



AT A CROSSROADS

CRISIS IN THE GERMAN
AUTOMOTIVE INDUSTRY

Konrad Popławski

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MAIN POINTS

- The automotive industry was the driving force of Germany's economic growth during the past two decades. In 1999–2017, German firms became the leading manufacturers owing to foreign expansion, and their share in the global market grew from 15.1% to 18.5%. Car manufacturers and their subcontractors employ 1.8 million people. This is one of Germany's most profitable sectors of industry (80% of premium cars sold worldwide are made in factories belonging to German manufacturers) and it generates a significant share of the demand for the products and services of other vital sectors of the country's economy, such as the electromechanical, chemical and logistics sectors. This concerns above all the giant automotive cluster in southern Germany (Bavaria and Baden-Württemberg), where orders from car manufacturers are sometimes the only source of income for many firms.
- The German economy had already begun to visibly slow down in 2019, and so before the COVID-19 epidemic, mainly due to the deteriorating condition of the automotive industry. All companies announced that they would restructure their factories in Germany, and subcontractors intended to shut down their plants or cut employment levels. Until 2019, the car companies still generated good financial results and had high sales but their strength was based on those of the past. Global trade wars and political tension undermined the development model pursued by German car manufacturers which was based on highly effective global supply chains capitalising on the competitive advantages of certain regions of the world. The German automotive industry has also been adversely affected by the ecological revolution, forcing it to withdraw from its specialisation, i.e. the production of cars with combustion engines (especially those with a diesel engine). German companies have to master the manufacturing technology of electric cars, while having no advantage over competitors in the area. The German automotive industry is also

losing its status of a pioneer in new technologies linked, for example, with car digitalisation and developing autonomous driving systems.

- The German automotive sector did not react to new challenges in time. The car manufacturers' response was quite arrogant – some of the moves linked to environmental protection were feigned and some major social and technological changes were not taken seriously. This affected the firms' image and led to the imposition of heavy restrictions on the entire sector. The German government's approach contributed to that. Formally, the government supported imposing stricter ecological regulations on the automotive sector but was nevertheless applying the brakes to this process behind the scenes, thus reducing the pressure on innovation. The Volkswagen diesel emissions scandal compromised the automotive sector's efforts to make its production more environmentally friendly and also created an atmosphere of public support for imposing stricter standards on the industry, especially in the case of vehicles with a diesel engine.
- The strengths developed by German vehicle manufacturers so far include: a highly reputed brand, well-developed distribution network, in-depth market knowledge and a strong financial position. These enabled them to cope with individual problems. However, the concentration of the numerous challenges is extremely risky for them. In the worst-case scenario the German automotive industry may even plunge into a long-term crisis which will seriously affect its global position. Furthermore, there is a risk of serious job cuts in the countries which are important links in its supply chain. The effects of this may include: the German economy losing a major share of its added value, economic and even political destabilisation, and Germany's position weakening in the EU.

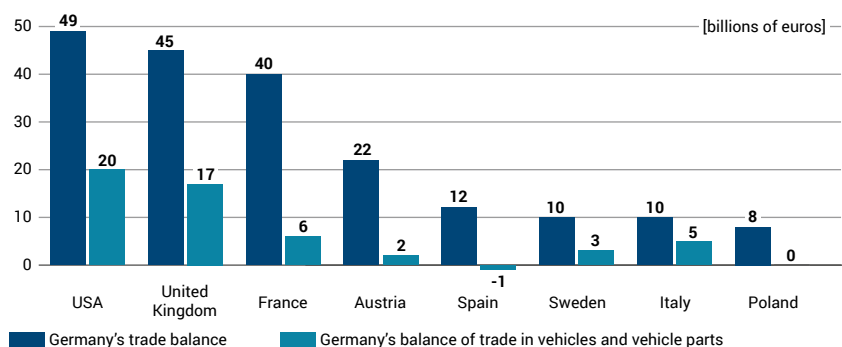
I. THE AUTOMOTIVE INDUSTRY IS (NO LONGER) THE DRIVING FORCE OF ECONOMIC GROWTH IN GERMANY

If not for the automotive sector, the German economy would not have grown uninterrupted for almost a decade. German car manufacturers have been among the world's most profitable companies for years. Furthermore, the automotive industry's importance for the national economy has been growing for more than a decade. According to data from the Federal Statistical Office, the automotive industry generated 3.4% of added value to Germany's GDP in 2005, and 4.5% ten years later. However, these figures fail to fully reflect the German economy's dependence on the industry. It employs 700,000 people directly and, along with related sectors, even 1.8 million people indirectly. It is also one of Germany's most profitable branches of industry (revenue per employee). The automotive sector does not only generate essential added value and a significant number of workplaces in Germany – it also generates the demand for products manufactured by industries which are vital for the country's economy: the electromechanical, chemical and logistics industries. Vehicle manufacturers are often the main and sometimes the only clients for many of Germany's small and medium-sized subcontractors. As the automotive sector was developing in southern Germany (especially in Bavaria and Baden-Württemberg) for decades, a powerful automotive cluster has been formed. Within this cluster a large group of subcontractors are concentrated around vehicle manufacturers.

The German economic boom on the global market would have been impossible without the automotive industry, which is one of the most internationalised industries of the German economy. In 2014, Volkswagen outpaced General Motors, and became the world's second largest vehicle manufacturer in terms of sales value, and it came very close to outpacing the global leader, Toyota, in the past few years. The German automotive sector has won an especially strong position in the premium car segment – German companies sell around 80% of cars of this type.

In 2009–2016, the share of the Chinese market in global sales of new vehicles grew rapidly – from 17% to 34%. This way it became the world’s largest automotive market in 2010. During this period, German vehicle manufacturers increased their share in this market from 18.6% to 21.1%.¹

Chart 1. Germany’s surplus in commodities trade with individual countries and the section of this generated by the trade in vehicles and vehicle parts in 2018²



Source: Federal Statistical Office of Germany, www.destatis.de.

The automotive sector played even a more important role in generating Germany’s trade surplus. In 2017, German exports of vehicles and vehicle components reached the value of 234 billion euros (18.4% of total export turnover), while the value of imports of vehicles and vehicle parts reached only 113 billion euros (11.2% of import turnover).³ Thus the

¹ *Der Pkw-Absatzmarkt China 2009 bis 2015 Analyse der Bedeutung Chinas für die deutsche Automobilindustrie*, E&Y, 2016.

² According to the Central Statistical Office of Poland (GUS), Poland generates a surplus of 9 billion euros in trade with Germany, while in the Federal Statistical Office’s opinion, Germany generates a surplus of 8 billion euros in trade with Poland. GUS explains this is an effect of the different methodologies applied, but the two offices have not reached a compromise concerning standardising the manner of data presentation that would best reflect reality (cf. [response from the deputy president of GUS to parliamentary question no. 22326](#), orkaz.sejm.gov.pl).

³ Author’s own calculations based on *Fakten zum deutschen Außenhandel*, Federal Ministry for Economic Affairs and Energy, September 2019, www.bmw.de.

balance of trade in the automotive industry's products – worth 121 billion euros – was the main source (45%) of Germany's trade surplus. Manufacturers of vehicles and vehicle parts generated 30–50% of Germany's surplus in the commodities trade (see chart 1) with such countries as the United States, Sweden, United Kingdom and Italy. The situation was slightly different in the case of such countries as Austria or Poland which reached a surplus or equal level of trade in vehicle products with Germany. However, this was due to the fact that these countries were major suppliers for the German automotive industry.

The automotive industry triggers not only the competitiveness but also the innovativeness of the German economy. It accounted for 40% of all patent applications submitted in Germany in 2015 alone.⁴ The greatest amount of innovations originate not from the vehicle manufacturers themselves (36%) but rather from their subcontractors (64%). German automotive companies are also highly innovative on the global scale. In 2017, Germany was ranked as the most innovative country in this area, accounting for 32% of innovations in the global automotive sector and outpacing vehicle manufacturers from China (18%), Japan (17%) and the USA (11%).⁵ The problem is, however, that many German patents have nothing to do with cutting-edge technologies. In 2015, around 30% of patents in the German automotive sector were linked to innovations concerning conventionally fuelled vehicles. According to statistical data from 2017, only 1–3% of innovations in the German automotive sector regard electromobility. As communication with other devices is gaining significance, the nature of the rivalry is changing, and hence the IT sector tycoons are becoming more and more serious competitors.

⁴ O. Koppel, T. Puls, E. Röben, *IW-Report 34/18. Die Patentleistung der deutschen KFZ-Unternehmen*, German Economic Institute based in Cologne, September 2018, p. 12, www.iwkoeln.de.

⁵ 'Deutsche Autohersteller sind Innovationstreiber', Statista, 21 August 2018, de.statista.com.

The sales of the German automotive industry noticeably fell (by 2.5%) in 2018, for the first time since the global financial crisis.⁶ The sector which over the past decade had accustomed everyone to record-high sales worldwide, was now providing surprises of more and consistently worse news, principally all year long in 2019. This adversely affected the subcontractors. Schaeffler was forced to reduce its staff's working hours due to an insufficient number of orders. Bosch announced redundancies. Continental and Mahle intend to close one factory in Germany each. German vehicle manufacturers also need to deal with problems. The largest companies are planning restructuring and higher investments in new technologies. In the coming years, Audi and Daimler intend to cut around 10,000 jobs each, Volkswagen will cut 5,000–7,000 jobs, Continental 7,000, and BMW 2,000–4,000. In turn, Bosch is considering reducing its level of employment by 3,500. As the demand for combustion vehicles falls, around 50,000 employees will be made redundant and 20% of German subcontractors will face bankruptcy.⁷ Therefore, it is not surprising that the leading politicians are increasingly concerned about the situation. Chancellor Angela Merkel already in 2018 made a statement in the Bundestag that was understood as a warning to the automotive industry. She said then that uncorrected mistakes may easily turn into systemic problems as was the case with Nokia, once a leading mobile phone manufacturer, which is now only a shadow of the corporation it used to be.

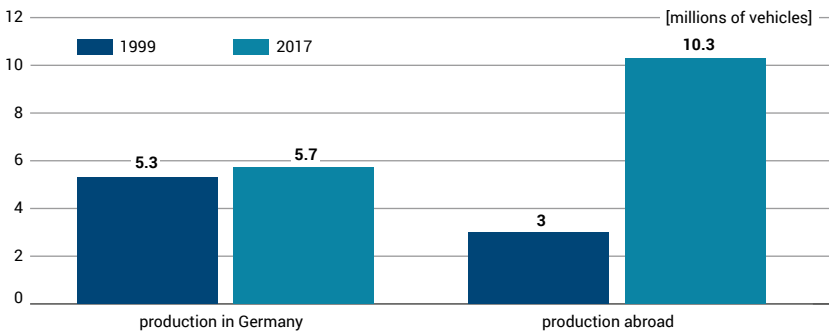
⁶ P. Fuß, C.M. Gall, *Die Automobilindustrie in Deutschland 2018: Umsatz- und Beschäftigungsentwicklung, wichtigste Auslandsmärkte*, E&Y, 2019, p. 4.

⁷ 'Krise kommt mit voller Wucht', DPA, www.uni-due.de.

II. THE GERMAN AUTOMOTIVE INDUSTRY AS THE GREATEST VICTIM OF THE VOLATILITY IN GLOBAL TRADE

Until recently, Germany was one of the greatest beneficiaries of the open globalisation model owing to the foreign expansion of vehicle manufacturers, followed by their subcontractors. The market boom was very skilfully used by German vehicle manufacturers, which created a global network of factories with optimal locations worldwide in the regions of key importance for the automotive industry. German politicians for years rejected reproaches for the excessive trade surplus and the economy's excessive reliance on the situation in the automotive sector. The hothouse conditions which enabled German vehicle manufacturers to achieve a c. 18% share in the global market are ceasing to exist. Trade is becoming tougher with the three most important markets for the German automotive sector: the USA (exports of vehicles and vehicle parts to this country are worth 27 billion euros), China (25 billion euros) and the United Kingdom (22.5 billion euros).

Chart 2. German vehicle manufacturers' domestic and foreign production in 1999 and 2017



Source: Verband der Automobilindustrie, www.vda.de.

The German automotive industry has gained global reach over the past two decades. While in 1999 German companies' factories located in

Germany manufactured 80% more vehicles than their foreign subsidiaries, this proportion was completely reversed 18 years later – in 2017 their factories outside Germany manufactured 10.3 million vehicles, against those in Germany with only 5.7 million. However, this does not mean that the proportion of production incomes was the same. Domestic factories predominated in manufacturing the most valuable elements, such as engines and gear boxes, while numerous factories outside Germany operated as assembly plants, especially for cheaper models. This was a way, for example, to effectively pay lower customs duties because the tariffs on components are usually much lower than on finished vehicles.

1. The US-China customs war

The German automotive industry owes its success to a great extent to the skilful building of complex supply chains, capitalising, for example, on low labour costs in China and Mexico, which enabled its international expansion. Even though the EU is not formally involved in the US-China customs war,⁸ the German automotive industry is already becoming one of the greatest victims of this conflict. The trade war between the USA and China strongly affects all German automotive companies whose major plants are located in those countries. The German automotive industry may suffer especially great losses due to retaliatory customs duty imposed by China on vehicle imports from the USA because more than half of these vehicles are manufactured by German companies in their US factories.⁹ German corporations and their subcontractors employ 80,000 people in the US. The key production plants of German manufacturers' SUVs sold worldwide are located in the USA. This was a very conscious strategy. Firstly, a great number of SUVs are sold in the USA, so economies of scale could be achieved. Secondly, it was less

⁸ J. Jakóbowski, 'A stalemate in US-China trade negotiations: the tariff war and technology sanctions', *OSW Commentary*, no. 303, 28 May 2019, www.osw.waw.pl.

⁹ C. Giesen, 'Handelskrieg zwischen USA und China bedroht deutsche Firmen', *Süddeutsche Zeitung*, 6 April 2018, www.sueddeutsche.de.

viable to manufacture vehicles, for example in China, given the need to offer part of the profit (sometimes the larger one) to Chinese partners, and co-operation with them was a precondition to enter the Chinese market.

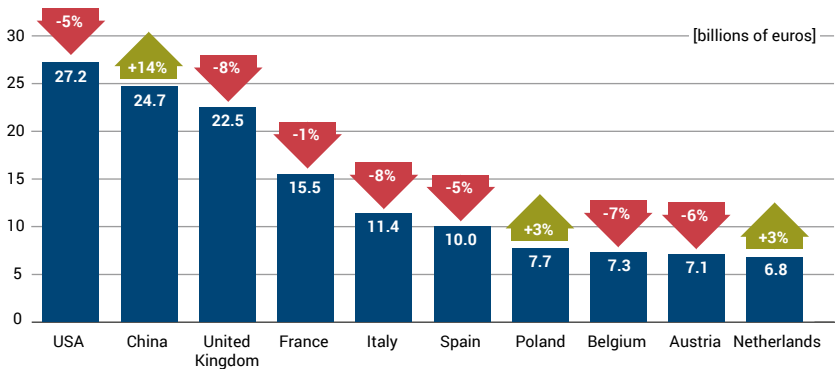
In July 2018, China imposed a 35% customs duty on vehicles imported from the USA; it was suspended towards the end of 2018. The sales of German vehicles in China did not fall most likely owing to the de-escalation of the dispute and Beijing's temporary withdrawal from the import duty. The sales on the US market were adversely affected by the customs duty imposed by President Donald Trump on steel and aluminium leading to increasing production costs in German companies' vehicle and vehicle part factories located in the USA. According to estimates, as a result of the duty imposed on steel imports to the USA, the costs incurred by the German economy linked to customs duty rose from 22 million euros to 400 million euros.¹⁰

The German automotive industry has also been affected by indirect consequences of the US-China trade war. In the past two decades, the Chinese market generated the highest growth in the sales of German vehicle manufacturers and their subcontractors. It was exports to China that balanced the slower growth rate of German vehicle sales on highly developed markets, especially at the time of the global economic crisis and the eurozone crisis. The situation may change radically in the coming years because the slump on the Chinese market is rapidly deteriorating due to the spiral of customs duties imposed by the USA and China. Vehicle sales in China dropped by 4% in 2018 and by 9.5% in 2019. These data are extremely worrying to the German automotive industry, especially given the fact that China is the world's largest market for vehicle sales (50% larger than the US) in which German manufacturers hold a high (24%) share. According to some estimates, the US-China trade war

¹⁰ *US-Zölle auf Stahl und Aluminium - Bedeutung für Bayern und Deutschland*, Vereinigung der Bayerischen Wirtschaft, December 2018, p. 13, www.vbw-bayern.de.

will lead to the number of vehicles sold worldwide in 2018–2024 falling by 35 million. This will mean that the automotive industry’s incomes will be reduced by 700 billion euros. As much as 83% of the difference will be an effect of the slump in China.¹¹ The US-China trade war has also affected the flexibility of German vehicle manufacturers’ response to fluctuations in demand. For example, BMW manufactures most of its SUVs in US factories. Usually the output is sufficient to satisfy the demand on this market. However, in the case of a rapid growth of sales in the United States, the company was able to supply more vehicles from its factories located in Germany and China. The present higher tariffs may limit this way of optimising the supply chain.

Chart 3. Vehicle and vehicle part sale value and growth rate on the German industry’s largest sale markets in 2018



Source: P. Fuß, C.M. Gall, *Die Automobilindustrie in Deutschland 2018: Umsatz- und Beschäftigungsentwicklung, wichtigste Auslandsmärkte*, E&Y, 2019, pp. 10–11.

Even though the upward trend in German vehicle manufacturers’ sales continued in 2018, this could be linked to the extraordinary measures taken by Beijing to sustain the favourable market conditions. This could also be linked to the fact that some consumers decided to buy a car earlier than they had planned, fearing new tariffs. The situation was not as

¹¹ F. Dudenhöffer, ‘Schaden von mehr als 700 Mrd. Euro durch Trump’schen Zollkriege für weltweite Autoindustrie’, Center for Automotive Research, October 2019.

good on other markets that are important for the German automotive sector. As illustrated in chart 3, German vehicles' sales dropped significantly on seven out of ten of these markets. German vehicle and vehicle part manufacturers could hope for an increase only in China (14%), Poland (3%) and the Netherlands (3%).

2. The NAFTA reform

The reform of the North America Free Trade Agreement (NAFTA) and its transformation in 2020 into the United States–Mexico–Canada Agreement (USMCA) will bring about costly changes in the German automotive sector's supply chains. Mexico has become a major production centre for German companies and their subcontractors over the past decades. Vehicles manufactured there have been sold on the US market. Audi, Bosch, Continental and Volkswagen already have plants there, and BMW and Mercedes are building ones. For those reasons terms of trade between the USMCA countries are very important for the German automotive sector. Goods will have to meet stricter conditions to be exempted from customs duty as part of trade within the bloc. The required share of components manufactured in the countries belonging to the group in the final product will be raised from 62.5% to 75%. This change may adversely affect the European factories of all the German manufacturers which have so far predominantly manufactured the most expensive parts (such as engines and gear boxes) in Germany. Another requirement is that a minimum wage must be ensured so that goods can be traded duty-free between the USMCA countries – at least 40–45% of the staff should earn at least a minimum of \$16 per hour. The NAFTA reform will thus undermine German vehicle manufacturers' price competitiveness on the USMCA markets. Furthermore, in many cases they will be forced to move a greater part of their production to these countries than has previously been the case. As a result of these changes the direct benefits for the German economy offered by the sale of vehicles in North America will be reduced because the opportunities of exporting vehicles and vehicle parts directly from Germany will shrink.

It is also unclear whether President Trump's threats to impose a duty on vehicles imported from the EU will be carried through. Since the beginning of his term the US president has criticised Germany for flooding the US market and importing amounts of American vehicles.¹² In 2018 alone, the USA exported vehicles worth \$3 billion to the EU and imported vehicles worth \$34 billion. The automotive industry is the main source of Germany's good results in trade with the USA.¹³ Sales of vehicles and vehicle parts accounts for 32% of German exports to the US market.¹⁴ For this reason, Germany was among those EU member states which insisted the most that Brussels de-escalate the trade dispute with the USA. In July 2018 Trump agreed to withdraw from imposing new trade restrictions, at least temporarily. At the same time he rejected the proposal to lift all customs duties on the trade of vehicles between the US and the EU, which had been put forward by the President of the European Commission, Jean-Claude Juncker. This in spite of the fact that, theoretically, it would have been beneficial to US manufacturers because customs duties on vehicles imposed by the EU are higher than the tariffs applicable in the USA.¹⁵ Trump argued that European consumers are committed to their brands, and tariff reduction would not change much. Some German experts view his threats as an attempt to force the EU to open up its market more to US agricultural products because farmers form a major group of Trump's electorate. In 2019, Trump repeatedly postponed the date of the final decision to recognise vehicle imports from the EU as a threat to the national interest, and this move would

¹² K. Bradsher, J. Ewing, 'Trump Attacks BMW and Mercedes, but Auto Industry Is a Complex Target', The New York Times, 16 January 2017, www.nytimes.com.

¹³ The USA is the largest outlet for German exporters and generates the largest share of the German trade surplus (50.5 billion euros; 20% of the surplus).

¹⁴ K. Popławski, 'Obawy Niemiec przed wojną handlową z USA', 14 March 2018, www.osw.waw.pl.

¹⁵ There is a clear imbalance: the EU imposes an average customs tariff of 5.2% on goods imported from the USA, while the average import duty on goods sold from the EU to the USA is 3.5%. This disproportion is even bigger in the case of the automotive industry's products. A 10% duty is imposed on vehicles and parts imported from the USA to the EU, while the USA imposes a smaller tariff of 2.5% on goods bought from the EU. If Trump increased the tariff to 25%, German companies would have to pay an additional 3-5 billion euros as compared to 0.5 billion euros at present.

have provided the grounds for imposing as much as a 25% duty on vehicles imported from the EU.

3. Brexit

The problems of the German automotive industry include not only global disputes but also the costs linked to Brexit. The United Kingdom participating in the single EU market became an important element of the German companies' supply chain, especially given the fact that British brands were beaten by the European competition. At present, many British subcontractors supply components to German vehicle manufacturers.

Already in 2015, i.e. before the Brexit referendum results were announced, the United Kingdom was the third most important outlet for German exports as a whole (after the United States and France). German exporters generated the second largest trade surplus on this market: 51 billion euros. However, Germany's surplus on the British market was reduced by 12% (to 45 billion euros) in 2018. The United Kingdom imported 800,000 vehicles from Germany – the most of all the countries worldwide, and this was linked to its participation in the single EU market. For the same reason it is also the most important market for the German sector of automobile subcontractors. They manufacture parts for 50% of German vehicles and 8% of other vehicles originating from the EU sold in the United Kingdom, which translates into 43,000 jobs in Germany.¹⁶ The situation on non-EU markets is different – Germany must build local plants there. The automotive sector is already Germany's greatest victim (along with the pharmaceutical sector) of the confusion caused by Brexit. While the value of German exports to the United Kingdom was reduced by 8% in 2015–2018, in the case of the automotive sector it fell by 23% (a loss worth 6 billion euros) and in the case of the

¹⁶ *Harter Brexit und die Lieferkette – Effekte auf deutsche Automobilzulieferer*, Deloitte Brexit Briefing 2018, no. 6, Deloitte, p. 4, www.deloitte.com.

pharmaceutical sector by as much as 41% (3 billion euros).¹⁷ This is not only an effect of the uncertainty about the form of future EU-UK relations (which has adversely affected the situation on the British market), it is above all an effect of the 20% drop in the pound's value against the euro over the past three years.

In the future, any form of undermining of economic relations between the EU and the UK will generate significant costs for the German automotive industry and the need to modify its entire supply chain. The effects of establishing a customs border will not be limited to the imposition of burdens linked to new tariffs and the estimated value of these will be 0.5 billion euros annually.¹⁸ Potential border crossing delays may upset the continuity of German companies' supplies and in effect force them to build new factories in the UK and limit exports from Germany. The British government may also introduce different technical standards or the requirement to include a certain share of local production in the final product in order to force foreign manufacturers to build factories in the UK.¹⁹ In this situation, replacing German subcontractors with their British competitors may be a way out for German vehicle manufacturers. However, all these trends will reduce the German economy's benefits generated by exports to the United Kingdom.

¹⁷ *Brexit so far – Die bisherigen Effekte auf den Standort Deutschland*, Deloitte Brexit Briefing 2019, no. 11, Deloitte, p. 11, www.deloitte.com.

¹⁸ If customs duties were introduced in compliance with WTO procedures, a 10% rate would be imposed on vehicles and a 4.5% on vehicle parts.

¹⁹ A. Börsch, T. Schiller, 'Brexit Fokus: Folgen für die deutsche Autoindustrie', Deloitte, www.deloitte.com.

III. THE COSTLY CHEATING ON ‘CLEAN DIESEL’

In September 2015 it was revealed that Volkswagen had installed special devices in its cars to manipulate fuel emissions tests. They limited car performance in laboratory conditions, temporarily reducing the range of pollutants emitted. This scandal shook the German automotive industry and ruined the opportunity of implementing the so-called ‘clean diesel’ strategy on the American market and also undermined the reputation of this type of engine in Europe.

The scandal ruined the strategy of German vehicle manufacturers. Before that they had hoped that diesel, originating from Germany, would become a technology that would be associated with ecology for a long time. Diesel cars typically consume less fuel and thus also emit less CO₂. However, extremely harmful nitrogen oxides produced in the combustion process were a problem. Until 2015, German manufacturers claimed that their vehicles generated only marginal quantities of these substances and even met the extremely high American standards. These assurances turned out to be untrue when Volkswagen admitted to the US government that devices manipulating fuel emissions during tests were installed in its diesel cars. It turned out in the following years that Volkswagen’s cheating was not an exception but rather the norm in the industry, and many more companies were accused of cheating on emission tests.

The reputation of German companies was further tarnished by another scandal, this time revealed by *Der Spiegel*. In 2017, the magazine published information that the key German vehicle manufacturers – Audi, BMW, Daimler, Porsche and VW – had set up a cartel with the intention of not introducing more costly ecological technologies in diesel engines starting from 2006.²⁰ A joint Vehicle Emissions Research Centre was established for this purpose in order to mutually coordinate actions. Foreign

²⁰ ‘Das Auto-Syndikat’, *Der Spiegel* 2017, no. 30, magazin.spiegel.de.

carmakers, such as Ford and Opel, were not invited to join the conspiracy. Some of the firms admitted their guilt, hoping to be treated more leniently. In October 2017, representatives of EU and German anti-trust authorities searched the headquarters of BMW. It is currently being considered whether Daimler or VW will be granted crown witness status in this case.²¹ The European Commission has not completed its investigation, and there are many grounds to expect that the companies may face multi-billion euro fines.²² If the accusations prove true, the carmakers might lose as much as 10% of their annual income.

The scandals turned out to be a factor that has essentially undermined the image of the diesel engine as an ecological solution and has led to a sudden decrease in its popularity. In the USA, where diesel cars accounted for around 3% of the total number of passenger sold cars before the scandal, the popularity of the diesel engine has fallen to a marginal level, while some analysts had expected that this share would grow to 10% within a decade. German vehicle manufacturers, such as Daimler and BMW, withdrew from offering diesel cars on the US market completely. The scandal affected the automotive industry in the EU to an even greater extent. In 2014–2018, the share of diesel cars in the total number cars sold in Western European countries dropped from 54 to 36%.²³ The scandal gave rise to a wave of lawsuits brought by environmentalist organisations to local courts in German federal states. Local authorities were accused of failing to react in the face of air quality standards being exceeded in many cities, caused to a great extent by the large number of diesel cars. German public opinion was especially outraged by the arrogant stance taken by the carmakers. They adopted a rather assertive stance and for a long time successfully claimed they did not have an obligation to introduce any technical changes in the vehicles sold by them in order to meet

²¹ M. Fasse, S. Menzel, 'Hausbesuche in der Autoindustrie', Handelsblatt, 23 October 2017, www.handelsblatt.com.

²² 'Autokartell vor möglichem Milliardenbußgeld', Der Spiegel, 8 March 2019, www.spiegel.de.

²³ Data from the database available at www.acea.be.

the environmental norms. They were supported in this by the German government. Already in September 2015 the press revealed that Germany (along with France and the United Kingdom) had insisted on maintaining the existing form of European fuel emissions testing form (which was full of loopholes) so that vehicle manufacturers could circumvent the regulations.²⁴ In December 2016, the German government was one of the seven member states' governments accused by the European Commission of failing to implement sanctions against VW for cheating on vehicle emissions tests.²⁵ The automotive industry's image was further tarnished by the information that Volkswagen had conducted research (co-financed by other German automakers, including Daimler) in order to prove that diesel was an ecological solution. This involved testing the harmfulness of breathing in fumes for many hours on monkeys, which outraged consumers worldwide.

As German public opinion began to lose confidence in automakers, favourable conditions were created for courts to pass decisions banning the entry of diesel vehicles to the centres of cities such as Berlin, Darmstadt, Hamburg and Stuttgart.²⁶ The regulations so far applied to older-generation diesel vehicles (usually of Euro 5 and lower standards, predominantly manufactured before 2015). However, some cities are considering a total ban on driving diesel vehicles in city centres. Germany is not an exception – regulations prohibiting diesel vehicles of older types from entering the city centres already apply in Brussels, Milan and Rome (amongst other cities), while Athens, Madrid and Paris are intending to impose a total ban on driving these vehicles in cities starting from 2025.²⁷ Many manufacturers active on the European market have announced the discontinuation of the production of diesel vehicles, considering the

²⁴ A. Neslen, 'UK, France and Germany lobbied for flawed car emissions tests, documents reveal', *The Guardian*, 24 September 2015, www.theguardian.com.

²⁵ A. de Carbonnel, 'EU takes legal action against Germany, UK over VW scandal', *Reuters*, 8 December 2016, www.reuters.com.

²⁶ *Bußgeldkatalog 2020*, www.bussgeldkatalog.org.

²⁷ A. Bendix, '15 major cities around the world that are starting to ban cars', *Business Insider*, 12 January 2019, www.businessinsider.com.

sudden drop in popularity of this technology in the EU. Toyota made this decision in 2017, and Fiat, Nissan, PSA (the owner of Peugeot, Citroën and Opel) and Renault made similar announcements in 2018. Meanwhile, German companies still remain on the defensive. Only Porsche decided to discontinue manufacturing diesel cars. However, these cars have only a 14% share in the company's production. In turn, BMW intends to continue manufacturing diesel vehicles for the next two decades, believing that the tempo of the development of electric cars is overhyped. It also seems that diesel vehicles will continue to have a major share in the production of Daimler and Volkswagen in the longer run. The position of many German companies depends too much on the sale of diesel vehicles even though this technology is becoming less and less popular. The share of diesel vehicles in German automakers' sales rapidly dropped in 2014–2018: from 74% to 48% in the case of BMW, from 67% to 44% in the case of Audi, from 59% to 48% in the case of Daimler, and from 54% to 40% in the case of Volkswagen.²⁸ The competitors of German carmakers have also sustained losses linked to the falling popularity of diesel engines, but their reliance on this technology is much lower. The share of diesel engines in Ford's sales on the German market shrank from 44% to 33% in 2014–2018, in the case of Renault from 35% to 19%, and in the case of Hyundai from 21% to 5%.²⁹

Volkswagen alone has sustained losses of around 30 billion euros due to the penalties and court charges it had to pay as a consequence of the scandal of 2015–2018.³⁰ Even though paying the costs was not a problem to the company, considering its good financial situation, this has had an impact on the company's research and development expenses and, above all, on the image of the firm and the entire German economy. According to a survey conducted by the global marketing agency Edelman (which

²⁸ Author's own calculations based on data from [de.statista.com](https://www.de.statista.com).

²⁹ In the case of Hyundai the comparison was made to data for the first half of 2018 due to the problem with the availability of data.

³⁰ A. Budde, 'Abgasskandal kostet und kostet', Deutschlandfunk, 2 May 2019, www.deutschlandfunk.de.

analysed the consequences of the recent scandals in which German companies were involved³¹), their reputation has suffered significantly over the past few years.³² In 2014–2019, confidence in them dropped in highly developed countries (France, the United Kingdom and the USA) by 19 percentage points to 44%, in Germany by 16 percentage points to 60%, and in developing countries (Brazil, China, India and Mexico) by 4 percentage points to 74%. Distrust in German firms translates into concrete decisions made by consumers. 37% of respondents from highly developed markets who had heard about the scandals declared that they were buying fewer products made in Germany due to the scandals and would only buy them if they had no alternative or they actively boycotted the products. The same was declared by 41% of respondents from analogous groups in developing countries. The distrust in German companies is intensifying even though consumers still relatively strongly believe in the high technological quality of these firms' products.

Another consequence of the diesel scandal was the introduction of more reliable combustion and emissions tests in new vehicles starting from 2017 (Worldwide Harmonised Light Vehicles Test Procedure, WLTP). This is a big problem for the entire automotive industry where manipulating measurements was the industry standard. Vehicle manufacturers hoped for a long time that resorting to various tricks will enable them to circumvent EU regulations imposing the obligation on EU carmakers to ensure that their vehicles emit on average no more than 95g of CO₂ per km starting from 2021. According to experts' estimates,

³¹ The past few years have seen not only scandals in the German automotive sector, but also reputation crises on an international scale in other sectors of the German economy. Deutsche Bank has been a source of scandals ongoing for years mainly due to problems linked to corruption and the unfair treatment of customers. Bayer also needs to deal with reputational issues after buying the US fertiliser manufacturer, Monsanto. These result from scandals linked to the potential carcinogenicity of glyphosate herbicides. The company may have to pay damages exceeding ten billion dollars.

³² 2019 *Edelman Trust Barometer. Special Report: Trust in Brand Germany*, Edelman, 2019, www.edelman.de.

three German vehicle manufacturers (BMW, Daimler and Volkswagen³³) may be unable to meet these standards and may have to pay fines of 0.2 billion euros, 0.2 billion euros and 1.4 billion euros, respectively. The excessively low share of electric cars in their total sales is the main cause of these problems. According to estimates, in order to avoid paying the fines, German companies will be forced to increase this share to 10–15% by 2021.³⁴

- ³³ Peugeot, Hyundai-Kia, Mazda and Fiat-Chrysler may also fail to meet the standards, while Toyota, Renault-Nissan, Volvo, Honda and Jaguar-Land-Rover are unlikely to have the problem (Cf. C. Sackmann, 'Aus Brüssel drohen hohe Strafen: Welche Autobauer zittern müssen', Focus, 11 April 2019, www.focus.de).
- ³⁴ E. Heymann, *E-Mobilität: Ohne Subventionen (noch) in der Nische*, Deutsche Bank Research, 9 December 2019, p. 4, www.dbresearch.de.

IV. NOT READY FOR ELECTROMOBILITY

German companies most likely would have quickly overcome the crisis linked to Dieselgate if not for their unpreparedness for the rapid changes taking place on the market. While the German automotive industry was still investing a lot in combustion engines, electric engine technology developed rapidly worldwide. During the past eight years, the price of batteries has reduced fourfold to 150 euros per 1 kWh. The development of electromobility may turn out to be the greatest revolution in the industry in decades. This change means that the fuel system and most of the components necessary for its correct operation will no longer be necessary. This will mean that Germany could lose its major advantage: decades of experience in developing specialist solutions for combustion engines. This will have grave consequences for the most important branch of the German economy.

The German automotive sector long delayed the decision to focus on developing electric cars, fearing that the German economy would lose its value-added and that its income generated by the sales of vehicles with combustion engines will be cannibalised. According to analysis conducted inside the sector, an electric car needs only 200 parts (a car with a combustion engine needs 1,400). For this reason, a major part of the German economy's technological advantage regarding engines, fuel systems, gear boxes and exhaust systems will no longer be essential. Manufacturing effective lithium-ion cells is the key competence in the process of manufacturing electric cars. This is so because the performance of such cars depends on them. At present, the cost of a battery, around 8,000–10,000 euros, may make up as much as 40% of a car's price.³⁵ The competence of producing battery cells has become the domain of electrochemical companies, mainly Asian ones. Since German automakers have not been interested in developing electromobility for years,

³⁵ S. Menzel, 'Wandel zur E-Mobilität: Vor allem Batteriezellen bereiten der Branche noch Probleme', Handelsblatt, 24 October 2019, www.handelsblatt.com.

German research institutes have reduced their capabilities in this area. While in the past most German universities of technology had world-class competences in electrochemistry and electrophysics (which are key for electromobility), at present the development of these fields of study leaves much to be desired.³⁶ This is coupled with the insufficient budgets of German research centres and their excessive bureaucratisation, which makes it difficult to attract world-class experts in the most innovative areas, such as artificial intelligence.³⁷ Furthermore, German vehicle manufacturers were uncertain for a long time as to whether the electric car would really be the future of the automotive industry. As a result, none of their European subcontractors has mastered the technology of manufacturing battery cells at competitive costs. Instead, their electric car models are equipped with cells supplied by companies from China, Japan or South Korea. According to the European Commission's estimates, in 2017 the EU as a whole was five years behind Asia as regards the technological level of battery production. At present, this gap has been reduced to three years. In turn, industry experts estimated that Germany itself is ten years late. For this reason, the German automotive sector for a long time did not even pick up the gauntlet that had been thrown down by its Asian competitors. In 2018, Bosch was the last of German companies to announce that it would not decide to build a lithium-ion battery factory on its own. The company's directors emphasised that the enterprise would only be profitable if a 20% market share was achieved by 2030, which would require investments of 20 billion euros. For the time being, the entire demand for lithium-ion battery cells for German electric cars is satisfied solely by imports. In this aspect Germany is lagging behind even some EU member states – while factories of foreign companies manufacturing battery cells already operate in Poland and Slovakia, the first plant in Germany, owned by China's CATL, is still under construction.³⁸

³⁶ B. Gillmann, 'Wolfgang Herrmann: "Ingenieure müssen politisch denken"', Handelsblatt, 13 September 2019, www.handelsblatt.com.

³⁷ *Ibid.*

³⁸ K. Popławski, 'Germany joins the electromobility race', 20 November 2019, www.osw.waw.pl.

The passiveness of German automakers has not slowed down the rapid development of electromobility, but it has opened the way for their competitors' expansion on this market. This expansion is supported by governmental programs subsidising the purchase of electric cars launched in numerous highly developed countries. For example, Tesla is designing electric cars for wealthier clients, and Renault has focused on the sector of cheaper compact cars. Rapid progress in the area of electromobility has also been made by manufacturers from China, especially given the fact that the Chinese government is putting pressure on the automotive industry to ensure that electric cars have an increasing share of production. According to forecasts presented by the Fraunhofer Institute, Germany has only six years to achieve the capability of battery manufacturing, because electric cars will become a mass product starting from 2025. According to the German Institute for Employment Research, by 2035 the number of jobs linked to combustion engine production may be reduced by 114,000 (84,000 in vehicle manufacturing and 30,000 in related areas). In effect, the economy will lose value-added of 20 billion euros (0.6% of GDP).³⁹ This effect will only be compensated to a small extent by the emergence of around 25,000 new jobs in the electromobility sector because it takes 30% less workforce to make an electric car than a combustion car. The most pessimistic calculations have been presented by the Ifo Institute, according to which, if radical regulations banning combustion cars from cities are introduced, 620,000 people in Germany will lose their jobs in the industry which manufactures engines for these cars.⁴⁰

³⁹ A. Mönnig, C. Schneemann, E. Weber, G. Zika, R. Helmrich, *Elektromobilität 2035: Effekte auf Wirtschaft und Erwerbstätigkeit durch die Elektrifizierung des Antriebsstrangs von Personenkraftwagen*, IAB Forschungsbericht, no. 8/2018, Institute for Employment Research, p. 7, doku.iab.de.

⁴⁰ K. Ulrich, 'Autoindustrie: Transformation oder Untergang', Deutsche Welle, 30 March 2019, www.dw.com.

V. CONCERNS ABOUT AUTONOMOUS VEHICLES

Many problems in the German automotive sector could have been avoided, if not for the tardiness in working on new technologies. The sector for a long time ignored Tesla's work on the development of autonomous electric cars, depreciating them and seeing them as a rather unrealistic attempt to conquer the automotive market by a small firm from Silicon Valley. However, technological progress and rapidly growing sales made it clear to Germans that Tesla may set a new trend in the global automotive industry. The vehicle digitalisation trend may pose an even more serious risk to German automakers than electromobility. If vehicles are reduced to autonomously moving devices in the future, and software becomes the criterion for choosing the optimal model instead of such parameters as driving comfort, a large share of the value-added generated by the automotive industry will be taken over by IT tycoons. It is they who have huge funds available, a massive amount of data, the capability to analyse and process them, and the skills of developing effective and user-friendly software. It is possible that the only thing remaining for German companies will be manufacturing the hardware, which may offer much lower margins. As Herbert Diess, the CEO of Volkswagen, stated in an interview, German companies have only a 50% chance of remaining among the top global carmakers in the coming decade. According to Diess, the highest risk is posed precisely by the digitalisation trend.

Tesla's market offer has for several years included cars partly capable of autonomous driving. However, human driver control is still necessary in cars operating in this mode. The overriding idea of many companies from Silicon Valley is to create robot taxis that would be capable of autonomously transporting passengers. Companies which offer urban passenger transport will be able to pay more for such cars, hoping that the autonomous fleet will help them significantly cut the costs generated by driver's wages, improve driving smoothness and reduce the risk

of accident.⁴¹ Unless the German automotive sector catches up with the trends, it will lose its share in the important market of vehicles meant for driving in cities. Even if developing software for autonomous city driving is a challenge that will take decades to overcome, autonomous driving on motorways is a much simpler task, considering the significantly less complex situation on these roads. This kind of software is already in the phase of advance testing.

At present, German automakers are not at the forefront of work on autonomous cars. According to a survey conducted by Navigant Research, the leaders in this race are: Google's subsidiary Waymo, General Motors and Ford. The German companies Volkswagen, Daimler (in co-operation with Bosch) and BMW, and the entire group of eleven other manufacturers, have been recognised as lagging behind the technological leaders.⁴² The test mileage achieved by autonomous car models in real-world driving is an imperfect indicator of the level of technological development of individual companies, though it is reliable to a certain extent. In turn, software quality can be assessed on the basis of the number of interventions from the driver controlling the vehicle per 1,000 miles of driving. Firms that have been authorised to test autonomous vehicles in California, which has the most liberal regulations in this area, are obliged to publish reports of this kind. These indicators also suggest that the leader of this classification is Waymo, with a mileage of autonomous vehicles of 1.27 million miles and 0.09 interventions per 1,000 miles. Next in the ranking is General Motors, with 447,000 miles and 0.19 interventions per 1000 miles.⁴³ German automakers are underperformers in this ranking: Daimler's autonomous vehicles have travelled 1,750 miles with 682 interventions per 1,000 miles, and BMW's 41 miles with

⁴¹ E. Rosenbaum, 'An MIT-trained Intel autonomous-driving exec explains why Tesla, Uber and Lyft are in a robo-taxi race for their lives', CNBC, 9 May 2019, www.cnbc.com.

⁴² M. Phelan, 'Detroit leads, Tesla lags in trillion-dollar race for robot-car business', Detroit Free Press, 13 March 2019, eu.freep.com.

⁴³ S. Crowe, 'Waymo autonomous vehicles leave Apple in the dust', The Robot Report, 15 February 2019, www.therobotreport.com.

219 interventions per 1,000 miles (while more than ten other firms have already earned more expertise than these two). German companies are also engaged in testing autonomous driving in their research centres, and so their information resources are certainly richer than what the figures presented above might suggest. However, even Diess, the CEO of Germany's largest vehicle manufacturer, has admitted that his firm is one to two years behind Waymo, though some analysts are of the opinion that this gap is at least five years.⁴⁴ It cannot be ruled out that German companies will use systems developed by their external partners, but this will entail loss of value-added. For example, BMW closely co-operates with Aptiv in the area of autonomous driving solutions in its latest vehicle models.

Furthermore, Germany is not among the top countries offering the best conditions for the development of autonomous vehicles. Germany is ranked eighth in the Autonomous Vehicles Readiness Index developed by KPMG, behind the Netherlands, Singapore, Norway, the USA, Sweden, Finland and the United Kingdom.⁴⁵ This means that the German automotive sector is not in a privileged position to be able to catch up with the top leaders in autonomous vehicle development and must test its solutions in the USA, relying on the knowledge of American experts. Germany is rated high in terms of the quality of traditional road and logistics infrastructure. However, it is ranked poorly as regards the availability of the 4G network, the country's administrative structure (it is too complex and impedes the development of standards on the national level) and consumers' acceptance of autonomous cars.

In the longer run, introducing the option of using autonomous driving systems may completely change the public perception of cars. A car may cease to be a status symbol and will rather become a more functional

⁴⁴ J. Becker, 'Überholspur ins Nichts?', Süddeutsche Zeitung, 27 March 2019, www.sueddeutsche.de.

⁴⁵ *2019 Autonomous Vehicles Readiness Index*, KPMG, 2019.

gadget expected to provide access to the extensive multimedia entertainment offered during driving, while functional values linked to driving will gradually lose importance. In this scenario, the brand may lose significance for the consumer. Consequently, the margin for luxury vehicle makers, such as Audi, BMW or Daimler, will fall. Unfavourable social trends are already visible in Germany. According to a questionnaire commissioned by Germany's digital association Bitkom, brand is an essential criterion for only 62% of Germans during vehicle purchase. The more important ones include: integrated navigation systems (93%), price (91%), environmental impact (such as fuel consumption, 91%), user experience (88%), engine type (electric or combustion, 84%), steering support systems (80%), design (79%), engine capacity (79%), services available on the basis of car data (such as repairs, 77%), or the vehicle's compatibility with a smartphone (62%).⁴⁶ Furthermore, six in ten Germans (including 58% of people older than 65 and 70% of people aged between 16 and 29 years) believe that owning a car is no longer a status symbol. According to another survey, 42% of German citizens aged between 18–25 would never be ready to give up anything to buy their own car, while in 2010 this answer was chosen by only 29% of respondents in this age group.⁴⁷ It cannot be ruled out that some of these opinions are rather declarative, while in fact owning a car with a good brand is still an important value, although people may not be fully aware of this. As can be concluded from other surveys, buying a car is falling ever lower on young people's priority list because their purchasing power and employment stability are much lower than those of their parents' generation.⁴⁸ Whatever the reasons for consumers' attachment to a car brand, there is a serious risk that the popularity of traditional car brands will decline.

⁴⁶ A. Streim, C. Meinecke, N. Teer, 'Das Auto der Zukunft spaltet die Deutschen', Bitkom, 5 September 2019, www.bitkom.org.

⁴⁷ 'Jungen Städtern sind Autos nicht mehr wichtig', Zeit Online, 19 April 2018, www.zeit.de.

⁴⁸ N. Häring, 'Das Märchen von den Millennials, die sich nicht für Besitz interessieren', Handelsblatt, 5 August 2019, www.handelsblatt.com.

Even if, contrary to optimistic opinions, autonomous vehicles do not achieve self-driving capability without human control, installing more and more functional and effective systems of this kind will be a must for premium segment brands. German automakers still have a very strong position in this area. However, Americans are already outpacing them at the present stage as regards the scope of commercialisation of simpler autonomous driving systems. On top of that, even if Waymo does not decide to launch the production of its own vehicles and sells its solutions, for example to German companies, this will lead to a decrease in the vehicle manufacturer's margin. As with electric cars, where a major share of the added value went to Asian battery manufacturers, the need to buy systems from subcontractors in the case of autonomous vehicles will limit the profitability of German premium brands (Audi, BMW, Daimler and Porsche). For example, according to data for 2018, vehicles of these brands accounted for only 43% of vehicles sold by German companies in total, but they generated as much as 60% of turnover and 75% of profits.⁴⁹ This is because selling a car in the premium sector generated much higher profits. In 2018, Volkswagen earned 954 euros per vehicle, while BMW earned 3,920 euros, Audi 2,611 euros, Daimler 3,130 euros and Porsche 13,667 euros.

⁴⁹ Author's own calculations based on German automakers' annual financial reports.

VI. GERMANY'S STRUGGLE WITH THE AUTOMOTIVE CRISIS

The long period of restructuring in the German automotive industry, during which it will not generate as high profits as over the past two decades, is already not only a pessimistic scenario but rather a consequence of the challenges automakers and their subcontractors need to face.

None of the three factors that undermine the German automotive sector's competitiveness is short-term. Global economic tension is unlikely to ease. Many countries do not intend to tolerate a situation of an endless macroeconomic imbalances that leads everywhere to the destabilisation of socio-economic systems. Principally, there is a consensus in the United States regarding the need to compete with China for primacy in the global economy. The United Kingdom has also demonstrated its readiness to seriously modify its contacts with the EU. Protectionist tendencies are strengthening in China and may lead to restrictions for the development of China-EU trade. German vehicle manufacturers will find it extremely difficult to maintain the previous highly complex supply chain, given such unfavourable conditions. Even if they manage to protect their position on foreign markets, they will do so as global brands with a smaller share of German value-added (as has already happened to American global digital corporations). As a consequence, Germany's direct benefits from exports to non-EU markets may fall, because a greater share of this added value will be generated locally.

Nothing seems to suggest that the evolution of the automotive industry towards electromobility and digitalisation would be held back. Both American and Chinese companies allocate significant funds on innovation in these fields. Beijing does not hide its intention (declared in the government strategy 'Made in China 2025') of becoming a global manufacturer of electric cars in the near future. This will weaken German companies' position in China and in the longer run also possibly on the

global market.⁵⁰ American firms from the IT sector are investing heavily in vehicle digitalisation software. Furthermore, the increasingly stricter climate regulations in the EU are forcing companies to sell more electric cars on the EU market. The development of the production technology of such vehicles is not unproblematic, and German manufacturers still have serious assets, such as knowledge of the market, a solid financial base, great technological potential and a well-developed distribution network. However, the dynamics of market trends is giving rise to a constantly growing risk that these companies' role will be reduced to that of sub-contractors or brand owners whose tasks will be limited to assembling components increasingly originating from outside Germany. It seems that the challenges the German automotive sector is about to face can be best determined by the thought included in the German industrial policy guidelines published in February 2019: if batteries for electric cars originate from Asia and systems for autonomous cars originate from the United States, Europe will lose 50% of its added value in the automotive sector.⁵¹ Unless German automakers introduce major innovations in the areas of electromobility and digitalisation, in the longer term they may face the risk of losing their position as the world's strongest automotive corporations, and the entire EU industry may lose a major share of added value. This would adversely affect not only Germany's economic situation and political stability, but also the competitiveness of the entire European economy.

⁵⁰ Proof of China's ambitions includes attempts to buy shares in German automotive companies. The news that one of China's largest automotive companies, Geely, bought a 9.69% stake in Daimler, thus becoming its largest shareholder, provoked a scandal in Germany over the past few weeks. The Chinese company resorted to accounting tricks to circumvent German regulations imposing the obligation to inform in public of any acquisition of stocks above the 3% and 5% thresholds. In effect of this transaction Geely may gain access to Daimler's key information and influence the company's strategic decisions.

⁵¹ *Nationale Industriestrategie 2030: Strategische Leitlinien für eine deutsche und europäische Industriepolitik*, Federal Ministry for Economic Affairs and Energy, Berlin 2019, www.bmw.de.

Germany is likely to respond to the automotive sector's challenges by intensifying action on three levels: sectoral, national and international.

1. Transformation of the automotive sector

The largest share of the tasks linked to the automotive industry's transformation will rest with the carmakers themselves. German companies will be forced to develop new business models in order to capitalise on some of their old advantages whilst simultaneously developing new ones. For a long time their response to electromobility has been limited to attempts to adapt part of the electric drive to the existing platforms for combustion models. This cautious strategy serves to limit the losses in case electric cars turned out to be merely a rich clients' fad; however, it has also resulted in poorer capacity of the electric cars on offer. The German automotive sector has already realised there is no turning point from electromobility. Volkswagen was the first German automaker to declare a radical technology shift and has allocated 60 billion euros on investments in electromobility and digitalisation. VW embarked upon designing a platform dedicated only to electric cars, hoping to set new standards in the industry this way. If this plan is successful, the firm will be able to manufacture cars that will have performance equal to Tesla's while reducing the prices owing to mass production. The direction of change set by Volkswagen is already translating into losses for its numerous subcontractors as VW is discontinuing its orders for further improvement of combustion vehicle systems with dim prospects. Many firms already have problems with remaining on the market because an electric vehicle requires different competences and its production involves a lower workload. In the pessimistic scenario, a sudden withdrawal from financing investments in combustion technologies may lead to the need to restructure entire regions (as was the case with restructuring mining areas) which have for decades been building the automotive cluster manufacturing combustion engines, especially diesels. This would particularly affect regions in southern Germany. The crisis might also spill out to other sectors since some small and medium-sized companies

in the electromechanical industry manufacture specialist machines and equipment dedicated solely for manufacturing combustion vehicles.

New technologies pose a huge threat to German premium vehicle makers who may be forced to radically modify their business model. So far, luxury has been defined by car performance. BMW and Daimler ordered the production of numerous components from their subcontractors and the brands themselves focused on making the most valuable units (i.e. the engine and other elements of the drive train) in the best possible way. German subcontractors, such as Bosch, Continental and ZF, do not have lithium-ion battery production technology. Therefore, they are focusing on producing electronics, software and drive train components for electric cars, thus entering a field which has so far been reserved for brand owners.⁵² These latter may be left with little opportunity to generate value-added. They need to face the difficult task of defining how luxury should be understood in the case of electric cars. It seems that the only way in which quality and innovation can be offered in the segment of premium cars is to create another generation of software for autonomous cars.⁵³

The development of new technologies in the automotive sector may be impeded by a phenomenon known from the energy transformation period: once conventional energy companies began to be viewed as entities which were set to be liquidated soon, their capitalisation began to fall, and thus they found it more difficult to obtain loans for further development. The beginnings of similar tendencies can be seen on the automotive market. Even though autonomous vehicles are a relatively distant future and are still more of a promise of a technological breakthrough, they are already popular among investors. On 3 February 2020, Tesla's market capitalisation exceeded US\$132 billion for the first time, achieving a higher value than the market value of BMW

⁵² 'Continental befürchtet auch 2020 maue Autokonjunktur', Der Spiegel, 12 November 2019, www.spiegel.de.

⁵³ M. Hesse, 'Etwas mehr Musk, bitte', Der Spiegel, 14 November 2019, www.spiegel.de.

and VW combined. This in spite of the fact that Tesla in 2019 had sold 367,000 vehicles, i.e. 37 times less than BMW (2.5 million) and VW (11 million) combined. Even though Tesla has generated significant financial losses since the beginning, it can still count on financing by holding new stock issues – investors view this strategy as setting a reliable market development trend. The consequences of these changes may include falling demand for the securities of traditional automakers, who will be branded as inflexible and technologically outdated. The stocks of BMW and Daimler over the past two years have been among the worst-priced amid Germany's 30 major companies listed on the DAX. Over the past few weeks, Continental (one of the top German subcontractors) surprised its shareholders by informing them about a significant deterioration in its market future partly due to the popularity of solutions linked to electromobility. Many German small and medium-sized companies already at this stage expect low-interest loans from the federal government for the transformation towards new automotive technologies.

2. The German government's moves on the national level

The German automotive industry's transformation will be successful on condition that the state effectively leads the process of structural changes. The state should support the sector of subcontractors (potentially the largest victim of the vehicle electromobility and digitalisation trends) and rebuild the research and development competences in the areas necessary for conducting the transformation. This will require the government's active engagement in initiating, coordinating and subsidising the transformation processes. This is a completely new situation for German state institutions which have shunned such deep engagement in economic processes so far. The assumptions of Germany's new industrial policy published in February 2019 by Minister Peter Altmaier are a manifestation of Germany's readiness to accept the challenge and alter the model existing to date. They have been criticised by numerous German economic circles for what they saw as a tendency leading to state interventionism.

The greatest challenge for the federal government will be reconciling the sector's interests, i.e. those of German automotive industry tycoons wanting a rapid transformation and to catch up with the technological leaders, as well as the interests of subcontractors from the sector of small and medium-sized enterprises whose further existence on the market may be jeopardised by overly rapid changes. Recent developments have further added to this dilemma. 70,000 workers of the automotive industry's subcontractors protested under the 'fair transformation' slogan in June 2019 during a meeting of CEOs of the vehicle manufacturers and representatives of the central government and the federal states at a summit devoted to the automotive industry.⁵⁴ Trade union activists insisted on establishing a special fund financed by the automakers and the state that would offer a low-interest loan to companies embarking on the transformation towards electromobility.⁵⁵ In turn, the manufacturers expected (and still expect) subsidies for the implementation of new technologies, the mobilisation of public funds and active engagement of the state administration. This is intended to contribute to creating the best possible ecosystem for the development of new automotive technologies. This is hampered to a great extent by the still very low sales of electric cars on the domestic market. Fully electric cars accounted for only 0.14% of the 57 million cars on the roads in Germany in 2018.⁵⁶ 52,900 new fully electric cars (1.7%) and 35,400 plug-in hybrids (1.2%) were bought in Germany between January and October 2019. The total of 143,000 electric cars sold on the German market has not lived up to Chancellor Merkel's ambitions expressed a few years ago that around a million of these cars would be seen on German roads in 2020. There should be around 7–10 million electric cars on German roads by 2030 for Germany's transport sector to fulfil the EU climate goals it has been set.

⁵⁴ M.-W. Buchenau, F. Hubik, 'Wo die Antriebswende zur Elektromobilität Tausende Jobs bedroht', Handelsblatt, 30 June 2019, www.handelsblatt.com.

⁵⁵ 'IG Metall fordert Milliardenfonds für Autozulieferer', Handelsblatt, 18 June 2019, www.handelsblatt.com.

⁵⁶ 'Zahl der Ladepunkte für E-Autos wächst in Deutschland', Handelsblatt, 8 April 2019, www.handelsblatt.com.

So far, German consumers' lack of interest in buying electric vehicles has not only been due to the prices but also due to the insufficient development of the charging infrastructure. In 2017, Germany was ranked 7th in the EU in terms of the number of charging points (70 per 100,000 city residents). It was far behind not only such small countries as the Netherlands, Denmark, Austria and Sweden, but also France, the size of whose territory is comparable.⁵⁷ It cannot be ruled out that Germany's position will improve in the near future. In 2018–2019, the total number of charging station grew by 144%, to 16,500.⁵⁸ The government has ambitious plans to increase the number of charge points by 250%, i.e. to 70,000, by 2021. Subsidies worth a total of 3.5 billion euros, which need to be used by 2025, are expected to help in achieving this goal. The subsidy for electric car purchase is also expected to be increased from the present level of 4,000 euros to 6,000 euros (in the case of cars which cost a maximum of 40,000 euros). This solution may apply to as many as 700,000 cars.⁵⁹

In the case of a slump on the global market and a more serious reduction of the German automotive industry's revenues in the coming years, the government is likely to take even more decisive measures to support sales in Germany – possibly something like the programme implemented in 2009 when subsidies for scrapping old cars and buying new ones were introduced.

3. Germany's moves on the EU and global arena

There is no doubt that EU law will be used to protect the interests of the German automotive industry. The more Germany feels it is on the back foot in terms of technology, the more it will be open to the French demands for “Europe's stronger industrial and digital sovereignty”.

⁵⁷ 'Electric vehicle charging points', European Commission, ec.europa.eu.

⁵⁸ Anzahl der Ladestationen für Elektrofahrzeuge in Deutschland im Zeitraum 2. Quartal 2018 bis 2. Quartal 2020, Statista, 5 May 2020, de.statista.com.

⁵⁹ K. Stratmann, M. Murphy, S. Menzel, M. Fasse, J. Hildebrand, 'Steuermilliarden werden zum Brennstoff der Mobilitätswende', Handelsblatt, 5 November 2019, www.handelsblatt.com.

Berlin has already agreed to subsidising the setting up of European consortiums tasked with manufacturing electric batteries. Just a few years back it would have been unthinkable for Germany to come up with a proposal like this because it wanted the model of the EU to remain as free-market as possible. The factors that contributed to changing Germany's mindset included the worsening condition of the German automotive industry and the launch of Brexit. London was opposed to the state's active engagement in the economy even more than Berlin. Meanwhile, Germany will no longer passively watch China take over further sectors through subsidies, as happened in the past to the once very promising photovoltaic sector. Germany has less and less qualms about building mechanisms that would use EU legislation to block the moves of American digital giants which are using their dominance in the area of data analysis for expansion in the automotive sector.

German automakers have so far contributed to strengthening Asian battery cell manufacturers' competitive advantage on the market by signing long-term supply contracts.⁶⁰ Politicians became seriously concerned about the slow rate of electromobility development and forced the domestic automotive sector to become more engaged in enhancing European capabilities in the area of lithium-ion battery cell production. Peter Altmaier, the Minister for Economic Affairs and Energy, in November 2018 promised to support the construction of battery factories in Germany with subsidies worth 1 billion euros by 2021. The programme has been coordinated with some EU member states (including France and Poland). Therefore, new plants will be set up as part of the Important Projects of Common European Interest initiative. This guarantees

⁶⁰ BMW signed a contract worth 1.5 billion euros under which it will buy battery cells from the factory of China's CATL which is under construction in Erfurt. It also signed a contract worth 2.5 billion euros envisaging battery cell supplies from China, and a contract with Samsung SDI. BMW itself guarantees cobalt supplies to these firms. Volkswagen has signed battery cell supply contracts worth a total of 20 billion euros with CATL, LG Chem and Samsung SDI, and will need battery cells worth a total of 50 billion euros by 2025. Daimler has signed battery cell supply contracts worth 20 billion euros.

that Brussels will readily accept subsidies for them. Two consortiums are certain to receive subsidies: the German-French consortium formed by BMW, Opel, PSA, Saft and Varta (amongst other companies); and the European one which will be created by BMW, BASF, Volkswagen, Sweden's Northvolt, and companies from Belgium, Poland and Italy.⁶¹ The projects may receive a total of 3.2 billion euros of subsidies which will be co-funded by the governments of individual member states. According to plans of the German Ministry for Economic Affairs and Energy, European manufacturers are expected to satisfy one third of the EU's demand for batteries in 2025–2030. This means that a production potential of 600–1500 GWh needs to be built in the EU by 2030.⁶² However, the latest economic development forecasts do not provide hope for this. In the opinion of Benchmark Mineral Intelligence, by 2028, 46 factories with a total production capacity of 1000 GWh will be located in China alone, while only nine plants with a total production potential of 248 GWh will operate in the EU.

The European Union also heavily relies on Chinese supplies of the raw materials necessary for battery production – 66% of the world's graphite deposits are located in China. Furthermore, Beijing has imposed the obligation to manufacture these components in China. Local battery manufacturers may count on considerable state support. European companies have no chance of similar privileges. In case Beijing's protectionist policy impedes market entrance, German companies will certainly expect Brussels to resolve these issues. In case the EU's economic relations with China and the USA deteriorate, it cannot be ruled out that Germany will agree to impose a CO₂ limit tax on manufacturers from countries where CO₂ emission levels are high.

⁶¹ 'EU-Gigafactory – der zweite Batteriezellen-Verbund steht', Manager Magazin, 6 September 2019, www.manager-magazin.de.

⁶² *Kleine Anfrage der Abgeordneten Oliver Krischer, Kerstin Andreae, Stephan Kühn (Dresden) u. a. der Fraktion BÜNDNIS 90/DIE GRÜNEN betr.: „Beschleunigung der Energie- und Verkehrswende durch eigene Batterieproduktion“*, Bundestag, no. 19/1041, 28 March 2018, www.bmwi.de.

EU institutions may also be used by Germany in the technological race against the US automotive industry. The manufacturers of Germany's premium car brands will want to catch up with the leading autonomous driving system developers, such as Google-owned Waymo, as soon as possible. However, Germany fears that American digital companies may be privileged in this technological race because they have vast data resources and data analysis tools, which makes it easier to create more precise algorithms. Besides, they will be able to offer perfect interoperability of systems and applications with the software installed in the cars. One example of the failure to catch up with US manufacturers was the failure of the joint initiative of Daimler and BMW intended at creating a competitor for Uber, a multinational ride-hailing company. They gave up their project known as 'Share now' due to excessive losses just before the end of 2019. The fact that two leading German carmakers have been beaten by a medium-sized company from Silicon Valley may serve as proof for Germany that it should apply pressure on Brussels to adopt legislation that will weaken the monopoly position of American digital companies and to ensure that European consumers' data are stored on European servers.⁶³ Nor can it be ruled out that a digital tax targeted at American companies will be imposed at the EU level, especially if the USA decides to impose an import duty on vehicles originating from the EU.

⁶³ K. Popławski, R. Bajczuk, *Industry 4.0 Germany's new industrial policy*, OSW, Warsaw 2019, www.osw.waw.pl.

VII. THE CONSEQUENCES FOR CENTRAL EUROPE

Investments made by German automakers and their subcontractors have been among the key factors strengthening economic links between Germany and Central Europe over the past two decades. The weakening of Germany's automotive industry may completely change the nature of economic relations between them and Central Europe, which will give rise to both major threats and new development opportunities for this region.

1. New threats...

Over the past few years, investments made by German vehicle manufacturers have been a major development trigger, especially in the Czech Republic, Slovakia and Hungary. The reduction of their scale will put those countries' economic model to the test and will provide an answer to the question whether their reliance on the automotive industry has reached a level that poses a threat to those countries' macroeconomic stability.

Each of the aforementioned challenges the German automotive industry needs to face may pose a threat to companies based in Central Europe. The requirement to move a greater share of their production to non-EU markets will reduce exports from all factories owned by German corporations – not only those located in Germany but also those in Central Europe. According to UNCTAD, the automotive industry accounted for 20% of Czech, 16% of Hungary's and 30% of Slovakia's exports, while the average ratio for the EU as a whole was 12%. Poland was significantly less dependent on the automotive industry, since this sector's production accounted for only 11% of its exports. The manufacture of electric cars will require fewer inputs, the demand for the production of Central European factories and subcontractors will also fall and many of these heavily rely on manufacturing components for combustion vehicles will also fall. In Poland the technological changes may adversely affect the manufacturers who generate 35% of the Polish automotive exports

(these are mainly manufacturers of combustion engines and their parts, gear boxes, clutches, other elements of the drive train, radiators and exhaust systems).⁶⁴ Vehicle digitalisation poses an equally high threat since it may increase the added value of the electrotechnical, electrochemical and IT sectors at the expense of the industrial sectors in which Central Europe has become specialised. According to Eurostat, the share of industrial production's value-added⁶⁵ in GDP in 2018 reached 27% in the Czech Republic, 21% in Hungary, 22% in Poland and 23% in Slovakia, while the average EU level was 17%.

A symbiosis was created between German and Central European factories during the boom on the global markets and a division of labour was formed. As a result, factories based in Central Europe manufactured cheaper models and carried out more time-consuming tasks. A strong sector of subcontractors manufacturing simpler components thus formed there. In turn, the production of more expensive models and almost all the research and development remained in the previous locations (mostly in Germany). Much stronger tensions and competition for the production of new models and workplaces may arise between German and Central European plants during the period of thorough transformation and restructuring of the sector. The German government will make pressure (and offer financial incentives) so that German manufacturers' investments above all support the transformation of the domestic automotive sector. Similar pressure can be expected from German trade unions. According to German law, companies must receive approval from the work council before they can move production outside Germany. Representatives of German workers are also members of automotive companies' supervisory boards. Volkswagen is especially sensitive to political influence – representatives of the Lower Saxony federal state, which owns a 20% stake in the company, have the right to veto the company's strategic decisions.

⁶⁴ K. Zduniuk, *Nowa era motoryzacji. Jak odnajdzie się w niej polski przemysł?*, Bank Pekao, 2019, p. 16, www.pekao.com.pl.

⁶⁵ Excluding the construction sector's production.

The example of Škoda Auto is a good illustration of the situation in Central Europe. This company's performance for years served as a perfect demonstration of the mutual benefits Germany and the Czech Republic derive from co-operation in the automotive sector. In the last decade of the 20th century, Volkswagen was gradually acquiring stakes in the Czech factory to ultimately become its sole owner. Germans made the needed investments in Škoda, improved its technological level and designed the brand practically anew. Over the past years, its vehicles have been among the bestsellers not only on the EU market but also in China, India and Russia (among other countries). Škoda's foreign expansion filled the Czech economy with pride, ensuring decent export incomes and increasing investments in R&D. In 2018 alone, the company generated 5% of the Czech Republic's GDP and 9% of its exports, thus becoming the country's largest employer and taxpayer. Although Škoda was breaking new sales records, VW's management liked less and less the fact that it was evolving from a manufacturer of cheap cars towards the medium class, offering practically the same solutions as Volkswagen for a lower price and gradually taking over clients from other brands belonging to the group.⁶⁶ These moves were tolerated as long as the German company's situation remained stable. However, Volkswagen announced in 2019 that, given the need to cut costs and improve profitability in order to become prepared for new challenges, it intended to restructure the brands portfolio so that they did not cannibalise each other. It is expected that Škoda will be the greatest victim of these moves.⁶⁷ It was decided that it would again become a cheap brand addressed, for example, to clients from developing countries (offering cars within a price range of 10,000–20,000 euros per car) and would compete with such European carmakers as Dacia, which is owned by France's Renault. The restructuring process may take a few years, and changes in Czech factories will be introduced gradually; unless this is accelerated by a potential sales collapse on the global

⁶⁶ D.H. Lamparter, 'Volkswagen: Schafft er das?', Zeit Online, 30 June 2016, www.zeit.de.

⁶⁷ G. Kacher, 'Skoda soll zur Billig-Marke werden', Süddeutsche Zeitung, 11 October 2019, www.sueddeutsche.de.

automotive market. The brand transformation may lead to losses for the Czech economy because the new Škoda will most likely become a car generating lower margins and involving much lower saturation with advanced technologies. As a consequence, VW may reduce investment in R&D in the Czech plants and limit the demand for highly qualified specialists, for example marketing specialists. This also gives rise to the threat that in the case of such countries as India and Russia, which are expected to become the main markets of Škoda, a large section of the production may be made locally in those countries.

Subcontractors' profitability may be further threatened as corporations will use their dominant position to force them to comply with climate protection standards. Since Dieselpgate, German manufacturers have been looking for new ways of manifesting their determination to reduce CO₂ emissions and to show their climate responsibility. One example of this is the series of Volkswagen's electric cars - ID. The company has also promised that it will make efforts to manufacture these vehicles in a climate neutral manner. A similar course of action has been declared by the CEO of Daimler. This change in the manner of production will have huge consequences for the subcontractors' sector since they generate on average around 70% of a vehicle's value-added⁶⁸ and thus it is they who will have the dominant share of responsibility for reducing CO₂ emissions during the production process. The largest German subcontractors, such as Bosch, ZF or Continental, are already preparing themselves for the challenge and are negotiating loans with banks for lower-emission technologies. However, higher expenses on climate policy may put at risk the survival of many subcontractors in Germany who already have problems due to low profitability levels. According to the German Foundry Association's estimates, 60% out of 600 domestic companies of this kind make a major share of their production for the needs of the automotive industry, using mainly such fuels as coke and natural gas.

⁶⁸ M.-W. Buchenau, S. Menzel, A. Müller, R. Tyborski, 'CO₂-Pläne der Autobauer gefährden Zulieferer', Handelsblatt, 6 December 2019, www.handelsblatt.com.

Subcontractors from Central Europe are also likely to face such problems and may suffer from such ambitious climate protection plans.

Similar threats to Central European subcontractors may also be linked to the industry 4.0 concept. This envisages (amongst other things) building a network of intelligent factories which will be able to significantly improve digital coordination, for example, between the corporations' and subcontractors' plants. This will definitely streamline their collaboration and accelerate the flow of information. However, from the subcontractors' viewpoint this will create a higher risk that the corporations will gain more control and much more extensive access to data. This means that they will be able to apply increasingly stronger pressure on price reduction and save much more money owing to investments in industry 4.0 at the expense of subcontractors.

In response to the requirement to locate a significantly greater share of production on non-EU markets, German companies may demand increasing engagement in foreign expansion from their subcontractors.⁶⁹ This course of development may be difficult to follow for small and medium-sized Central European companies which lack the sufficient capital and organisational capabilities to be able to invest on the much tougher non-European markets.

2. ...and new opportunities

Besides the new threats that come along with the shake-up caused by the technological challenges and the risks linked to increasing protectionism, there are also some opportunities for the Central European automotive sector. Certainly, not all German corporations' multiannual subcontractors from Germany will be able to continue their operation on the market, even if they may count on the government's support. This means that

⁶⁹ O. Wyman, 'Automobilindustrie vor stürmischen Zeiten', VDA, 17 May 2018, www.vda.de.

the automakers will be forced to look for new subcontractors in place of their traditional partners. This gap may be filled by some Central European firms that will use the opportunity of entering a higher level in the supply chain, especially if they manage to cope with the challenge of expansion onto markets outside the EU.

It cannot be ruled out that Germany will continue investing in plants manufacturing combustion vehicles in Central Europe in the short and medium term. This market segment is still set to generate an essential sales volume in the EU for years. Therefore, German companies may move a larger share of their combustion vehicle production to Central Europe in order to achieve as high margins as possible. At the same time they may allocate all the resources left into the R&D of new automotive technologies, especially in Germany. In the same time new workplaces linked to obsolete combustion vehicle production will still be created in Central Europe. However, these will be investments into declining technologies that will not entail essential investments in innovation needed for Central Europe.

In case the German automotive sector focuses on restructuring their plants in Germany, Central Europe's trade and investment flows may be quickly diversified, and Germany's share in this area may fall significantly. If the region's productivity remains on a similar level, Asian electric carmakers will certainly become engaged in it because the EU will continue to be a very important market for them for at least a decade or so. This trend is already visible in the sector of production of lithium-ion cells and batteries for electric vehicles. There is an LG Chem factory located near Wrocław in Poland. After its planned development in 2020 it is expected to become the world's largest battery cell production plant, with a production potential of 70 GWh. The company is already planning to build another plant in Poland.⁷⁰ In turn, a Samsung SDI factory (with a production potential of 3 GWh) operates in Hungary, and a plant of SK Innovation (7.5 GWh) is set to be launched there soon.

⁷⁰ K. Popławski, 'Germany joins the electromobility race', *op. cit.*

The most important question is whether Central European companies will be able to develop new competences in the areas of the production systems and software for electric vehicles. Some of them may be able to create a production cluster of parts in the chain of supplies for electric vehicles, especially given the fact that well-motivated and qualified employees remain the region's greatest asset. Another opportunity for subcontractors from Central Europe will be presented by the attempt to take the role of an integrator assembling more complex electric vehicle units from components available on the market.⁷¹ Their cost advantage will help them achieve high competitiveness in this area, even if this activity does not generate the highest margins. This trend is already visible in the region in the machine-building sector.

If collaboration with German automakers ceases to be such a strong development trigger for Central Europe as it proven so far, the companies forming the region's automotive sector may tighten co-operation between themselves independently of German firms. Many regional companies have significant competences in the area of combustion vehicle production – the Czech Republic in the area of the management and marketing of a global brand (Škoda is already one); Slovakia in the area of premium car assembly; Hungary in the area of advanced engine production; and Poland in the area of manufacturing vehicle components. Central European automotive companies may even face a dilemma as to whether intensified co-operation between them without the involvement of German firms would not even place them in a better position in the supply chain of the automobile market than before. Such co-operation might lead to the foundation of a separate corporation, entering a higher level in the combustion vehicle production chain, and gaining a stronger position in negotiations with global corporations.

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⁷¹ O. Wyman, 'Automobilindustrie vor stürmischen Zeiten', *op. cit.*