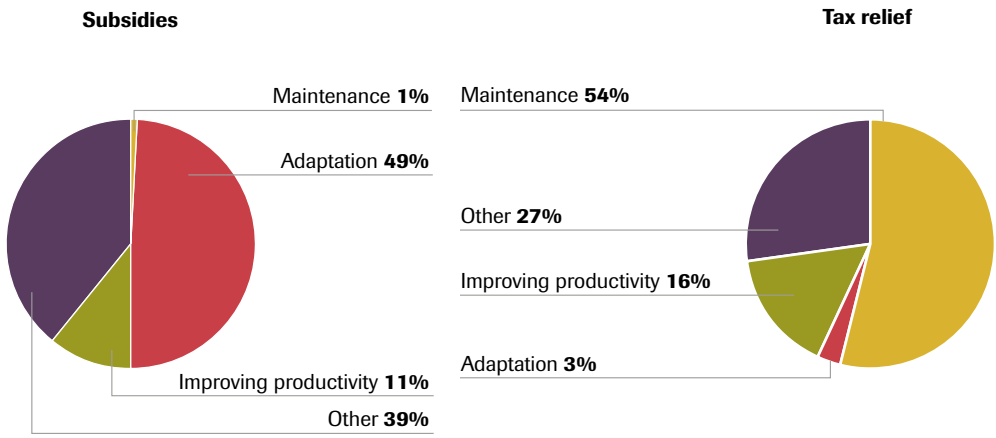
Source: *26. Bericht der Bundesregierung über die Entwicklung der Finanzhilfen des Bundes und der Steuervergünstigungen für die Jahre 2015 bis 2018*, Federal Government of Germany, 2017, https://www.bundesfinanzministerium.de/Content/DE/Standardartikel/Themen/Oeffentliche_Finanzen/Subventionspolitik/2017-08-23-subventionsbericht-26-anlage.pdf?__blob=publicationFile&v=1; C. Laaser, A. Rosenschon, *Subventionsbericht und die Kieler Subventionsampel: Finanzhilfen des Bundes und bis Steuervergünstigungen 2017–eine Aktualisierung*, Institute for World Economy in Kiel, 2018, https://www.ifw-kiel.de/fileadmin/Dateiverwaltung/IfW-Publications/-ifw/Kieler_Beitraege_zur_Wirtschaftspolitik/wipo_14.pdf

However, if we look more closely at the data on the scope of subsidies in the German economy, it turns out that the full extent of financing for private enterprises is greater than that indicated by the above data; they are granted direct support in the form of funding only rarely (in the federal government's reports, subsidies are defined very narrowly as direct financial assistance granted to the private sector by the state)[72]. According to the government, the drop in the amount of subsidies for the German economy has been continuous since the 1970s. In the period 2005–2017 the share of grants fell from 1.1% to 0.8% of GDP. However, according to the Institute for World Economy in Kiel, the extent of support for the private sector in direct or indirect forms is much higher, and is subject to strong fluctuations. Until the global financial crisis,

[72] In German reporting on the extent of the subsidies, one problem is the country's federal structure. Although the state has the obligation to prepare annual reports on the scope of the subsidies, the data obtained from the *Bundesländer* are not standardised, because each province applies its own definition of what constitutes a subsidy. In addition, the data does not include support for some public sector companies, such as Deutsche Bahn. Likewise, the state does not count investments in the field of research and innovation as subsidies.

the share of subsidies and indirect forms of support fell from 5% of GDP in 2005 to 3.5% in 2008–2009, then rose again to 5% of GDP in 2012–2013, and in subsequent years fell to 3.5% of GDP.

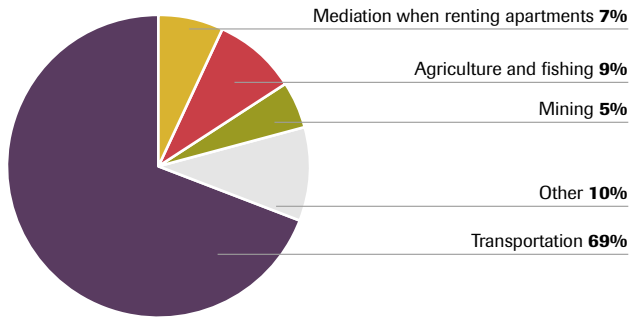
Figure 13. Federal subsidies and tax breaks for specific targets in 2017



Source: 26. *Bericht der Bundesregierung über die Entwicklung der Finanzhilfen des Bundes und der Steuervergünstigungen für die Jahre 2015 bis 2018*, Federal Government of Germany, 2017, https://www.bundesfinanzministerium.de/Content/DE/Standardartikel/Themen/Oeffentliche_Finanzen/Subventionspolitik/2017-08-23-subventionsbericht-26-anlage.pdf?__blob=publicationFile&v=1

An analysis of the structure of expenditures for specific purposes shows that Germany avoids subsidising companies solely in order to 'keep them alive', preferring to grant them financial relief. Only 1% of funds goes directly to the declining industries, whereas up to 49% is earmarked for the purposes of adapting to the market situation. With regard to distributing benefits in the form of tax breaks, the reverse is true; up to 54% of funds go to declining industries (those which have little prospect of development and are in need of state support to maintain their profitability), while only 3% goes towards restructuring companies to adapt to changes on the market.

Figure 14. The manner of allocation of federal subsidies and tax relief for specific purposes



Source: C. Laaser, A. Rosenschon, *Kieler Subventionsbericht und die Kieler Subventionsampel: Finanzhilfen und des Bundes Steuervergünstigungen bis 2017–eine Aktualisierung*, https://www.ifw-kiel.de/fileadmin/Dateiverwaltung/IfW-Publications/-ifw/Kieler_Beitraege_zur_Wirtschaftspolitik/wipo_14.pdf, p. 11.

In 2017, out of a sum of €29 billion, 9% went on agriculture and fisheries, 5% on mining, 69% on transport, 7% on mediation in renting living space[73]. To this must be added the amount of support available to all sectors of the economy. Out of a sum of €7.6 billion, 8% went on structural and regional policy, 50% on the employment funding policy, 9% on retraining employees and 19% on support for SMEs. Many of these funds went to the strongest German companies. In recent years the automotive industry has received €18 million of support for the design of self-driving cars and €16 million for the construction of infrastructure to charge electric cars[74]. After several years of resistance, the government gave way to the companies, and in 2016 allocated subsidies to buy electric cars, which costs the budget €275 million annually[75]. In turn, the Federal Ministry of Education and Scientific Research has assigned €120 million to support Industry 4.0 projects.

[73] This amount does not include the funds contributed to the economy from the regional level. The federal states and municipalities offer financial aid to companies worth 28.5 billion euros: 48% in subsidies and 52% in tax relief; *26. Bericht der Bundesregierung über die Entwicklung der Finanzhilfen des Bundes und der Steuervergünstigungen für die Jahre 2015 bis 2018*, Federal Government of Germany, 2017, https://www.bundesfinanzministerium.de/Content/DE/Standardartikel/Themen/Oeffentliche_Finanzen/Subventionspolitik/2017-08-23-subventionsbericht-26-anlage.pdf?__blob=publicationFile&v=1

[74] 'Wieso wird der Elektro-Porsche mit Steuergeld unterstützt?', *Die Welt*, 22 March 2016, http://www.welt.de/print/die_welt/politik/article153551570/Wieso-wird-der-Elektro-Porsche-mit-Steuergeld-unterstuetzt.html

[75] K. Popławski, 'Niemcy: rząd wprowadzi dotacje dla samochodów elektrycznych' [Germany: The government will introduce subsidies for electric cars], *Analizy OSW*, 11 May 2016, https://www.osw.waw.pl/pl/publikacje/analizy/2016-05-11/niemcy-rzad-wprowadzi-dotacje-dla-samochodow-elektrycznych

A wide range of support is also assured for the logistics industry, which is struggling with competition from Central and Eastern European companies. According to industry associations, logistics companies can receive funding from 750 support programmes, and receive grants for programmes including the creation of an energy management system, replacing tyres, training employees, AdBlue fuel, and building logistic centres[76]. Usually environmental and safety considerations motivate the granting of such subsidies.

The government also offers support to regions with structural problems. Under the 'Improvement of the regional economic structure' programme (*Verbesserung der regionalen Wirtschaftsstruktur*) funds are given to companies from the eastern and northern parts of the country. The essence of the programme is to promote investment in craft businesses in order to provide jobs and increase revenue through the development of efficient infrastructure, financing strategies and concepts for regional development and networking local actors, promoting competitiveness and innovation in the SME sector, and activating the regions' inhabitants. The programme is funded from government and regional sources as well as EU funds; in 2014, out of a sum of around €1 billion, 80% went on craft businesses, 19% on service providers, and 1% on other industries[77]. New instruments of support for farmers in case of bad weather have also been created, costing €300 million a year.

Support for exports has also become a way to push through structural changes in the agricultural regions. One example of this might be the 'Improving agricultural structures and coastal protection' programme (*Verbesserung der Agrarstruktur und Küstenschutz*)[78] which is being implemented by the Federal Ministry of Food and Agriculture. Its aims are to create agriculture and forestry which can compete on international markets, and to adapt agriculture to the challenges of climate change, environmental protection and consumer rights. This programme's annual expenditure amounts to about €1 billion, of which 60% is financed by the federal government and 40% by the *Länder*. Sup-

[76] 'Noch viel Geld für Logistik abrufbar', 17 June 2015, https://www.dvz.de/rubriken/management-recht/detail/news/noch-viel-geld-fuer-logistik-abrufbar.html

[77] 'Förderung der Wirtschaft gewerblichen; Bewilligungen nach gewerblichen Sektoren 2014 einschließlich EFRE', http://www.bmwi.de/DE/Themen/Wirtschaft/regionalpolitik,did=557750.html

[78] 'Förderung landwirtschaftlicher Unternehmen ab 2014', Federal Ministry of Food and Agriculture, 2014, http://www.bmel.de/SharedDocs/Downloads/Broschueren/FoerderungLandwUnternehmen2014.pdf;jsessionid=F7A80C2976CC479556D76CCA93156E2B.2_cid385?__blob=publicationFile

port is provided in the form of grants and low-interest loans. The funds are earmarked for activities such as co-investment in agriculture, diversification of sources of income, support for rural tourism, as well as granting loans to support rural entrepreneurship and improving the export competitiveness of agricultural enterprises.

The system of export credits, investment guarantees and programmes to support the process of internationalising companies is still an important instrument of the country's industrial policy. In 2015, the German state underwrote contracts totalling €26 billion (equivalent to 2.2% of annual exports)[79]. The largest part of these guarantees went on exports to Russia, the US, Egypt, Turkey, Italy and China. 75% of the guarantees went to firms exporting to developing countries, which primarily served as a hedge against political risk. The financial guarantee system is also useful for German companies as they expand into developed countries such as the US and Italy, which often means that the guarantees allow them to reduce the cost of export credit.

An analysis of the structure of the aid provided leads to some interesting conclusions. The fact that less than 20% of the guarantees went to the shipbuilding industry shows that it is an effective instrument for supporting the internationalisation of industries with structural problems (more on this in the section 4.2). 9% of the guarantees went to the energy sector, which is intended to help in expanding the renewable energy sector. The manufacturing industry was also covered by the guarantees (9%), as was the aeronautics industry (8%). 7% of the funds were earmarked to support the gas extraction industry. In recent years there has been a redefinition of the role of the development policy, which today is an important factor in promoting exports. In order to promote German environmental technologies, the following programmes have been created: the Renewable Energies Export Initiative[80](*Exportinitiative Erneuerbare Energien*) and the Energy Efficiency Export Initiative (*Exportinitiative Energieeffizienz*). These help SMEs from the fields of renewable energy sources and improving energy efficiency to expand internationally. Funds from this programme have been allocated to financing participation in trade fairs, business trips and promotional events, education, and promoting German technology to foreign

[79] *Exportkreditgarantien der Bundesrepublik Deutschland: Jahresbericht 2015*, https://www.agaportal.de/_Resources/Persistent/c7c432b5e5c02233220ffd27856f64c7c28787d3/jb_2015.pdf

[80] The principles of the programme are available at https://www.bafa.de/DE/Wirtschafts_Mittelstandsfoerderung/Auslandsmarkterschliessung/Exportinitiative_Energie/exportinitiative_energie_node.html

policy-makers, academics, journalists and students. In many cases, the state institutions help in organising such events, for example through the foreign branches of the German Chamber of Commerce and Industry.

Table 4. Differences between new and old industrial policy

Old industrial policy	The new industrial policy
Tax breaks for energy-intensive companies	Focus on technologies and services
Supporting national champions	Aiming for sustainable development and the needs of society
Emphasis on low costs and wages	Emphasis on innovation
Subsidies for large traditional companies	The use of market forces and competition
Optimism in planning	Greater realism and exploring market needs
Conditions set by the state	Conditions set by dialogue between various actors
Sectoral strategies	Systemic approach, shared vision
Decreasing importance of manufacturing	New services and environmental technologies complementary to manufacturing products

Source: K. Aiginger, T. Bauer, 'Industriepolitik 2.0', *Wirtschaftsdienst* 96 (8), 2016; http://archiv.wirtschaftsdienst.eu/jahr/2016/8/industriepolitik-20/#footnote-32982-4-backlink, pp. 592–602.

The traditional industrial policy instruments that exist in Germany are often directed towards offering instruments to subsidise certain sectors or companies, or to carry out giant investments subsidised by the state. This approach has been criticised because it leads to the implementation of inefficient projects, which are based often on unrealistic assumptions and poorly developed strategies (for example, the reconstruction of the Stuttgart 2020 railway junction can be considered as a misguided investment, as it cost huge amounts and caused strong protests connected with accusations of mismanagement as well as environmental questions[81]).

[81] 'Protesty obywatelskie osłabiają chadecję w Badenii-Wirtembergii' [Civil protests weaken the Christian Democrats in Baden-Württemberg], *Analizy OSW*, 6 October 2010, https://www.osw.waw.pl/pl/publikacje/analizy/2010-10-06/protesty-obywatelskie-oslabiaja-chadecje-w-badenii-wirtembergii

The way in which the recipients of grants are selected has been subject to criticism from representatives of academia and non-governmental organisations, who question the sense of giving grants to profitable businesses and the use of public funds to support the riskiest projects[82]. The German press has also accused the government of hypocrisy; Berlin criticised Athens for abolishing taxes on shipowners, while itself introducing a similar instrument in 2015. Germany has also introduced instruments of financial support under the pretext of improving some companies' environmental performance; for example, road transport companies can obtain subsidies to purchase tyres for their vehicles under the Support for Environment and Security programme[83].

Within the German debate, the need to implement a so-called new industrial policy is being raised increasingly often. This policy should eliminate the drawbacks of the conventional solutions[84]. Its main objectives include: focusing on creating innovative products and services to meet developmental and social needs; stimulating innovation; taking into account the knowledge and skills not only of state institutions, but also of representatives of public and expert circles, and building support mechanisms on the principles of competition.

One example of this new type of industrial policy is the project of energy transformation (*Energiewende*) which has been implemented since 2011. This envisages the creation of conditions for the development of renewable-energy and energy-efficiency technologies, so that they become the new flagship export product (more on this in section 4.4). The process of designing this transformation was contributed to not only by representatives of public administration or business, but also by social organisations. Its strategy is focused on the long term, and its support mechanisms are oriented so as to achieve specific goals, rather than to subsidise specific companies. In accordance with this principle, the government was ready to significantly reduce the profits of the traditional industrial concerns (such as E.ON and RWE) during the *Energiewende*'s implementation period in the name of expanding the potential of the renewable energy industry. Producers of environment-friendly energy were subsidised

[82] D. Bocking, 'Wie Deutschland seine Wirtschaft päppelt', *Der Spiegel*, 9 April 2018, http://www.spiegel.de/wirtschaft/soziales/subventionen-wie-die-deutsche-wirtschaft-gepaeppelt-wird-a-1201607.html

[83] https://www.bag.bund.de/DE/Navigation/Foerderprogrammeme/Deminimis/deminimis_node.html

[84] K. Aiginger, T. Bauer, 'Industriepolitik 2.0', *Wirtschaftsdienst* 96 (8), http://archiv.wirtschaftsdienst.eu/jahr/2016/8/industriepolitik-20/#footnote-32982-4-backlink, pp. 592–602.

directly from the pockets of consumers by charges added to their electric energy bills[85]. The subsidisation of renewable energy sources resulted in a limit to energy price rises for German industry, as it launched heavily subsidised renewable energy onto the market and reduced wholesale energy prices on the German stock exchange. In the period 2013–2015 the German steel industry was able to reduce its energy costs by €9 billion, while British companies could only manage a reduction of €200 million[86]. In addition, the renewable-energy subsidy system includes a form of support for energy-intensive enterprises which are partially or completely exempted from subsidies. In 2015 alone, this amount was reduced by €4.8 billion[87].

[85] The fee for RES is around 23% of the electricity bill. In 2017 due to the RES subsidies, producers were given around €30 billion, and the forecasts for 2018 run at about €32 billion.

[86] In Britain, unlike in Germany, the costs of financing climate policy are incurred to a greater extent by companies rather than consumers. See K. Stacey, 'Steel crisis turns up heat on energy subsidies', *Financial Times*, 3 April 2016, http://www.ft.com/intl/cms/s/0/d91c122c-f828-11e5-96db-fc683b5e52db.html#axzz44qO01bfp

[87] 'Firmen Verlangen 4.8 Milliarden Euro discount auf Strompreis', *Manager Magazin*, 15.07.2015, http://www.manager-magazin.de/unternehmen/artikel/firmen-verlangen-4-8-milliarden-rabatt-auf-strompreis-a-1043715.html

IV. CASE STUDIES OF SUPPORT FOR GERMAN INDUSTRY

The following case studies contribute to the analysis of the German state's influence on the structure of the economy, the support it offers to declining industries (here, the shipbuilding industry), how it bolsters the position of thriving industries (the automotive industry), and the development of new technologies (renewable energy industry).

1. Shaping the structure of the economy

The trend towards privatisation was especially evident in Germany in the 1990s, when the state reduced its stake in the telecommunications, postal, energy and air travel sectors[88]. Over time, however, German society started to evaluate these activities negatively, as it did not see any clear benefits from privatisation in the form of better quality services or reduced prices[89]. In the period 2007–2014, support for the further privatisation of state-owned companies fell from 24% to 12%, and support for maintaining the status quo rose (from 50% to 57%), as it did for the re-nationalisation of private property (from 19% to 28%)[90]. When in 2016 German Finance Minister Wolfgang Schäuble proposed the partial privatisation of motorways in Germany in order to modernise them, he quickly had to withdraw the proposal due to fierce public criticism[91].

German politicians seem increasingly unwilling to limit the state's participation in the economy. The Treasury has a 100% stake in Deutsche Bahn, 32% in Deutsche Telekom[92] and 21% in Deutsche Post. In addition, the federal province of Lower Saxony holds a 20% stake in Volkswagen[93]. The state also re-

88 J. Leidinger, M. Steinhäuser, 'Lieber Staat als Privat', *Süddeutsche Zeitung,* 17 May 2010, http://www.sueddeutsche.de/wirtschaft/privatisierung-in-deutschland-lieber-staat-als-privat-1.711088

89 'Privatisierung staatlicher Leistungen–Was wollen die Bürger?', *Forsa,* 1 August 2008, http://www.who-owns-the-world.org/wp-content/uploads/2008/01/forsa.pdf

90 'Bürgerbefragung öffentlicher Dienst: Einschätzungen, Erfahrungen und Erwartungen', Bundesleitung des DBB Beamtenbund und Tarifunion 2014, http://www.dbb.de/fileadmin/pdfs/2014/forsa_2014.pdf, p. 37.

91 'Schäubles Autobahn-Plan offenbar ist vom Tisch', *Die Welt,* 23 November 2016, https://www.welt.de/politik/deutschland/article159717628/Schaeubles-Autobahn-Plan-ist-offenbar-vom-Tisch.html

92 In 2016, the government also decided to slightly increase its stake in Deutsche Telekom from 31.8% to 32%.

93 Under a special law, the federal province of Lower Saxony is able to block the decisions of the board of the company, despite the fact that under German legislation this power is vested in

tains a significant interest in the energy sector. German municipalities (including the cities of Dortmund and Essen) also hold about 24% of shares in RWE[94], and the company EnBW is mostly owned by the federal province of Baden-Württemberg. After the outbreak of the global financial crisis, the state acquired shares in several major financial institutions such as Commerzbank and Hypo Real Estate, which resulted in an increase in its share of the sector from 34% to 50%[95]. In addition, the German *Bundesländer* have a significant share in the financial sector through the *Landesbanken* which they control.

The federal government's influence on the strategic areas of the economy is increased thanks to its shareholdings in strategic sectors, together with the operation of specific legal regulations. For example, the Federal Ministry of Infrastructure forced Deutsche Telekom to make a written commitment to accelerate the development of infrastructure in the country's most digitally backward communities[96]. The state-owned Deutsche Bahn can always expect a lot of support, and for many years the federal government has been criticised for favouring the company by maintaining its control over access to rail infrastructure[97]. It was not until 2013 that a law prohibiting bus connections from running on routes of rail tracks, which had been in operation for decades, was abolished[98]. However, Deutsche Bahn can still count on privileged access to rail infrastructure[99].

The divergence of views in the dispute about where the boundary of the government's intervention in market processes should be became apparent during

shareholders which own at least 25% of the company's shares. Germany does not intend to change this law, despite many years of legal disputes with the European Commission on this matter. 'Germany will uphold the veto over Volkswagen's strategic decisions', *OSW Analyses*, 30 October 2013, https://www.osw.waw.pl/en/publikacje/analyses/2013-10-30/germany-will-uphold-veto-over-volkswagens-strategic-decisions

94 'RWE-Kommunen verzichten Beteiligung auf', *Handelsblatt*, 28 September 2016, http://www.handelsblatt.com/finanzen/maerkte/ipo/innogy-boersengang-rwe-kommunen-verzichten-auf-beteiligung/14613574.html

95 Ch. Kaserer, 'Staatliche Hilfen für Banken und ihre Kosten–und Merkmale einer Notwendigkeit Ausstiegsstrategie', https://www.ibbnetzwerk-gmbh.com/uploads/media/Kaserer-Exitstrategien_2010_.pdf, p. 9.

96 D. Delhaes, I. Karabasz, 'Die stille Verabredung', *Handelsblatt,* 30 January 2017, p. 8.

97 'Bund benachteiligt Bahn-Konkurrenten', *Tagesschau,* 22 July 2015, https://www.tagesschau.de/wirtschaft/bahn-monopol-101.html

98 M. Riemen, 'Fernbusse–echte Konkurrenz für die Bahn', *RP Online,* 2 January 2013, http://www.rp-online.de/nrw/staedte/duesseldorf/fernbusse-echte-konkurrenz-fuer-die-bahn-aid-1.3121640

99 'Bund benachteiligt Bahn-Konkurrenten', *Tagesschau,* 22 July 2015, https://www.tagesschau.de/wirtschaft/bahn-monopol-101.html

Edeka's takeover in 2015 of the Kaiser's Tengelmann supermarket chain, which at that time was in a bad financial situation. Due to the risk of Edeka monopolising the market, the Cartel Authority wanted to block the transaction; the *Bundestag*'s Committee on Monopolies also expressed its opposition to this move. Ultimately, however, the then Minister of Economy and head of the SPD Sigmar Gabriel decided to grant a one-off authorisation for the transaction, arguing that protecting jobs took priority. Gabriel's decision was subsequently annulled by an administrative court, which considered it as overly partial, and Edeka had to sell some of the supermarkets to the Rewe network[100].

Another example of politicians interfering in the market involved the bankruptcy of Air Berlin. After this was announced in September 2017, many politicians of the then ruling coalition, including the Minister of Transport Alexander Dobrindt (CSU), declared their support for a takeover by Lufthansa, which would strengthen its position as a national champion in the context of increasing competitive pressure from outside Europe. These measures were criticised by former representatives of the Committee on Monopolies, who stated that such a move would not promote competition on the German aviation market. Lufthansa, which before it acquired Air Berlin had a monopoly on 10 routes connecting German cities with foreign countries, could have obtained a monopoly on a further 16 routes within Germany, possibly leading to a rise in prices[101]. Finally, with the support of German politicians, Lufthansa bought 81 of the bankrupt company's 130 aircraft, as well as the rights to most of Air Berlin's old routes. Lufthansa also acquired the most lucrative part of the business, but only took on 1700 of the roughly 8000 previous employees. At a time when Air Berlin was still continuing its negotiations with Lufthansa, the German government gave the former a bridging loan, and obliged its officials to use Air Berlin despite many complaints about the company's growing organisational problems. These actions were criticised by Lufthansa's private competitors.

With the ongoing progress of globalisation, government institutions have been increasingly disturbed by the wave of takeovers of German high-tech enterprises by their competitors from China. In July 2017 the Federal Ministry of

[100] 'Edeka und Rewe einig bei Kaiser's Tengelmann', *Die Welt*, 3 December 2016, https://www.welt.de/print/die_welt/wirtschaft/article159942201/Edeka-und-Rewe-einig-bei-Kaiser-s-Tengelmann.html

[101] S. Happel, 'Die neue Macht der Lufthansa: Wo die Preise steigen könnten', *WirtschaftsWoche*, 25 October 2017, http://www.wiwo.de/unternehmen/industrie/die-neue-macht-der-lufthansa-wo-die-preise-steigen-koennten/20501426.html

Economy and Energy amended a regulation to the act on external economic relations[102], thus increasing the number of sectors protected from takeovers, as well as (for security reasons) adding the option of investigating proposed takeovers in sensitive sectors. At the request of Germany, among others, the European Commission is working on amendments to EU legislation which would allow greater supervision over takeovers of companies by investors from outside the EU. These changes were connected with the controversy in Germany about the wave of takeovers of German SMEs by companies from China. Particular indignation among German public opinion was aroused by the purchase of the leading robotics company Kuka by the Chinese fund Midea[103], which the federal government was unable to prevent. This prompted the Federal Ministry of Economy and Energy to be more cautious about investments from China, and to reconsider issuing permits to subsequent transactions involving Chinese investors, such as the acquisitions of the chip maker Aixtron and the manufacturer of lighting technology LEDvance. Eventually only the latter transaction was completed, as the acquisition of Aixtron (which also had branches in the US) was blocked by the US administration for security reasons.

2. Restructuring the shipbuilding industry

The German shipbuilding industry has been struggling for years with the problem of low profitability, a phenomenon which was further aggravated by the outbreak of the 2008 global financial crisis. In 2008, turnover in this sector dropped by 26% to €5.3 billion, and six large shipyards were put at risk of bankruptcy. The German government has had a consistent policy of supporting the shipbuilding industry, as it believes that a country so dependent on global trade, like Germany, must have its own shipbuilding industry, especially as 90% of global trade is carried out through water transport[104]. Moreover, the shipbuilding industry was a major employer in the less developed north-eastern *Bundesländer*, and the share of value added for the German economy in the final product of many shipyards is as high as 100% (this means that all the revenue from the ships' construction goes to domestic producers).

[102] *Neunte Verordnung zur Änderung der Außenwirtschaftsverordnung*, Ministry of Economy and Energy, 14 July 2017, https://www.bmwi.de/Redaktion/DE/Downloads/V/neunte-aendvo-aww.pdf?__blob=publicationFile&v=6

[103] K. Popławski, 'Capital does have nationality: Germany's fears of Chinese investments', *OSW Commentary*, 25 January 2017, https://www.osw.waw.pl/en/publikacje/osw-commentary/2017-01-25/capital-does-have-nationality-germanys-fears-chinese

[104] http://www.ics-shipping.org/shipping-facts/shipping-and-world-trade

Supporting the shipbuilding sector financially and enabling it to carry out structural reforms has become a priority for the German government. At the same time, it has tried to do so without recourse to direct aid, not wishing to invite criticism from the public or alarm the EU's institutions. On the basis of dialogue with representatives of the industry, the German government developed a far-reaching strategy for transformation in the sector, in order to revive the industry's competitiveness on foreign markets. A representative of the rank of Secretary of State was appointed within the structure of the Ministry of Economy and tasked with making contacts with the shipbuilding industry; his task was to analyse the sector's problems, create new instruments to support it, and devise a comprehensive development strategy. As Germany could not compete with most shipyards in Asia in terms of costs, the primary goal was to increase innovation, the intention being to focus on the production of specialised ships and components for them. On this basis, German shipyards were to gain the ability to provide customers with solutions to complex problems, for example, by ensuring its ships displayed greater energy efficiency or better environmental performance. This goal was to be assisted by the following measures:

- grants for the development of innovation (30% of the investment);
- funding research in collaboration with specialised research institutions;
- financial support for cooperation with other industries, e.g. in the field of extracting raw materials from the seabed, the production of autonomous maritime craft, and of technologies related to maritime safety.

The government allocated €190 million within 330 projects in 2011–2016 to improve innovation at the shipyards[105]. Another means of supporting the shipbuilding industry was connected with the energy transformation project being carried out in Germany. The shipbuilding industry could rely on contracts as part of the expansion of wind farms[106]. Shipyards may also apply for additional funding to develop the technology to construct offshore wind farms, for example as part of the Ministry of the Economy's 'Next-generation sea technologies' programme[107]. At present shipyards already have orders totalling €700 million for the construction of wind farms. By 2030 wind farms with a capacity of 15 GW are to be installed along the

[105] https://www.vsm.de/sites/default/files/dokumente/c32d05e474cd162d7f48918b863d36e7/schiffbau-industrie_i-2016.pdf, p. 7.

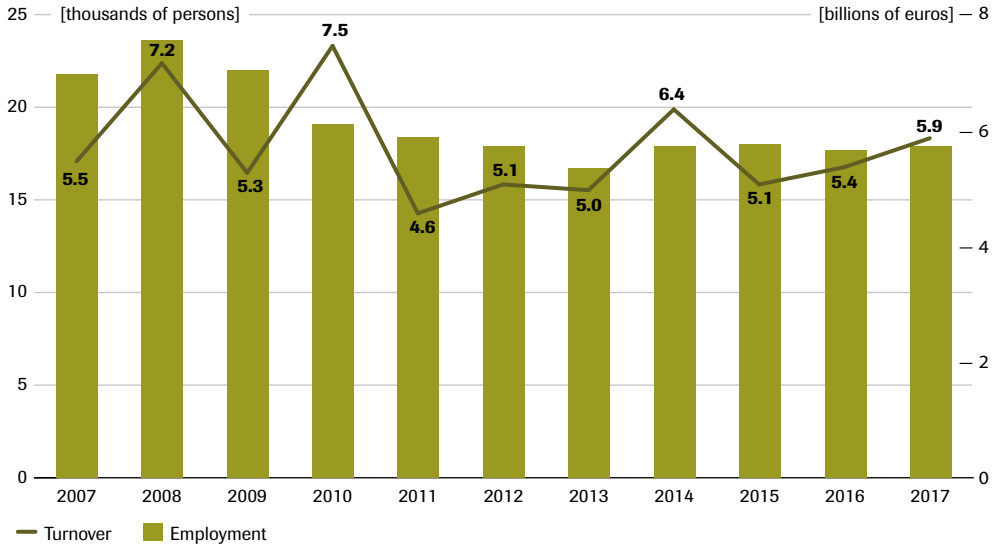
[106] 'Milliardenauftrag für deutsche Werften', *Tagesschau*, 24 May 2017, https://www.tagesschau.de/wirtschaft/werften-kreuzfahrtschiffe-101.html

[107] 'Maritime Koordinator: BMWi fördert Vernetzung von maritime Branche und Offshore-Windenergie', http://bmwi.de/DE/Themen/energie,did=764560.html

German coast. Around 143,000 people are currently working in the offshore wind-energy industry, with a capacity of 5.3 GW. The state has also supported the shipyards' export activities, offering them guarantees which amounted to €5.5 billion in 2014 (30% of all the export guarantees which the government has granted)[108].

The public authorities are trying to improve conditions for the development of the shipbuilding sector by financing educational programmes for specialists in the field, as well as new research centres which will allow the shipyards to attain higher levels of technology and eliminate the generation gap. About 200 institutes throughout the country are involved in marine technology research, which generates a turnover totalling €11 billion annually[109]. The position of German shipyards in the field of civil security is to be assisted by their collaboration with the German Aerospace Centre. The innovativeness of the shipyards is also to be aided by the German Marine Centre, established in 2017 in Hamburg, which will coordinate research in the field of marine technology[110].

Figure 15. Turnover (billions of euros) and employment (in thousands of persons) in the shipbuilding industry



Source: Federal Ministry of Economy and Energy

[108] *Exportkreditgarantien der Bundesrepublik..., op. cit.*

[109] *Jahresbericht 2015/2016,* Verband für Schiffbau und Meerestechnik, 2016, https://www.vsm.de/sites/default/files/dokumente/2ae6737c9b62e04cabf7b35e4db75d49/vsm_jahresbericht_2015-2016.pdf, p. 11.

[110] Maritimes Zentrum entwickelt sein Profil, KN, 30.04.2018, http://www.kn-online.de/Nachrichten/Hamburg/Das-neue-Deutsche-Maritime-Zentrum-DMZ-in-Hamburg-entwickelt-sein-Profil

Since the collapse in 2011, trade turnover in the shipbuilding industry has begun to maintain an upward trend. The effectiveness of state aid is also demonstrated by the employment rate, which has remained stable since a decline in 2008–2012. The state's mobilisation has also helped the shipyards to develop their cooperation with the most modern branches of German industry, which may allow the creation of innovative products in the future.

3. Defending the automotive industry's interests

One of the key driving forces of the German economy is the automotive industry, which is why the state works to stabilise its revenues in crisis situations, takes care to raise its technological level, and supports its expansion into international markets.

The German government's involvement in stabilising the situation in the automotive industry was evident during the global financial crisis. Almost immediately after its outbreak in 2008, the German government launched the *Kurzarbeit* programme; this made it possible to impose temporary limits on the duration of working periods for the employees of companies affected by a drop in demand for their products. Thanks to this programme, in 2008–2009 carmakers avoided mass redundancies that had threatened up to 50,000 employees[111]. Another important instrument of support for the automotive industry was the environmental bonus scheme, which allows consumers to obtain financing to purchase a new car in exchange for scrapping the old one. The programme received €1.5 billion, which allowed the purchase of around 600,000 cars to be subsidised. The popularity that the programme enjoyed prompted the government to raise the amount of support to €5 billion, which ultimately helped subsidise the purchase of about 1.7 million cars and protected the industry from a collapse in sales[112]. A similar programme was launched in 2016. Meanwhile, the government has planned to introduce subsidies on the purchase of electric cars, out of fear that competitors to German carmakers will master the technology to produce these cars more quickly. These subsidies are intended to spur the sales of electric cars, in order to achieve greater economies of scale and reduce the costs of producing this type of vehicle.

[111] M. Dalan, 'Wie die auf den Autoindustrie Abschwung reagiert', *Die Welt,* 29 October 2008, https://www.welt.de/wirtschaft/article2646093/Wie-die-Autoindustrie-auf-den-Abschwung-reagiert.html

[112] I. Schindler, 'Die Folgen der Abwrackprämie', *Badische Zeitung,* 12 February 2010, http://www.badische-zeitung.de/loerrach/die-folgen-der-abwrackpraemie--26878300.html

Another part of the anti-crisis policy was the German government's negotiations with General Motors in order to keep jobs in that company's German plants. In 2009 the US company considered selling its subsidiary Opel because of its financial problems. This meant that a new investor would have had to decide which factories in Belgium, Germany, Spain or the UK would lose the most jobs. Chancellor Merkel's government began to exert pressure on General Motors' directors to sell their factories to the investor most favoured by Germany, the Canadian-Russian consortium of Magna and Sberbank. Germany had a strong bargaining chip because it had given Opel a bridging loan worth €1.5 billion, and promised another loan of €4.5 billion if the 25,000 jobs in Opel's German factories were guaranteed, which – in their opinion – would have been assured by the above-mentioned choice of investor. The European Commission, together with representatives from the other countries in which Opel assembly plants operate, expressed doubts as to the legality of these relief activities in Germany[113]. Finally, at the end of 2009, GM decided to keep Opel in its hands, arguing that the market situation had improved. The German government demanded a punctual repayment of the loans it had previously granted[114], and also rejected the company's request next year for financial assistance for restructuring worth €1.1 billion euros[115].

An important role in creating favourable conditions to develop the automotive industry and resolve its problems is played by regular consultations between the companies' representatives and the public administration. Between 2012 and 2015 there were over 70 meetings between representatives of the Federal Chancellery and representatives of the automotive industry, and the directors of Volkswagen met Chancellor Merkel 20 times[116]. These consultations served not only to discuss future problems and challenges, but also to coordinate actions in case of emergencies. This is evidenced by the fact that when the scandal concerning Volkswagen's falsification of emissions data broke in 2015, the frequency of meetings between the car companies' leaders and government

[113] 'Unfair, uncompetitive and upsets the neighbors', *Der Spiegel,* 14 September 2009, http://www.spiegel.de/international/germany/magna-s-opel-deal-unfair-uncompetitive-and-upsets-the-neighbors-a-648866.html

[114] 'GM makes shock decision to keep Opel', http://www.spiegel.de/international/germany/auto-industry-poker-game-ends-gm-makes-shock-decision-to-keep-opel-a-659241.html

[115] 'Germany: Federal government has rejected the motion for financial support for Opel', *OSW Analyses*, 16 June 2010, https://www.osw.waw.pl/en/publikacje/analyses/2010-06-16/germany-federal-government-has-rejected-motion-financial-support

[116] D. Delhaes, 'Lobbyismus: direkter Draht–zu jeder Regierung', *Handelsblatt,* 24 September 2015, p. 7.

representatives increased significantly[117]. In 2017 it was revealed that not only Volkswagen but also other German carmakers could have installed devices in their cars that manipulated the measurements of exhaust gases, which raised the threat that German courts would impose a ban on cars with older models of diesel engines from entering city centres. The German government convened a summit with company directors on the matter which was also attended by federal and provincial ministers. Its intended effect was to negotiate a solution to the problem of German cars not complying with the environmental standards in force in the country.

Consultations at the highest level are also used to agree on measures to protect the automotive industry's interests on foreign markets, which increasingly forces Germany to block the implementation of new environmental regulations. This has been confirmed by Chancellor Merkel herself. During a hearing on the Volkswagen fuel affair by a Bundestag inquiry committee, she acknowledged that Germany had to ensure a balance between the implementation of laws protecting the environment and the automotive sector's options in upholding them, because the interests of the EU countries are very diverse in this regard[118]. In 2013 Ireland, which then held the presidency of the EU Council, suddenly removed a vote from the agenda regarding a plan to tighten CO_2 emission regulations for cars, which would have been unfavourable for the German automotive industry[119]. Most likely, one of the main reasons for this decision was the pressure Germany exerted on Ireland, whose economy had suffered heavily as a result of the eurozone crisis (Germany had the final say on the granting of loans to Ireland).

Chancellor Merkel has also been accused of putting pressure on the authorities in California to moderate environmental regulations which affected German manufacturers of diesel-powered cars. According to the environmental movement in Germany, the federal government has played an important role in

[117] In the period from September 2015 to April 2016, the heads of automotive companies and industry associations have met Chancellor Merkel directly five times, five times with the head of her office, eight times with the minister of the economy, five times with the minister of infrastructure and transport, three times with the minister of justice and once each with the foreign minister and finance minister. See the response to the question put by members of die Linke, Herbert Behrens, Caren Lay & Eva Bulling-Schröter: No. 18/12060, http://dip21.bundestag.de/dip21/btd/18/128/1812880.pdf

[118] D. Delhaes, T. Hoppe, 'Direkter Draht ins Kanzleramt', *Handelsblatt,* 9 March 2017, p. 6.

[119] 'Merkel seeks to derail EU compromise deal on car emissions', 27 June 2013, http://www.euractiv.com/section/transport/news/merkel-seeks-to-derail-eu-compromise-deal-on-car-emissions/

shaping EU law to favour the sales of diesel cars, and also in discouraging producers from lowering emissions from their cars, despite the numerous technical capabilities which exist to improve their environmental performance[120]. Germany has repeatedly insisted that the government in Beijing should not introduce new strict environmental criteria that could limit German car companies' sales in China.

In recent years, more and more questions have arisen as to whether Germany's policy of supporting its automotive companies does not contradict the country's declared objective of becoming the world leader in environmental matters. The close relationship between the German government and representatives of its car companies has been criticised by environmentalists, who believe that these relations and the accompanying closeness of their positions blocks technological progress and weakens the authorities' determination to introduce stricter environmental standards on diesel exhaust emissions[121]. There are also more and more signs that German companies cannot keep up with the pace of the market's development of new automotive technologies.

For the German automotive giants, two events above all have proved to be disadvantageous. The outbreak of the fuel scandal has shown that the companies are making little progress towards greater environmental performance. It turned out that Volkswagen (as well as other German producers) had for years been mounting a special device designed to falsify the results of tests measuring the emission of harmful exhaust gases (mainly nitrogen oxides), while advertising their cars under the slogan of 'Clean diesel'. The disclosure of this information resulted in multibillion-dollar losses for the company, which was forced to pay fines to the public authorities, dealers' networks and consumers in many countries. It also contributed to a decline in the sales of diesel-powered cars, as well as the start of a debate in Germany on prohibiting cars with old diesel engines (below the Euro 6 standard) from entering city centres. Secondly, the German automotive industry was taken aback by the pace of development of the Tesla company, whose sales proved that self-driving electric cars could change the automotive market much more quickly than expected. Even the French carmakers, struggling with their own financial problems, were able to set aside funds to invest in electric cars faster

[120] E. Helmers, 'Versprochen–Gebrochen: Wie die deutsche Autoindustrie den Klimaschutz ignoriert', https://www.vcd.org/fileadmin/user_upload/Redaktion/Publikationsdatenbank/Auto_Umwelt/Analyse_Modellentwicklung_deutsche_Autoindustrie_2015.pdf, p. 8.

[121] *Ibid.*, p. 3.

than the German manufacturers, launching several models which gained popularity among customers.

If the German car companies do not keep up with market trends, they may lose a significant portion of their revenues to American companies, particularly in the area of mobility services[122]. Self-driving cars are indeed an innovation which will radically change the rules governing the car market and threaten the current leaders.

The German government is trying to encourage companies to master new technologies by digitising the road infrastructure, creating new regulations (allowing self-driving cars to be tested on German roads), subsidising research in this field, and improving data security. From the government's reply to a question from the parliamentary Left Party, it appears that the German government allocated around €1 billion in the period 2007–2017 to fund R&D for car companies, and supported their investments to the tune of €200 million[123]. If one adds the subsidies to purchase new cars in exchange for scrapping old ones, and the reduced excise duty for diesel, the automotive industry has been supported with €115 billion in this period. The question is increasingly being asked in Germany: what portion of these funds have actually served to increase innovation in the industry?

In other words, in recent years the German government has created 'greenhouse conditions' for the automotive industry's existence, which has revealed its limited motivation to implement innovations, especially in the environmental field. This has led to a public relations scandal for the German economy (the Volkswagen fuel affair) as well as insufficient investment in new technology. However, the efforts to stabilise the situation in the automotive industry during the economic downturn in 2009 can be considered extremely effective.

4. Supporting the development of the green technology industry

When in 1998 the Greens entered the government for the first time in postwar Germany, it was clear that a change to the state energy policy would be one of its priorities. In 18 months after taking office, the coalition government of Social Democrats and Greens implemented two decisions that profoundly

[122] *Ibid*., p. 7.

[123] D. Delhaes., D. Neuerer, 'Mit freundlicher Unterstützung', *Handelsblatt,* 23 May 2017, p. 6.

changed the country's energy policy and led to Germany becoming a leader in the development of renewable energy sources. In 2000 a law on renewable energy sources (RES) came into force which has created some of the best conditions in the world for investing in this industry, guaranteeing that investors would receive electricity produced at favourable prices. In the same year, the government reached an agreement with the four largest energy companies and the operators of nuclear power plants, after which the decision was made to turn off all nuclear power plants by 2022. However, the energy companies (including RWE and E.ON) misinterpreted this as an incentive to invest in conventional coal- and gas-fuelled power plants, and not in the fledgling renewable energy sector.

The dynamic development of renewable energy sources in Germany meant that work began on devising a new paradigm of German industrial policy[124]. This was based on the assumption that in the future the world economy would become increasingly dependent on disappearing natural resources. Success, therefore, would be attained by those countries that managed to overcome these limitations. The German state's idea was to use the economy's power to develop machinery and equipment for the production of technologies related to environmental protection. The German economy thus took advantage of the increasingly prominent global trend of 'greening' industry. The new basis of Germany's economic policy quickly became the foundation for a consensus linking supporters of environmental protection and representatives of industries.

Another element of the development of an industrial policy based on ecology was the government's reaction to the nuclear disaster in Fukushima in 2011. The CDU/CSU-FDP coalition decided to support the opposition's environmental demands. It established a comprehensive energy strategy for Germany (*Energiewende*) whose main objective was to accelerate the rapid development of renewable energy sources and gradually halt the utilisation of nuclear energy[125]. The *Energiewende*'s long-term goals are to reduce greenhouse gas emissions by 80–95% by 2050 and increase the share of renewable energies in primary energy consumption to 60% (13% in 2016). The government in Berlin is hoping that due to a sharp increase in investment in the development of a greener

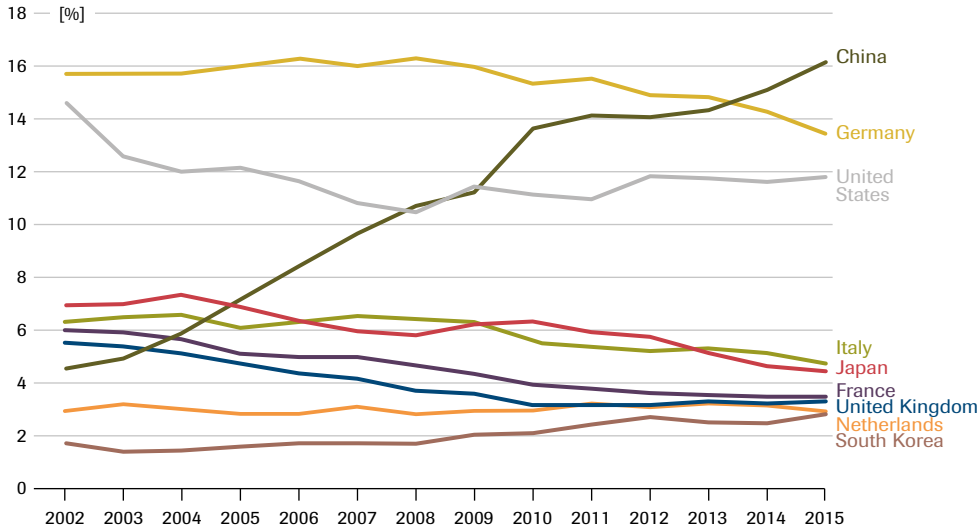
[124] I. Blühdorn in S. Bukow, W. Seemann, *Die Große Koalition: Regierung-Politik-Parteien 2005–2009*, Heidelberg 2010, p. 215.

[125] For more see A. Kwiatkowska-Drożdż (ed.), 'Germany's energy transformation: difficult beginnings', *OSW Report*, 6 December 2012, https://www.osw.waw.pl/en/publikacje/osw-report/2012-12-06/germanys-energy-transformation-difficult-beginnings

economy, German manufacturers will gain a technological advantage over their main competitors. To quote the then environment minister Peter Altmaier (CDU): "If we succeed, the *Energiewende* will be our hit export[126]."

The green industry, i.e. the environmental goods and services sector[127], is seen in Germany as an opportunity for the German economy and a chance to boost German companies on the new global market. In particular the technologies related to wind turbines and energy efficiency could be developed by the mechanical engineering sector, which is very strong in Germany. According to data from the Federal Office for the Environment, it appears that in 2015 Germany had a 13.5% share in the trade of goods on the environment sector's global market (see Figure 16).

Figure 16. Shares of the largest suppliers of environmental goods on the world market



Source: *Die Umweltwirtschaft in Deutschland 2017*, Federal Office for the Environment, https://www.umweltbundesamt.de/publikationen/die-umweltschutzwirtschaft-in-deutschland-0

[126] 'Altmaier: Energiewende riesige Chance ist für Deutschland', 6 October 2012, https://www.derwesten.de/politik/altmaier-energiewende-ist-riesige-chance-fuer-deutschland-id7168980.html

[127] Green industry is described in international literature as *green technologies* or *clean technologies*. The German term is *Umwelttechnologien*. Government reports on the subject list six key sectors: 1. Friendly environment, production, storage and transport of energy; 2. Energy efficiency; 3. Material and raw-material efficiency; 4. Sustainable transport; 5. The circular waste economy; 6. The sustainable water economy.

In 2015, turnover of manufacturing and service companies in the field of environmental protection amounted to €66 billion[128], of which products and services worth €41.4 billion were sold in Germany, while exports amounted to €24.6 billion. The largest sector in this area was the mechanical engineering sector (€24.6 billion). 86% of turnover (€57 billion) went on products and services related to climate protection, such as the production of equipment to generate energy from renewable sources. According to data from the Federal Statistical Office in 2015 around 260,000 people worked directly for the environmental sector, of whom c. 174,000 were in the manufacturing industry, 45,500 in construction, and 37,000 in the service sector. The production value of companies from the environmental sector amounted to €83.4 billion in 2015, which accounted for around 6% of total industrial production. The largest market is the production of articles in the area of energy efficiency (€17.8 billion) and the generation of electricity from renewable sources (€13.8 billion), and the use of sewage (€17.1 billion) and household waste (€10.2 billion).

Table 5. Production of potential environmental goods in Germany in 2011–2015

Sector	Production, in billions of euros					Change in %			
	2011	2012	2013	2014	2015	2011/ 2012	2012/ 2013	2013/ 2014	2014/ 2015
Household waste	10.2	10.2	10.3	10.3	10.2	-0.5	0.6	0.7	-0.9
Sewage	16.1	16.2	16.8	17.1	17.1	0.4	3.6	2.1	-0.1
Noise	5.3	5.5	5.4	5.2	5.1	2.5	-1.8	-3.6	-1.4
Air	7.6	7.6	7.3	8.5	9.3	0.3	-3.3	15.4	9.6
Instrumentation and control engineering	6.7	6.9	7.0	7.3	7.5	2.1	2.2	3.1	3.0
Climate protection	37.5	35.1	33.3	33.2	33.7	-6.3	-5.1	-0.1	1.4
including									
products for the rational use of energy	17.9	18.1	18.1	18.0	17.8	1.4	0.0	-0.6	-1.6

[128] *Publikationen im Bereich Umweltökonomie*, Federal Statistical Office, https://www.destatis.de/GPStatistik/servlets/MCRFileNodeServlet/DEHeft_derivate_00032680/2190330157004.pdf

Sector	Production, in billions of euros					Change in %			
	2011	2012	2013	2014	2015	2011/ 2012	2012/ 2013	2013/ 2014	2014/ 2015
products for rational energy conversion	2.7	2.9	2.6	2.3	2.2	6.0	-10.2	-10.3	-6.7
products for the use of renewable energy sources	16.8	14.0	12.5	12.9	13.8	16.6	-10.8	2.7	7.0
Environmental goods, total	**84.8**	**83.7**	**81.6**	**82.4**	**83.4**	**-1.3**	**-2.5**	**1.1**	**1.1**
Industrial production in Germany	1366	1370	1370	1368	1382	0.3	0.1	-0.2	1.0

Source: *Die Umweltwirtschaft in Deutschland 2017*, Federal Office for the Environment, https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/171204_uba_hg_umweltwirtschaftdl_bf.pdf

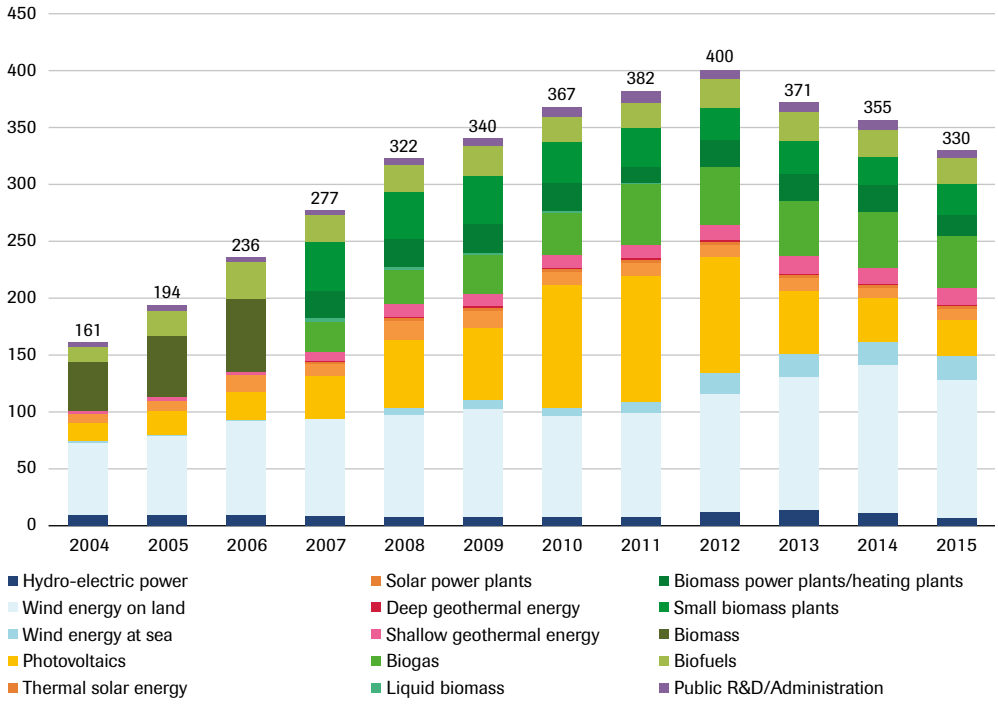
330,000 people were employed in the renewable energy sector alone in Germany in 2015. Employment in the RES sector has decreased; as recently as 2012, the sector employed around 400,000 employees. This trend is primarily related to the reduction of jobs in the solar industry, where in 2010–2015 the number of employees fell by 71% from 107.800 to 31,600 employees. German manufacturers of photovoltaics could not stand the competition with foreign manufacturers, mainly the Chinese, who turned out to be much more cost-effective. Not even the introduction in 2013 of anti-dumping duties on Chinese photovoltaic panels, ranging from 37% to 68%, could help. In 2010–2013 alone, 30 German companies filed for bankruptcy. Today, the photovoltaic market no longer has any significant producers from Germany, and the biggest companies have either filed for bankruptcy or been taken over by their Chinese competitors.

The situation in the wind energy sector is completely different; German companies have continued to record an increase in employment there. In recent years offshore wind energy has been the driver of growth. In 2012–2015 the number of jobs in wind energy rose from 122,000 to 143,000[129]. In 2016, of the 10 largest wind turbine manufacturers (75% of the global market) three producers came from Germany: Enercon (7% of the market), Siemens (6% of the market) and Nordex Acciona (5% of the market)[130].

[129] 'Zukunftsbranche Windindustrie bundesweit ist ein starker Beschäftigungsfaktor', Federal Wind Energy Association, 21 March 2017, https://www.wind-energie.de/presse/pressemitteilungen/2017/zukunftsbranche-windindustrie-ist-bundesweit-ein-starker

[130] REN21 report, http://www.ren21.net/gsr-2017/chapters/chapter_02/chapter_02/#wind-power

Figure 17. The development of employment in the RES sector in Germany



Source: *Bruttobeschäftigung durch Erneuerbare Energien in Deutschland und verringerte Brennstoffimporte fossile Energien und durch erneuerbare Energieeffizienz–Ergebnisse für das Jahr 2015*, Federal Ministry of Economy and Energy

Germany's advantage on the RES market is evident in virtually all sectors. The amount of people employed in the renewable energy sector in 2016 was estimated at up to 283,100. This represented around 20% of all people employed in the renewable energy industry in the EU. The German renewable energy industry has generated around 25% of the entire turnover of the European RES market. German companies were among the leaders on the markets for wind energy (with an annual turnover of €16 billion), biomass (€5.1 billion), biogas (€4.1 billion), and photovoltaics (€3.4 billion)[131].

In decisions on economic policy, Germany's decision-makers are guided by the assumption that the demand for goods and services from the green sector will continue to grow. This is mainly due to beliefs about the dangers posed by the depletion of non-renewable natural resources and the negative effects of global

[131] 'The state of renewable energies in Europe', EDITION 2017, 17th EurObserv'ER Report, https://www.isi.fraunhofer.de/content/dam/isi/dokumente/ccx/2018/EurObservER-Annual-Overview-2017-EN-1.pdf

warming. "Efficiency and environmental technologies will play a key role in the twenty-first century. The use of these technologies is becoming increasingly important, primarily on the automotive and machine markets, and will have a significant impact on the competitiveness of enterprises"[132]. Whereas in 2013 the services sector and environmental goods produced 13% of the German GDP, in 2025 this figure should be as high as 20% of GDP[133]. At the same time, as German officials have indicated, the global market for environmental technology is expected to rise from €2 trillion in 2011 to €4.4 trillion in 2025. For German politicians, supporting the development of green technologies is a way of searching for another specialisation for the country's economy. It is common knowledge that German companies did not take a leading position in the electronics sector which developed in the 1960s and 1970s, or in the IT sector in the 1980s and 1990s. The plan is for the production of wind power turbines, or of zero-emission vehicles, to guarantee sales of German products over the next few decades.

KONRAD POPŁAWSKI, RAFAŁ BAJCZUK

[132] 'Grüne Zukunftsmärkte/Umweltschutzwirtschaft', 26 January 2018, Federal Office for the Environment, https://www.umweltbundesamt.de/themen/wirtschaft-konsum/wirtschaft-umwelt/gruene-zukunftsmaerkte-umweltschutzwirtschaft

[133] *Ibid*.

ANNEX

THE STAGES OF DEVELOPMENT OF GERMANY'S INDUSTRIAL POLICY

German economic thought is derived from ordoliberalism, which means Germany is historically reluctant to confirm the significant role of the state in the economic life of the country. However, both this country's past and more recent experiences have revealed the significant influence of public institutions on the development of the economy.

Laying the foundations of industrial policy in Germany

The foundations of German industrial policy, which persist to this day, were shaped in the post-war period. The concept which contributed to the formation of the German economic system after World War II was ordoliberalism. This doctrine, formed in opposition to the experience of state intervention in the days of the Third Reich[134], assumed that the best form for managing economic processes was to follow the rules of the free market, and the state's responsibility was to supervise them[135]. The possibility of state institutions intervening was to be limited to situations which arose due to the abnormal functioning of market mechanisms (for example, when an entity obtained a monopoly market position, or a price cartel was formed).

However, these rules have never been fully applied. As early as the 1950s, the state supported the development of German exports by maintaining an undervalued exchange rate and introducing tax breaks for prospective industries, as well as loans and guarantees for exporters. The core of the system for financing exports was the KfW public bank, which offered export loans for small- and medium-sized enterprises, and managed the Institute of Export Loans, which was co-financed by commercial banks[136]. The system of loans

[134] The traditions of state intervention in Germany date back to the policy of the Prussian state in the seventeenth century. The state also actively supported the industrialisation of first Prussia and then the united Germany. After the First World War, Germany became "a country of corporations and cartels", which led to a decline in the competitiveness of industrial production and lower economic growth. Cf. B. Rakow, *Ökologische Industriepolitik in Deutschland und Europa*, Frankfurt 2013, p. 118.

[135] M. von Prollius, *Deutsche Wirtschaftsgeschichte*, Vandenhoeck & Ruprecht, Göttingen 2006, pp. 50–61.

[136] G.H. *Borsdorf, Die Internationalisierung deutscher Unternehmen nach dem Zweiten Weltkrieg bis 1973*, Shaker, Aachen 2007, pp. 43–44.

was supplemented by Hermes export insurance, which was itself guaranteed by the German government[137].

Until the mid-1950s the state limited its intervention in the economy to the strategic sectors of heavy industry, energy and railways, and the funding of science by the Federal Government was limited to basic research. In 1955, however, the state began to support research in the fields of nuclear energy and aviation, which had commercial applications. In the 1960s, after experiences in implementing projects supporting R&D in the nuclear power industry, the state expanded the flow of financing into other industries (information technology and aerospace research) in order to achieve a strong position on foreign markets[138]. In parallel to subsidising R&D, the federal government supported specific industries and enterprises through interventions[139] including coal, shipbuilding and steel[140].

At the turn of the 1960s the conviction ruled in Germany that politics should serve not only to maintain the efficiency of the abstract market mechanism, but also to implement goals which are important to the community. Under the doctrine of the social market economy, social arguments became equally important, and in some cases even more important than taking care to uphold the rules of competition. These trends were reflected in legislation. The amendment of the Act on stability and growth in 1967 included a provision on the state's responsibility for the level of GDP growth, a high employment rate, stable prices, and the balance of trade.

[137] Enterprises applying for loans from KfW had to guarantee 20% of the equity, and 40% of its own shares when applying for a loan from AKA. In the case of Hermes insurance it had to pay 10–30% of its own shares.

[138] In 1962, the government initiated a programme for the development of space exploration, which in 1967 included computer science, and in 1969 added marine studies and allowed aid to be granted to the so-called key technologies. See A. Fier, D. Harhoff, 'Die Evolution bundesdeutschen Forschungs- und der Technologiepolitik: Rückblick und Bestandsaufnahme', *Perspektiven der Wirtschaftspolitik,* 2002 (3), pp. 279–301.

[139] The first major intervention was a response to the crisis in coal mining in the late 1950s. From 1957, its domestic production began to decline and the use of oil and natural gas expanded. To address the decline in sales of domestic coal, the state adopted support programmes for the mining sector. Adopting this policy resulted in the introduction of the subsidies to the mining sector which are still paid out today. R. Bajczuk, 'The uncertain future of the coal energy industry in Germany', *OSW Commentary,* 20 October 2015; https://www.osw.waw.pl/en/publikacje/osw-commentary/2015-10-20/uncertain-future-coal-energy-industry-germany

[140] N.D. Klag, *Die Liberalisierung des Gasmarktes in Deutschland*, Marburg 2003, pp. 56–57.

The economy was strongly influenced by the formation and development of corporatist structures, i.e. associations and interest groups in economic and social life (despite the fact that efforts had been made to limit them after the war)[141]. One example of this trend was the existence of consistently reinforced and strongly institutionalised lobbying organisations, especially in heavy industry. Federal ministries were obliged to take the views of interested industrial organisations into account when devising laws[142]. The state's increased interest in conducting industrial policy resulted not only from the growing aspirations of society and pressure from German companies, but also from the situation in other industrialised countries. Germany's major competitors of that time, in Japan or the US, could count on a broad scope of state support.

When the Social Democrats came to power in the 1970s, industrial policy objectives were expanded, abandoning the earlier policy of not supporting deficit sectors, including mining. In parallel, the state began to encourage the development of new and innovative sectors of the economy. In 1973 (as part of the so-called *Ministererlaubnis*) the economy minister was given the power to authorise the takeover of companies, even if the Federal Office for Cartels (the German competition authority) had previously issued a negative decision. The minister's decision had only to be justified on the grounds of common interest or benefit for the whole economy[143]. This provision was used in later years to support German companies in the energy (E.ON), finance (Deutsche Bank) and logistics sectors (Deutsche Post).

Chancellor Kohl's course correction to the industrial policy

In the 1980s and 1990s there was a paradigm shift under Chancellor Helmut Kohl (1982–1998). This was the period of neo-liberalism's triumph in the economy. The wave of liberalisation and privatisation arrived from the United States and Britain into West Germany as well, where the government began to limit the use of industrial policy, and with it to reduce the subsidies for the economy. However, this was not carried out in full. Coal mining was still supported, and

141 M. von Prollius, *Deutsche Wirtschaftsgeschichte nach 1945*, Vandenhoeck & Ruprecht 2006, pp. 103–104.

142 As early as the 1960s, most of the demands on specific issues were directed primarily to the government (82% of letters), and to parliament to a much lesser degree. T. Rheinisch, 'Europaische Integration und industrielles Interesse: Die deutsche Industrie und die Gründung der Europäischen Wirtschaftsgemeinschaft', *Beiheft* 152, Stuttgart 1994, pp. 43–44.

143 Since this law came into force the prerogative has been used 22 times.

German reunification forced the use of large public funds to reconstruct the East German economy and modernise its infrastructure. It was during Kohl's term in office that the state moved its focus from large corporations to small- and medium-sized enterprises, supporting their expansion into foreign markets. An important breakthrough in changing the thinking around how to support industry was the establishment in the 1980s of a network of knowledge exchange and commercialisation which was funded by the public[144]. In this way the state became involved on a larger scale, not just in directly supporting industry but also in scientific research, and in promoting that research.

The symbol of the new approach to industrial policy was the process of German reunification. Although the government had allocated significant funds to the reconstruction of the eastern federal states, they were directed mainly to the modernisation of infrastructure and social objectives, while not establishing strong instruments of support for local industry. A currency reform was carried out, under which the values of the eastern and western Mark were equalised, and the population were guaranteed a significant wage increase in the short term; but this was done at the cost of the rapid bankruptcy of East German industry, as well as a significant increase in unemployment. The effects were similar during the three-year process of privatising state-owned companies, which only exacerbated the problems on the labour market.

Germany's new position also emerged in its scepticism towards the establishment of a European industrial policy, which Berlin blocked[145]. When such a policy was finally created in 1993, at Germany's initiative it was used mainly to support R&D and the regulation of rules for granting state aid, which had to be agreed every time with the European Commission.

The renaissance of industrial policy after 1998

During the rule of the SPD-Green coalition (1998–2005), there was a renaissance of German industrial policy. At that time the foundations were laid for the so-called ecological industrial policy[146]. In 2000 a law on renewable energy sources was enacted, under which subsidies went to support the development

144 M. Kitson, J. Michie, *The Deindustrial Revolution: The Rise and Fall of UK Manufacturing 1870-2010*, Working Paper No. 459, Centre for Business Research, 2014, p. 28.

145 B. Rakow, *op. cit.*, p. 122.

146 Ecological industrial policy refers to achieving the objectives of economic policy in accordance with the principles of sustainable development.

of solar, wind and biomass energy in Germany. This was also associated with the granting of tax relief to the owners of these power plants[147]. Also in 2000, the Ministry of Economy and Technology adopted a strategy for technology policy which was based on supporting enterprises in the fields of innovation, research and technological cooperation, and was intended to increase their competitiveness on foreign markets.

The shift towards industrial policy was also dictated by the attitude within the EU of France, which pursued an active industrial policy of building national champions under the banner of protecting the country's interests[148]. For some time Germany tried to follow a similar path in the fields of energy, gas, telecommunications and postal services. For example, in 2000 the energy company E.ON was established by the merger of the VEBA and VIAG companies, and it has now become the largest German energy company. In 2003, E.ON took over Ruhrgas, the largest German gas company. This takeover was only possible because the minister of economy issued a ministerial permit which ignored the negative opinions of the antitrust institutions, i.e. the Federal Office for Cartels and the Bundestag Committee on Monopolies. This situation led to the appearance of an oligopoly of several energy companies on a newly liberalised energy market[149]. The state also maintained preferential conditions for the German Post (Deutsche Post AG, privatised in 1995), German Railways (Deutsche Bahn) and the energy company RWE.

In 2003–2005, as part of the Agenda 2010 programme, the German government decided to undertake reforms conducive to improving industrial competitiveness, such as creating a more flexible labour market, reducing the fiscal burden, and reducing social benefits. The constructive position adopted by the trade unions was important, as for several years they had limited their salary expectations in order to increase employment in Germany. The reforms also introduced restrictions on labour costs, which helped to increase the competitiveness of German industry.

147 Environmental taxes (*Ökosteuer*) are a series of amendments to existing laws and the implementation of the law imposing excise duty on electricity. The aim of these changes was to encourage the consumption of goods and services that have a lower negative impact on the environment.

148 B. Rakow, *op. cit.*, p. 124.

149 S. Fischer, *Die Energiewende und Europa: Europäisierungsprozesse in der deutschen Energie- und Klimapolitik*, Wiesbaden, Germany 2017, p. 194.

In response to the global financial crisis which broke out in 2008, the German government continued to conduct an active industrial policy. Investments in renewable energy sources were increased even more by introducing legislation favourable to their expansion; this led to the dynamic development of the market for photovoltaic panels and wind turbines. January 2009 saw the introduction of a support package for the economy through means including public investment, recapitalising the financial sector, and providing financial support and opening up regulations for industries. During the 2009 election campaign, there was no longer any debate on whether the state should intervene in the economy at all through its industrial policy, but only on how far this intervention should go[150].

After the elections in 2013 a coalition between the SPD and the CDU/CSU was re-established. The Ministry of Economy and Technology changed its name to the Ministry of Economy and Energy, and took over the responsibility for developing renewable energy sources; the minister's portfolio was taken up by the Social Democrats' leader Sigmar Gabriel. After eight years of being run by right-wing politicians, the ministry came under the control of the SPD, which has changed the department's priorities and the internal hierarchy of values. Whereas the liberal and right-wing politicians from the FDP and the CDU/CSU had avoided implementing protectionist and interventionist policies, in the SPD's hands the ministry had no problem implementing the objectives of economic policy with the active participation of the state. The change was primarily seen in the rhetoric, which began to emphasise the state's active role in the economy, as well as the country's industrial and technological development.

[150] 'Industriepolitik als Wahlkampfthema', *Wirtschaftswoche,* 28 August 2009, http://www.wiwo.de/politik/deutschland/staatlicher-einfluss-industriepolitik-als-wahlkampfthema/5141748.html