

# The automotive industry in the Visegrad Group countries

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# Executive summary



Among the Visegrad Group countries, Poland and Czechia had the largest number of enterprises manufacturing motor vehicles, trailers and semi-trailers. In 2010-2017, production in the automotive sector in Slovakia and Hungary grew especially rapidly, doubling in Slovakia in current prices and increasing by almost 90% in Hungary.



In 2010-2017, value added in current prices generated by the automotive sector increased the fastest in Poland (by four-fifths) and Slovakia (by 78%) and only slightly more slowly in Hungary and Czechia (by 68% and 63%). In the EU28, it increased much more slowly, by 53%.



According to key economic figures, the Czech automotive sector is the best developed in all the V4 countries. The role of the automotive industry in the V4 countries (except Poland) is much more important than in the EU28 as a whole.



The automotive sector is one of the biggest employers in the V4 countries' industry, accounting for 11-13% of employment in industry and 2-3% of the entire labour market. Since 2010, employment in the automotive sector in the V4 countries has grown constantly, at a faster rate than in the EU28. It rose the most in Slovakia, by 54%.



Labour productivity in the manufacturing of motor vehicles, trailers and semi-trailers (calculated as the ratio between gross value added and the total numbers of employees) in the EU28 was double that in the V4 countries and amounted to EUR 85,000 in 2016. Labour productivity was highest in Czechia and Hungary (around EUR 48,000). It was lower in Slovakia (EUR 41,100) and the lowest in Poland (EUR 34,100).



Of the V4 countries, Czechia exported the most motor vehicles, trailers and semi-trailers in 2016 (EUR 30.7 bn), followed by Poland (EUR 25 bn). In Hungary and Slovakia, they amounted to over 19 bn euro. In 2014, domestic value added accounted for 53.1% of Poland's automotive exports, the highest among the V4 countries.



The high domestic value added in Poland's automotive exports results from the country's specialisation in attracting investors to the auto parts and components industry; manufacturing them creates more domestic value added than assembling cars. Poland's stronger, compared to the other V4 countries, forward linkages in the automotive value chain present opportunities to increase the benefits of participating in GVCs.



The V4 expects the automotive sector to develop towards:

- electromobility, i.e. the development of electric cars or plug-in hybrids that will replace traditional cars,
- car sharing,
- autonomous cars.

3.53 m vehicles produced in V4 countries in 2017

18% of EU vehicles production is in the V4 countries

The Hungarian, Czech and Slovak automotive industry plays an important role in their national economies and is crucial for their development

In 2017, the Czech automotive industry achieved the highest level of gross output, value added, labour productivity and exports in the V4 countries

The Slovak automotive industry recorded the highest growth in the number of enterprises, gross output, value added, employment, labour productivity and compensation<sup>1</sup>

Poland is the biggest exporter of auto parts

2.10 multiplier effect in the V4, meaning that for every euro of added value in the automotive sector generates an additional 1.10 EUR in the entire economy

2.29 total multiplier effect in the V4, meaning that one job in the automotive sector creates 1.3 more jobs in the entire economy

2.03 multiplier effect in the V4, meaning that one euro of salaries paid in automotive sector generates one additional euro of salaries in the entire economy

<sup>1</sup> Compensation is defined as „the total remuneration, in cash or in kind, payable by an enterprise to an employee in return for work done by the latter during the accounting period“. It represents the total labour cost to an employer (Eurostat).

# Basic data on the automotive industry in the V4

▾ **Table 1.** Basic data on the manufacturing of motor vehicles, trailers and semi-trailers in the Visegrad Group countries (Czechia, Hungary, Poland and Slovakia) in 2017

	Czechia	Hungary	Poland	Slovakia
Enterprises	1093	489	1380	501
% in industry	0.6	0.96	0.7	0.7
Gross output (ms of EUR)	48,552.5	25,830.0	35,563.3	26,606.1
% in industry	25.0	24.9	8.4	29.8
Value added (ms of EUR)	9701.9	4983.1	7204.8	3436.3
% in industry	17.8	18.2	5.6	16.9
Employment (thousands)	198.4	101.7	314.7	79.1
% in industry	12.8	11.2	8.0	13.7
Exports (ms of EUR)*	30,745.8	19,265.2	25,198.2	19,201.5
% in industrial export	37.4	32.6	21.3	42.9
Labour productivity (gross value added per employee, thousands of EUR)*	48.2	48.0	34.1	41.1
% in manufacture industry	146.1	156.9	125.8	134.3
Nominal monthly compensation (EUR)	1742	1565	1141**	1815
% of industry's level	129.4	132.5	94.9**	133.8

\* 2016

\*\* 2017 estimated

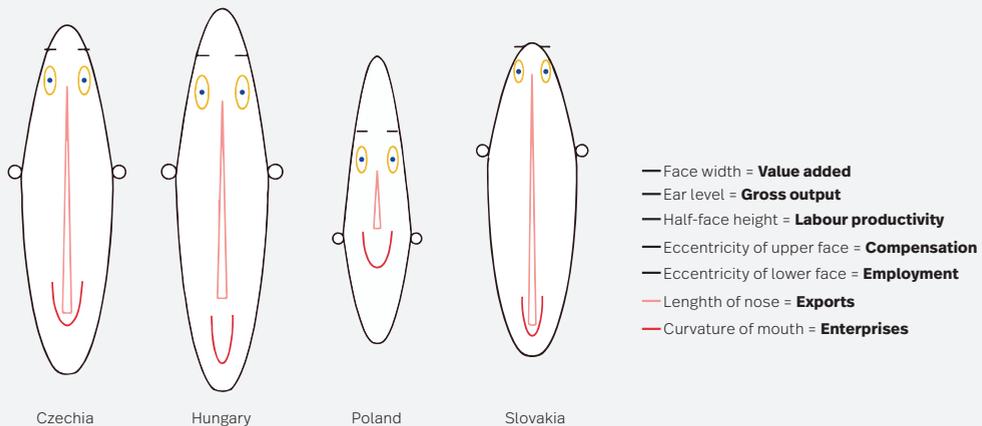
Source: GUS, Eurostat and own calculations based on Eurostat data.

## The V4 countries' faces

The figure below shows faces symbolising the V4 countries. Each face's parts show the

automotive sector's position in various economic categories in the country's industry, as a share or percentage of the average in the entire industry.

➤ **Figure 1. Chernoff Faces for the V4 countries**



## Enterprises

In 2017, there were 3463 active enterprises in the automotive sector in the V4 countries, accounting for 17.2% of automotive companies in the EU. The largest number were in Poland (1380) and Czechia (1093), which together accounted for 71.4% of automotive companies in the V4 (chart 1).

In both Slovakia and Poland, enterprises in the automotive sector make up 0.7% of enterprises in the industrial sector (chart 2). This is slightly lower in Czechia (0.6%) and significantly higher in Hungary (1.0%). It is worth noting that the share of automotive enterprises as a percentage of the total number of industry enterprises in the V4 is close to the ratio for the EU28, 0.9%.

While the number of enterprises in Poland's automotive sector decreased slightly in 2010-2017 (by 0.4%), and by 15% in Czechia, the number grew strongly in Slovakia (by 145.6%). This results from new investments, including the opening of the

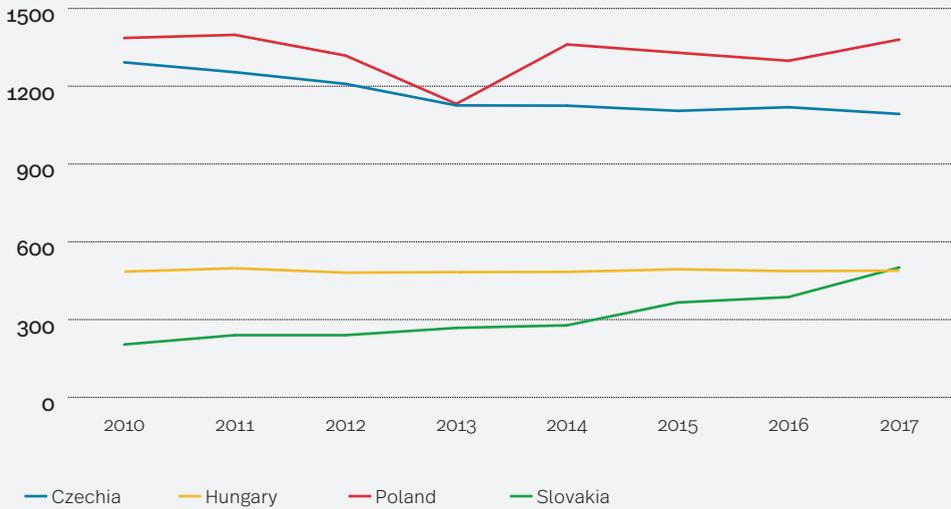
Jaguar Land Rover factory in Nitra, with a production capacity of 150,000 vehicles per year. The producer moved from the plants from Solihull, England, to Slovakia to produce the Land Rover Discovery SUV model, investing EUR 1.4 bn in the new facility ("Jaguar Land Rover opens manufacturing plant in Slovakia", 2018). In Hungary, the number of enterprises increased slightly.

In Slovakia, most automotive enterprises are located in the north-western regions close to the Czech and Polish border. The main enterprises are: Volkswagen, Kia Motors, PSA Peugeot Citroën and Jaguar Land Rover (SARIO, 2018).

In Czechia, most of the enterprises are located in the north, close to the Polish and Slovak border (Czech Invest, 2019). The main enterprises are: Škoda Auto, Tatra Trucks, SOR (buses and trolleybuses), TPCA – Toyota Peugeot Citroën Automobile, Iveco Bus and Hyundai (Ministry of Industry and Trade of the Czech Republic, 2018).

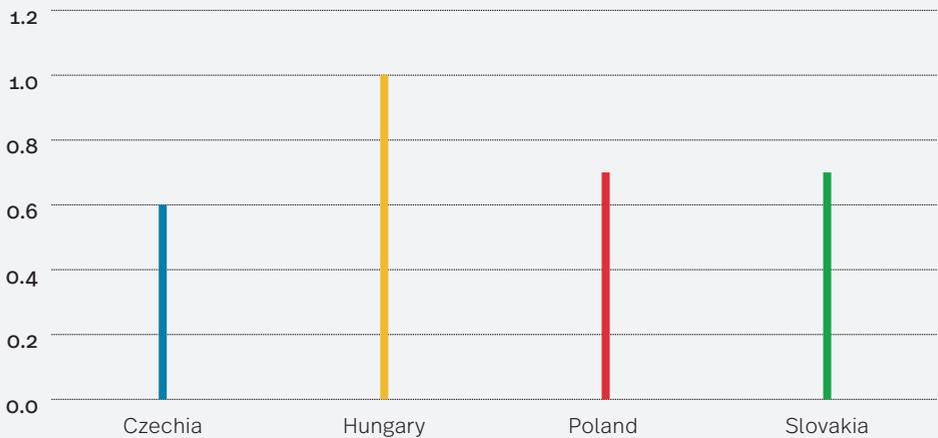


▼ **Chart 1.** Number of active enterprises in the automotive sector in 2010-2017



Source: Eurostat.

▼ **Chart 2.** Automotive enterprises as a percentage of industry enterprises in 2017



Source: Authors' calculations based on Eurostat data.

The automotive industry is also an important sector in the Hungarian economy. Traditionally, most of the enterprises were located in north-western Hungary, close to the Austrian and Slovak border, but lately, new investments have also been located in the eastern part of the country. The main enterprises are: Audi, Suzuki, Mercedes-Benz Manufacturing Company and BMW. In Hungary, new investments are being made by Mercedes. Audi is also developing in Győr, where enterprises are preparing to produce electric motors, as well as building a car body factory, where robots will be installed. In 2019, production of the next Audi (Q4) model will start in Győr (*Audi Q4 od 2019 roku. Produkcja na*

*Węgrzech, 2019; Canadian Trade Commissioner Service, 2014).*

In 2017, there were 1380 active enterprises in Poland, 46.8% of them with fewer than 50 employees. They accounted for about 2% of production in the automotive sector. The biggest enterprises, with over 1000 employees (8.4% of all automotive sector enterprises), accounted for 69.3% of sold production. In Poland, the automotive industry is concentrated in south and west of the country, close to the Czech and German border (PAIH, 2017). The main enterprises are: Fiat Chrysler Automobil (FCA), Volkswagen and PSA Peugeot Citroën (PZPM, 2018).

#### Latest greenfield automotive investments in Poland:

According to a 2018 report (fDi Intelligence, 2018), the number of foreign direct investments in Poland increased by 24%, to 338, making Poland the fifth-largest destination for FDI in Europe. The country ranked top for FDI in terms of job creation in 2017, with an increase of 53%.

Examples of the latest greenfield automotive FDI:

**Adient** – production of components and structures for car seats, location: Siemianowice Śląskie (Silesian Voivodeship), employment: 700 jobs, opened: 2018 (*Adient...*, 2019).

**Oetiker** – production of clamps, rings, straps and quick connectors, location: Legnickie Pole (Lower Silesian Voivodeship), employment: 75 jobs, opened: 2018 (*Oetiker*, 2019).

**Mercedes Benz** – production of engines, location: Jawor (Lower Silesian Voivodeship), approximate employment: 1000 jobs, planned opening: 2019 (*Mercedes-Benz Manufacturing Polska*, 2019).

**Umicore** – production of cathode materials, location: Nysa (Opole Voivodeship), approximate employment: 400 jobs planned, opening: late 2020 (*Umicore outlines...*, 2018).

**Varroc Lighting Systems** – production of innovative exterior vehicle lighting systems and electronics, location: Niemce (Lublin Voivodeship), approximate employment: 350 jobs, planned opening: 2019 (*Varroc Lighting Systems*, 2018).

**Korea Electric Terminal** – production of electrical and electronic modules for electric cars, location: Zabrze (Silesian Voivodeship), approximate employment: 200 jobs (*New automotive components manufacturing plant to be built in Poland*, 2019).

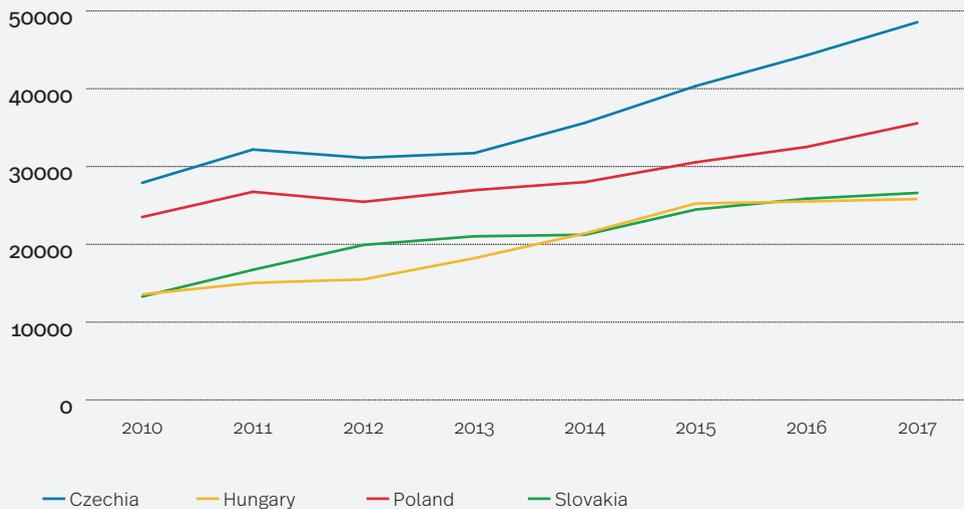
**Iron Force** – production of airbag inflators and seatbelt components, location: Zabrze (Silesian Voivodeship), approximate employment: 100 jobs, planned opening: 2023 (*Taiwanese-based company to build factory in southern Poland*, 2019).

## Production

The automotive sector plays a significant role in industry in the V4 and is very important for the development of Slovakia, Czechia and

Hungary. In 2017, gross output of motor vehicles, trailers and semi-trailers in the V4 countries amounted to EUR 136,552 m, 74.5% higher than in 2010 (chart 3).

▼ **Chart 3.** Gross output of motor vehicles, trailers and semi-trailers in V4 countries in 2010-2017 (millions of EUR)



Source: Eurostat, GUS.

The Czech automotive sector generated a gross output of more than EUR 48 bn in 2017. Poland was second, with production worth EUR 35.6 bn (growth by over a half, in current prices). In Hungary and Slovakia, gross output of motor vehicles, trailer and semi-trailer production came to around EUR 26 bn.

Slovakia's automotive industry has a relatively high share in total industrial production (29.8%). In Czechia and Hungary, it is around 25%. In Poland, the share is low; below 10% (chart 4).

In 2010-2017, production in Slovakia and Hungary's automotive sector grew rapidly due to big new investments. In Slovakia, production in

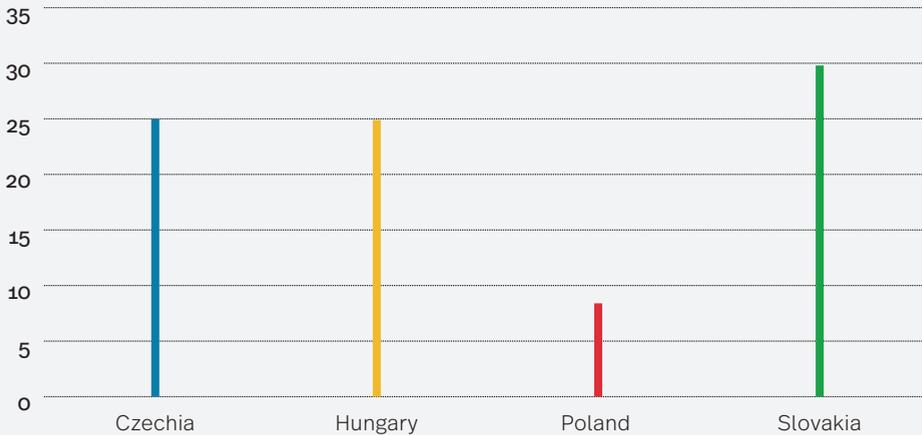
current prices doubled; in Hungary, it increased by almost 90%. Hungary has become one of the European centres for manufacturing motor vehicles; it is the country's most successful industry. In Czechia, production increased of almost 75% between 2010 and 2017. The weakest growth was recorded in Poland; a 50% increase between 2010 and 2017.

A total of 3.5 m vehicles were produced in the V4 countries in 2017, 3.6% of global and 18% of EU production. In 2017, the EU produced 19.6 m vehicles, including almost 17 m passenger cars and 2.6 m commercial vehicles; 23.3% of the 98.9 m produced globally. Czechia

produced the most passenger cars in the V4 (1.4 m, 8.3% of EU28 production). Slovakia

manufactured 0.95 m (5.6% of EU28 production), Poland 0.52 m (3.0%) and Hungary 0.47 m (2.8%).

▼ **Chart 4.** Share of automotive industry output in total industry output in 2017 (%)



Source: Authors' calculations based on Eurostat data.

Production of passenger cars grew the most in Hungary (by 130%), Slovakia (100%) and Czechia (40%). In contrast, production in Poland decreased by almost 30%.

Poland is the only V4 country that specialises in the production of light commercial vehicles weighing up to 3.5 tonnes. The country produced 0.16 m of them (7.6% of EU production). Heavy commercial vehicles weighing over 15 tonnes are produced in Czechia and Poland. In 2017, Poland produced 0.14 m of them (3.4% of EU), twice as many as Czechia.

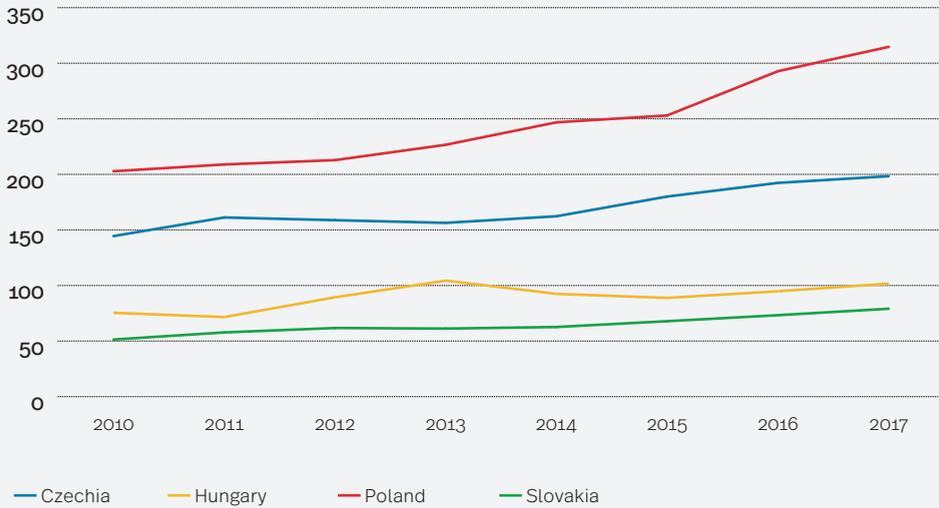
According to the PZPM (Polish Automotive Industry Association), Poland produced around 659,000 vehicles in 2018, 4.4% fewer than in 2017. Vehicle production was directed towards smaller vehicles, although Poland is also one of the EU's top producers of buses. (EIU, 2019). In 2017, diesel engines accounted for over 75% of all car engines manufactured in Poland.

The segment of components for electric vehicles is developing, with both whole lithium-ion batteries and components in the form of casings, electric wires, cathodes or electrolytes being produced.

## Employment

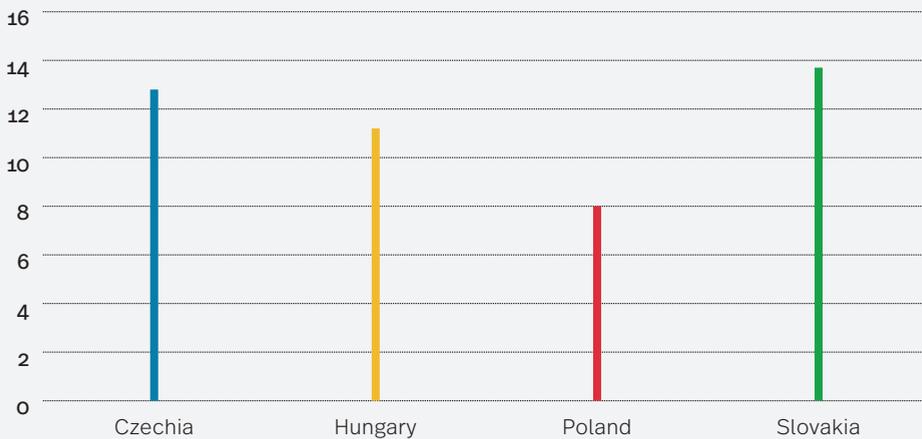
The EU automotive sector employs directly 2.5 m people in the manufacturing of motor vehicles, trailers and semi-trailers. Over a quarter of them work in the V4 countries (almost 0.7 m people); 314,700 in Poland, 198,400 in Czechia, 101,700 in Hungary and 79,100 in Slovakia (chart 5). The automotive sector is one of the biggest employers in the V4 countries' industry, accounting for 11-13% of employment in industry and 2-3% of the whole labour market. In Slovakia, the manufacturing of motor vehicles, trailers and semi-trailers is the biggest employer in industry (chart 6).

▼ **Chart 5.** People employed in the manufacturing of motor vehicles, trailers and semi-trailers in the V4 countries in 2010-2017 (thousands)



Source: Eurostat.

▼ **Chart 6.** People employed in the automotive industry as a percentage of total employment in industry in 2017 (%)



Source: Authors' calculations based on Eurostat data.

Since 2010, employment in the V4 countries' automotive sector has grown constantly, more rapidly than in the EU28. The greatest increase was in Poland (55%) and Slovakia (54%). In Hungary and Czechia, it was slightly lower; around 35%. Growth in employment in the automotive sector was higher than in industry overall. Significantly, the automation of production lines will offset the shortage of workers and rising wage requirements.

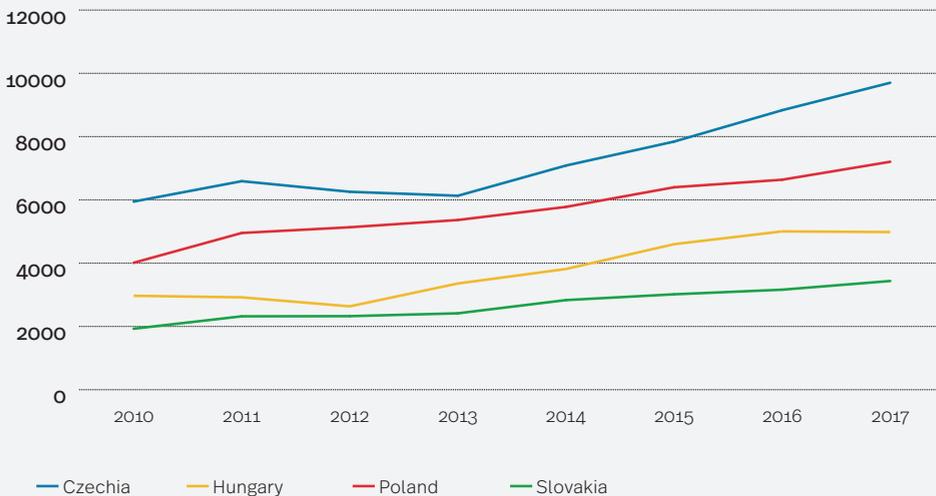
Initially, when the automotive sector in the V4 countries first started to grow dynamically, foreign investors mainly chose to locate their factories in the region due to the availability of relatively skilled and cheap workers (Kurekova, 2018). Now, the major obstacle to the automotive industry's further development in the V4 countries is the lack of suitable labour. One cause is underperforming education systems, which have only partially adapted to market demands. According to the MotoBarometr 2018 (Exact Systems, 2018)

survey, this is the biggest problem in the automotive sector. The report points out that there is also strong competition between Poland, Czechia and Hungary to attract Ukrainian workers, who are the remedy for the lack of workers. German employers want to employ Ukrainians, too. With Germany planning to change its migration policy, the V4 countries' automotive sector could find it even more difficult to find workers.

## Value added

In 2010-2017, the value added in current prices generated in the manufacturing of motor vehicles, trailers and semi-trailers grew the fastest in Poland (by 4/5) and Slovakia (by 78%), with Hungary and Czechia close behind (68% and 63%) (chart 7). In the EU28, it grew much more slowly, by 53%. In 2017, the highest level was recorded in Czechia (EUR 9,702 m), with the lowest in Slovakia (EUR 3,436 m).

↘ **Chart 7.** Value added in the manufacturing of motor vehicles, trailers and semi-trailers in the V4 countries in 2010-2017 (millions of EUR)

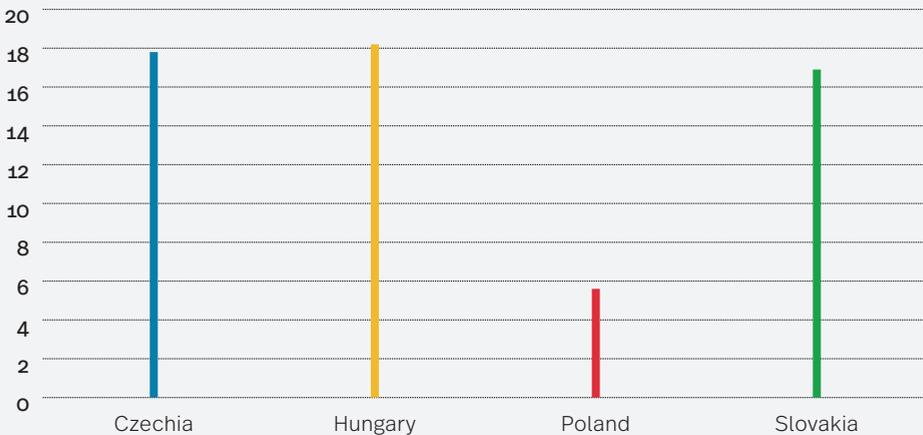


\* 2017, Poland - GUS data  
Source: Eurostat, GUS.

This sector plays a significant role in the economy, especially in Czechia and Hungary. In 2017, its share in the value added generated by these countries' industry amounted to 17.8% and 18.2% respectively, and to 5.6% and 4.7% in the value added generated in the entire economy (chart 8). It also plays a significant role in Slovakia's economy, whereas its meaning in Poland

is much smaller. In Polish industry, the share of value added in this sector was even lower than in industry in the EU28 overall (9.3% and 5.6% respectively) and the same in the Polish economy as in the entire EU28 economy, 1.8%. This means that the automotive industry is much more important in the V4 countries (except Poland) than in the EU28 as a whole.

➤ **Chart 8.** Value added in the automotive industry as a share of the value added of industry overall in 2017 (%)



\* 2017, Poland – GUS data

Source: Own calculations based on Eurostat and GUS data.

In 2015-2016, the share of employment costs in gross value added in the automotive sector in Poland was about 45-46%. In 2017, it rose to 55% due to growing employment problems and costs (GUS, 2018).

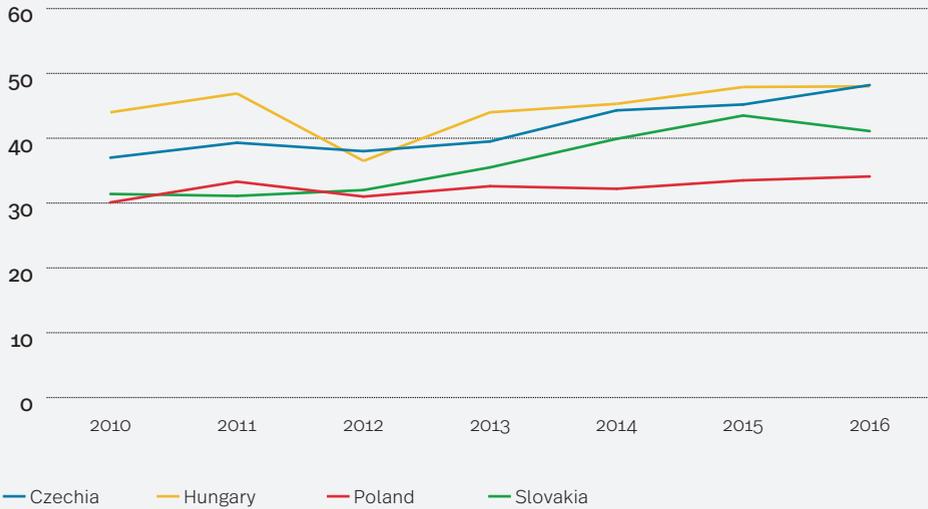
## Labour productivity

In the EU28, labour productivity in the manufacturing of motor vehicles, trailers and semi-trailers (calculated as the ratio between gross value added and the total numbers of employees) was twice as high as in the V4, reaching

EUR 85,000 in 2016. Among the V4 countries, it was highest in the Czech and Hungarian automotive sectors in 2016 (around EUR 48,000). It was lower in Slovakia (EUR 41,100) and the lowest in Poland (EUR 34,100) (chart 9).

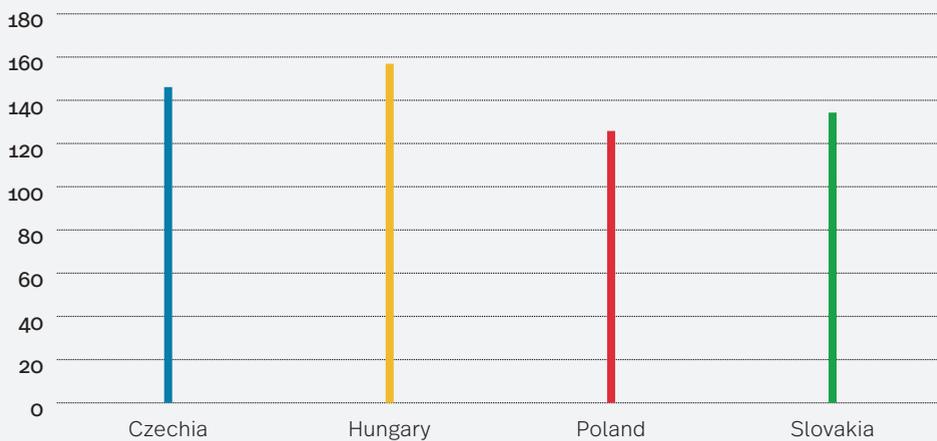
Labour productivity in the automotive industry in both the EU28 and the V4 was significantly higher than in manufacturing overall. The biggest difference was in Hungary and Czechia, where labour productivity was 56.9% and 46.1% higher. In Slovakia (34.3%) and Poland (35.8%), the difference was somewhat lower (chart 10).

▼ **Chart 9.** Labour productivity in the manufacturing of motor vehicles, trailers and semi-trailers in V4 countries in 2010-2017 (gross value added per employee) (thousands of EUR)



Source: Eurostat.

▼ **Chart 10.** Labour productivity in automotive industry as a percentage of that in manufacturing industry in 2017 (%)



Source: Authors' calculations based on Eurostat data.

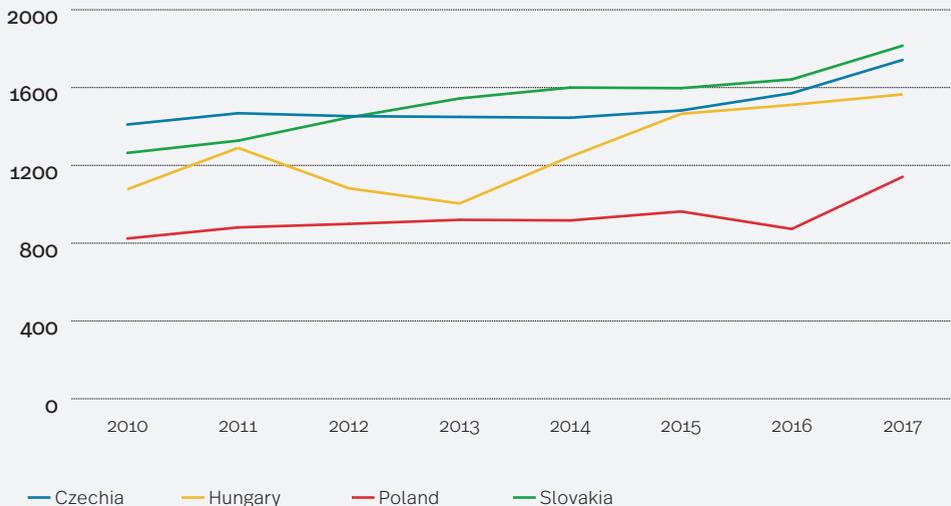
Since 2010, labour productivity has risen in both the EU28 and the V4. It rose the most rapidly in Slovakia (by almost 79%), with significant increases in Czechia and Poland (around 30%). In Hungary, labour productivity rose by less than 10%. There were the most positive changes in Slovakia, where labour productivity rose the most rapidly, eventually overtaking Poland. Over the years 2010-2016, Czechia reached Hungary's productivity level. In the years after 2010, labour productivity in Poland dropped from third to the last place in the V4.

Improvement in labour productivity is one of the key indicators of a country's comparative advantages, with a significant impact on its international competitiveness (Kazimir et al., 2016). This has led to concern about the future of the Polish automotive industry and its ability to attract foreign investment.

## Nominal compensation per employee<sup>2</sup>

In 2010, the highest average monthly compensation per employee in the automotive industry in the V4 was in Czechia (EUR 1410), with the lowest in Poland (EUR 824) (chart 11). In subsequent years, compensation per employee grew the most rapidly in Hungary and Slovakia (by 45% and 44% respectively in 2010-2017). As a result, Slovakia overtook Czechia in 2017 (EUR 1815 and EUR 1742 respectively). In contrast, compensation in Poland (EUR 1141) in 2017 was the lowest, according to the authors' own assessment. In 2010-2017, it grew by 38.5%. In 2015, in Slovakia compensation per employee was more than twice as low and in Poland over four times lower than in the EU28 overall. This makes Poland particularly attractive for foreign investment due to low labour costs.

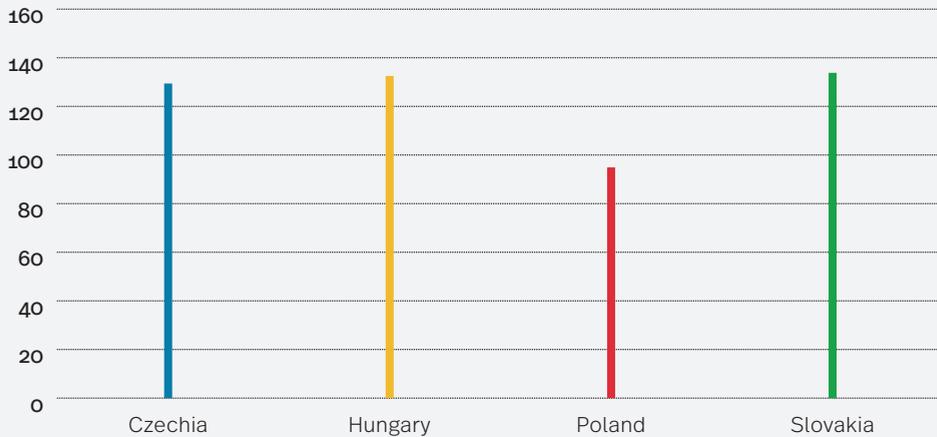
Chart 11. Average nominal monthly compensation per employee in 2010-2017 (EUR)



\* 2017, Poland – estimated  
Source: Eurostat.

<sup>2</sup> Compensation is defined as „the total remuneration, in cash or in kind, payable by an enterprise to an employee in return for work done by the latter during the accounting period“. It represents the total labour cost to an employer (Eurostat).

▼ **Chart 12.** Nominal monthly compensation per employee in automotive industry as a percentage of that in the industry in 2017 (%)



\* 2017, Poland – estimated

Source: Authors' calculations based on Eurostat data.

In 2017, Poland was the only country in which compensation per employee in the automotive sector was lower than in industry overall (chart 12). In Slovakia and Hungary, it was one-third higher than in industry overall and, in Hungary, even three-fifths higher.

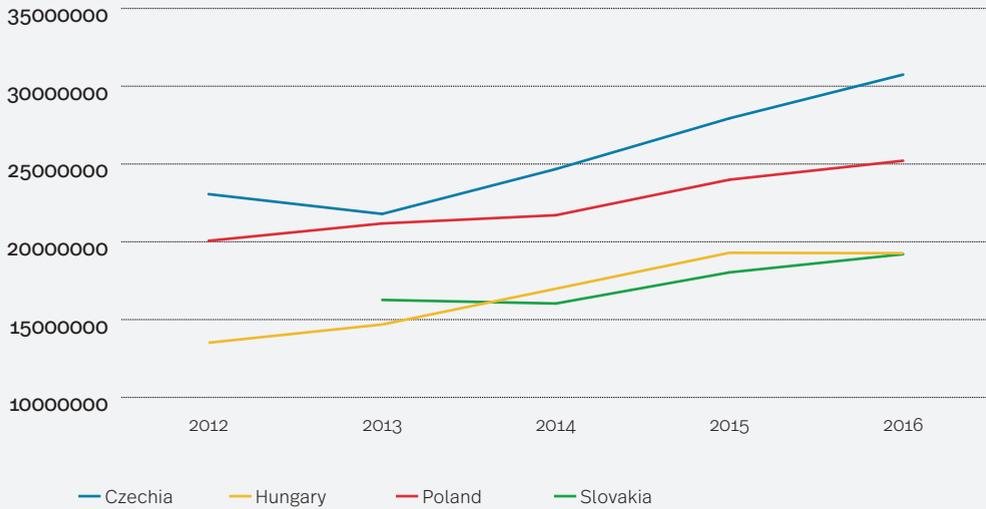
## Exports

Of the V4 countries, Czechia exported the most motor vehicles, trailers and semi-trailers in 2016 (EUR 30.7 bn), followed by Poland (EUR 25 bn) (chart 13). Automotive exports from Hungary and Slovakia amounted over EUR 19 bn. However, this sector accounted for the largest share of industrial exports and entire exports in Slovakia (43% and 27% respectively) (chart 14). It was lowest in Poland (21% and 14% respectively). In 2012-2016, automotive exports in current prices grew by 43% in Hungary, by a third in Czechia and by a quarter in Poland. Slovak automotive exports were 18% higher in 2016 than in 2013. As exports of automotive products have increased more than industrial and total exports, their share has increased. The

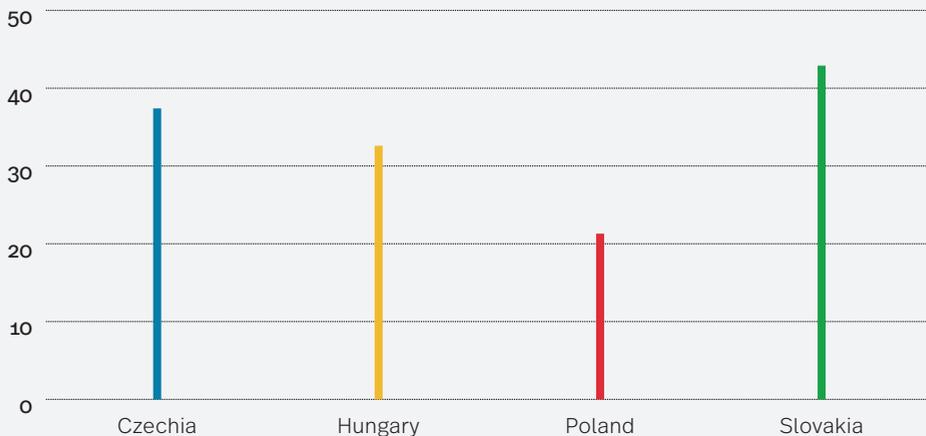
only exception was the slight decrease in this sector's share in Poland's total exports.

Meanwhile, Poland is the biggest exporter of auto parts not only in the V4, but also is Central and Southeast Europe. In 2017, these exports were worth EUR 16 bn, accounting for almost 60% of automotive and 8% of all Polish exports. Poland is the third-largest exporter of auto parts in the EU, after Germany and France. In 2017, 7% of auto parts exports from EU countries came from Poland (Mroczek, 2018).

In 2010-2017, there were no change in automotive exports' share in Polish industry (it was about 21-22%). Almost 94% of automotive exports went to developed countries. Of these, 90% went to EU countries and this share is steadily growing. The main destination was Germany, followed by Italy and Britain. The share of automotive exports going to other countries in Central and Eastern Europe increased from 0.3% in 2010 to 1.7% in 2017. Automotive exports to developing countries grew even faster, with their share increasing from 0.5% in 2010 to 4.5% in 2017 (GUS, 2018).

▼ **Chart 13.** Exports of automotive sector in V4 countries in 2012-2016 (thousands of EUR)

Source: Eurostat.

▼ **Chart 14.** Share of automotive exports in the value added in industry overall in 2016 (%)

Source: own calculations based on Eurostat data.

### Poland's record automotive exports in 2018

**EUR 25.95 bn** – automotive exports  
**EUR 12.19 bn** – export of parts and accessories  
**EUR 3.2 bn** – export of heavy commercial vehicles

In 2018, Polish automotive exports rose by 2.93%, to a record level. They have been rising constantly since 2013, although they rose significantly more slowly in 2018. This year's growth mainly results from the increase in exports within the EU; exports to non-EU countries declined by 10%. Car parts and accessories account for 46.97% Polish automotive exports; this year, they rose by 7.64%. Unfortunately, exports of passenger and light commercial vehicles (23.72% of exports) declined for the second year in a row, by almost 11%. Heavy commercial vehicles (12.35% of exports) grew rapidly, by almost 20%. Exports of other groups (16.96% of exports) rose, especially chassis with engines (by 36.20%) and special vehicles (by 34.42%).

Polish automotive exports mostly went to Germany (31.32%), Czechia (8.54%), Italy (7.67%), Britain (6.28%) and France (5.75). Exports to Germany, Czechia and France have risen by several percent, whereas those to Britain and Italy have declined by almost 4% over 13% respectively.

It is difficult to say where 2019 will be another record year for Poland, with automotive exports higher than in 2018. The situation on the main markets is complicated. In Germany and Britain, production of new cars has declined significantly since the start of the year. Global circumstances seem unfavourable, too, with rising protectionism in the US and weakening economic growth in China. Nevertheless, the export of auto parts and accessories and heavy commercial vehicles could still rise in 2019.

Source: *Eksport w 2018: kolejny rekordowy rok przemysł u motoryzacyjnego!* (2019).

## Final remarks

The rapid growth in the V4 countries' automotive sectors is unlikely to be maintained, as threats have appeared. With Germany the largest producer and exporter of cars in Europe (and third globally, after China and Japan) and the strong international production chains created by the largest German automotive companies, the situation there has a significant impact on that in Europe industry, especially in the V4. German car production grew steadily in 2013-2016, but decreased by over 100,000 units in 2017 compared to the previous year. This downward trend was reinforced at the start of 2018.

Firstly, demand for German cars was affected by the start of moving away from cars with diesel engines. This was caused by the emissions scandal involving the largest German manufactures, in which cars with software falsifying emissions tests from diesel engines were sold. Another reason was the acquisition of Opel's factories by the PSA Peugeot Citroën Group (Mroczek, 2018). Other challenges faced by the German automotive sector include Brexit (including the risk of a no-deal Brexit, after which customs duties between the EU and Britain could be introduced), the threat of higher US tariffs on car imports from the EU (currently 3%)

and stringent CO<sub>2</sub> targets. The increases in US import duties for steel and aluminium will affect the German automotive industry, too, as there are German automotive factories in US.

All these threats not only affect German car producers, but also their suppliers. According Eurostat, the largest suppliers of automotive parts to Germany in 2017 were Czechia (EUR 5.78 bn), Hungary (EUR 5.76 bn), Poland (EUR 5.23 bn), Austria (EUR 5.14 bn), France (EUR 4.55 bn), Romania (EUR 4.54 bn) and Slovakia (EUR 3.08 bn). Importing auto parts from Central and Southeast Europe reduces production costs and increases German cars' competitiveness.

The largest importers of Polish automotive parts are Germany (where one-third of Polish auto parts exports go) and Czechia. The emissions scandal hit Poland especially badly, as diesel engines accounted for over three-quarters of all car engines produced in Poland (Mroczek, 2018). Fortunately, the role of the automotive industry in Polish industry overall is lower than in the other V4 countries.

Apart from Germany, which accounts for one-third of sales to foreign markets, the main destination for auto parts from Poland are car factories in Czechia. The total volume of trade, as well as trade in parts and components, between countries in Central Europe has risen rapidly in

recent years. Czechia has very intensive relations with Poland and Slovakia, while Hungary has a significant volume of trade with the three other V4 countries (Molnar, Penzes, Kozma, 2015).

The V4 countries advantages, in terms of attracting investment in the automotive industry:

- good geographical location (centre of Europe),
- stable political environment favouring investment,
- good governmental development efforts,
- central banks' low basic interest rate,
- competitive labour costs,
- low corporate taxes<sup>3</sup>.

The V4 countries' disadvantages are:

- low workforce mobility within the country,
- lack of qualified staff.

In Hungary, the lack of production of raw materials and materials is also a barrier to investment (Canadian Traded Commissioner Service, 2014).

It is worth noting that the growing shortage of qualified staff in the V4 countries calls into question the current economic model, largely based on attracting foreign investment through cheap labour, well-developed transport infrastructure and an attractive state offer in the form of tax breaks, subsidies, and so on.

<sup>3</sup> In Hungary, the corporate income tax rate was reduced to a flat rate of 9 per cent in 2017. In Poland and Czechia, the CIT rate is 19%. In Slovakia, it is 21%.

# The automotive industry's impact on the economy and social-economic development in the Visegrad Group

The automotive sector is driving economic development in the Visegrad Group countries by providing thousands of jobs, paying ms of euros in salaries and by generating bns of euros of value added.

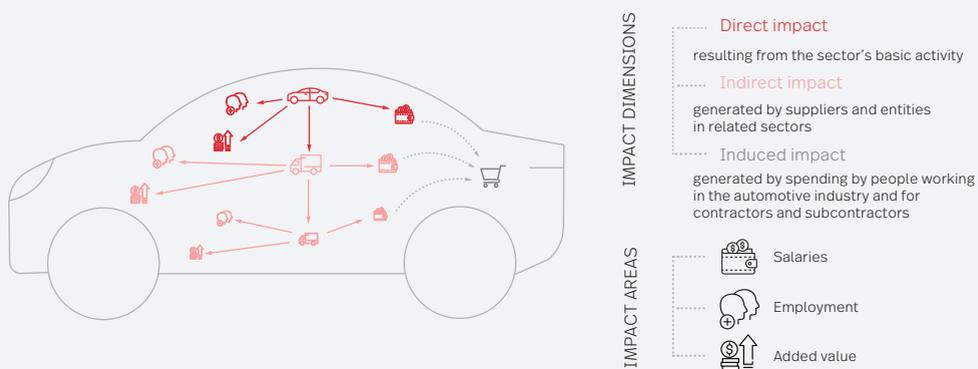
To measure the automotive industry's impact on the V4 economies, Wassily Leontief's Input-Output model was used. It reflects the internal links and relationships between branches of the economy. The model helps examine the industry's impact on its environment, including suppliers and sub-suppliers from various branches of the economy.

The effects generated by the automotive sector were depicted using three variables: value added<sup>4</sup>, employment and salaries. As part of the impact study, three levels of the sector's impact on the V4 economies were distinguished.

Firstly, the study considered the direct impact, which is caused by everyday business, including value added generated, jobs created and salaries increasing household income.

Secondly, it looked at the indirect impact, measuring the automotive industry's effect on contractors, which develop and grow with it, creating more value added, jobs and salaries.

▼ Figure 2. Input-Output model



Source: prepared by the authors.

<sup>4</sup> Added value is also the main component in GDP, where  $GDP = \text{sum of added value from all branches} + \text{taxes on products} - \text{subsidies to products}$ .

Furthermore, people working in the automotive sector and for suppliers and sub-suppliers create internal demand by spending their salaries. This means that the automotive sector influences the growth in household consumption of the V4. Spending on consumption supports GDP growth and the development of other companies. This is known as the induced impact.

## Value added

Value added is one of the key economic indicators when assessing the automotive industry's contribution to economy development in the V4. In terms of accounting, value added is what remains after the value of goods and services used is deducted from the final price. At the macroeconomic level, it is calculated as the difference between the industry's total revenue and the cost of inputs.

# EUR 53.1 bn

in value added generated by  
the automotive sector in the V4

In 2017, direct value added generated by the automotive industry was

- EUR 7.2 bn in Poland
- EUR 9.7 bn in Czechia

→ EUR 3.4 bn in Slovakia

→ EUR 5.0 bn in Hungary

In the industries where the automotive sector purchases equipment, materials and services and in the related industries, it generated value added of

→ EUR 8.2 bn in Poland

→ EUR 6.4 bn in Czechia

→ EUR 2.2 bn in Slovakia

→ EUR 1.1 bn in Hungary

Through cooperation with different branches, enterprises and subcontractors and remuneration paid to them, the automotive industry increased demand in the economy, which resulting in an induced value added in 2017 of

→ EUR 4.1 bn in Poland

→ EUR 4.0 bn in Czechia

→ EUR 1.3 bn in Slovakia

→ EUR 0.5 bn in Hungary

2,10 multiplier effect in V4, which means that one euro of value added in the automotive sector generates an additional EUR 1.10 in the entire economy

→ 2.71 - multiplier effect of added value in Poland

→ 2.07 - multiplier effect of added value in Czech

→ 2.01 - multiplier effect of added value in Slovakia

→ 1.32 - multiplier effect of added value in Hungary



▼ **Figure 3. The automotive impact of Value Added on V4 economies**

Poland



**EUR 19.50 bn**

total value added generated in the economy in 2017 by the automotive industry.

This is equal to the value of Warsaw, Poland's capital.

Czechia



**EUR 20.10 bn**

total value added generated in the economy in 2017 by the automotive industry.

This is equal to 27% of total government spending in Czechia.

Slovakia



**EUR 6.91 bn**

total added value generated in the economy in 2017 by the automotive industry.

This would be enough to fund 56% of the Slovak government's annual budget for social protection.

Hungary



**EUR 6.60 bn**

total added value generated in the economy in 2017 by the automotive industry.

This would be enough to repay nearly 30% of the value of loans taken out by Hungarian citizens.

## Employment

Through the automotive sector's purchases from other industries and the interdependencies between them, the automotive helps maintain existing employment and create new jobs in many sectors.

**1,592,156** – total number of jobs retained in the V4 economies through automotive operations

In 2017, the number of employees in the automotive industry was

- 314,700 in Poland,
- 198,350 in Czechia
- 79,100 in Slovakia
- 101,710 in Hungary.

In the industries from which materials, equipment and services are purchased and in related sectors, the automotive industry created

- 265,132 jobs in Poland
- 201,898 jobs in Czechia
- 65,222 jobs in Slovakia
- 44,695 in Hungary.

By awarding contracts for investments, upgrades and repairs and through cooperation with multiple suppliers and sub-suppliers in related industries, the automotive created

- 150,218 jobs in Poland
- 114,186 jobs in Czechia
- 35,609 jobs in Slovakia
- 21,337 jobs in Hungary.

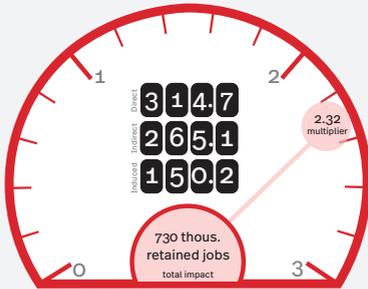
2,29 – total multiplier effect in V4, meaning that one job in the automotive sector creates 1.3 additional jobs in the entire economy.

- 2.32 – multiplier effect of employment in Poland
- 2.59 – multiplier effect of employment Czechia
- 2.27 – multiplier effect of employment Slovakia
- 1.65 – multiplier effect of employment Hungary.



Figure 4. The automotive impact of Employment on V4 economies

Poland

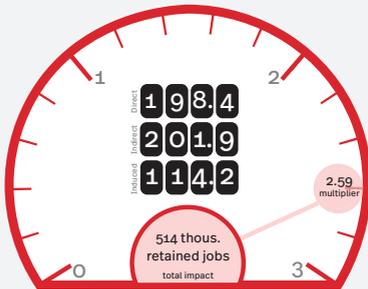


# 730,000 jobs

total number of jobs retained in the economy in 2017 through the automotive industry's operations

This would be enough to hire 71% of unemployed people in Poland.

Czechia

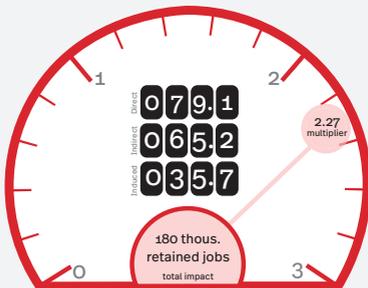


# 514,000 jobs

total number of jobs retained in the economy in 2017 through the automotive industry's operations

This is more than four times the number of unemployed people in Czechia.

Slovakia

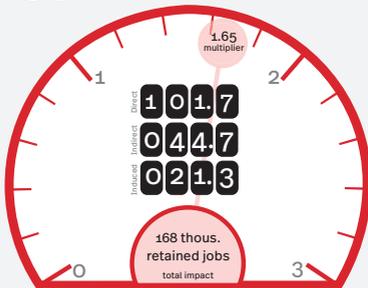


# 180,000 jobs

total number of jobs retained in the economy in 2017 through the automotive industry's operations

This would be enough to hire all of unemployed people in Slovakia.

Hungary



# 168,000 jobs

total number of jobs retained in the economy in 2017 through the automotive industry's operations

This corresponds to 93% of V4 military personnel in NATO.

## Salaries

By employing people and paying them their salaries, the automotive sector increases household income. Salaries are one of the most important measures of household affluence. Hiring staff and having indirect influence over contractors, suppliers and subcontractors, who hire thousands of people and pay their salaries, and through the induced contribution, automotive positively contribute to the generation of additional salaries in other industries in the V4 economy.

**EUR 15.7 bn** total  
value of salaries generated in  
the V4 economy in 2017 through  
automotive operations

Total salaries at automotive companies in 2017 were

- EUR 2.2 bn in Poland,
- EUR 3.0 bn in Czechia
- EUR 1.2 bn in Slovakia
- EUR 1.3 bn in Hungary.

Through procurement with suppliers and economic relations between branches,

contractors, suppliers and subcontractors paid their employees

- EUR 2.1 bn in Poland,
- EUR 2.1 bn in Czechia
- EUR 0.7 bn in Slovakia
- EUR 0.4 bn in Hungary.

Salaries paid directly at automotive companies and indirectly in industries where the sector purchased materials and services increased household consumption. This created new jobs and induced salaries

- EUR 1.1 bn in Poland,
- EUR 1.1 bn in Czechia
- EUR 0.4 bn in Slovakia
- EUR 0.2 bn in Hungary.

2.03 multiplier effect, meaning that one job in the automotive sector creates one additional job in the entire economy.

- 2.45 is multiplier effect of salaries in Poland
- 2.06 is multiplier effect of salaries in Czechia
- 1.83 is multiplier effect of salaries in Slovakia
- 1.42 is multiplier effect of salaries in Hungary.



Figure 5. The automotive impact of Salaries on V4 economies

Poland



EUR 5.39 bn

total value of salaries generated in 2017 by the automotive industry.

This would fully cover annual household spending on package holidays.

Czechia



EUR 6.23 bn

total value of salaries generated in 2017 by the automotive industry.

This would cover annual spending on utilities for every fourth household in Czechia.

Slovakia



EUR 2.27 bn

total value of salaries generated in 2017 by the automotive industry.

This value is the equivalent of building 30 national stadiums (Národný futbalový štadión).

Hungary



EUR 1.82 bn

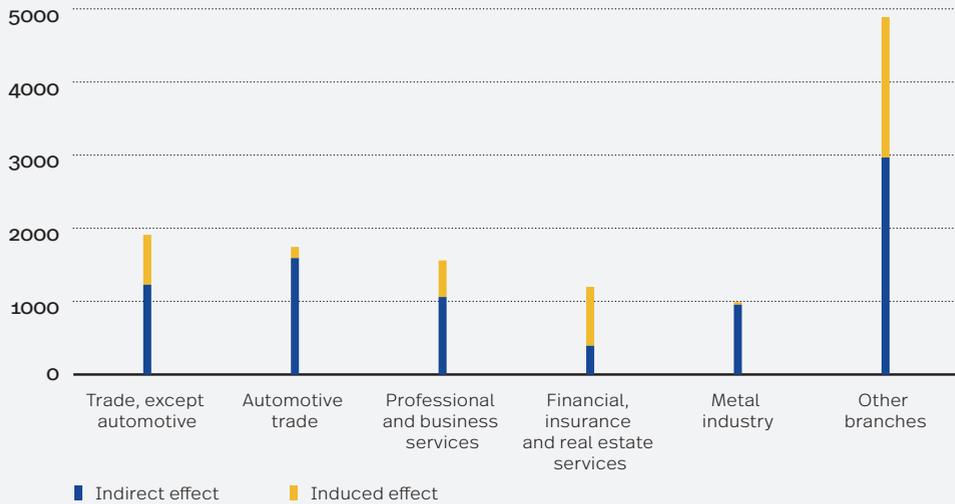
total value of salaries generated in 2017 by the automotive industry.

This would allow every fourth car in Hungary to be replaced with an electric one over 20 years.

## Poland

### Value added

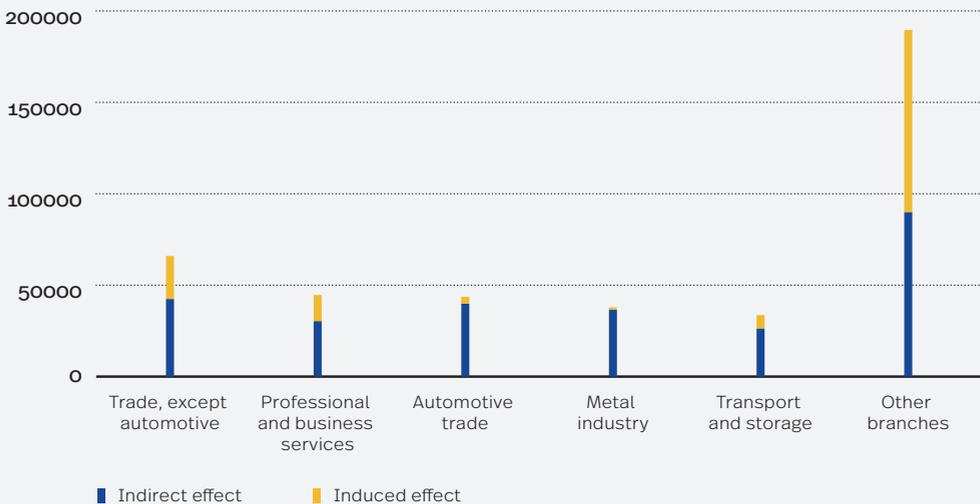
➤ **Chart 15.** Branches with the highest added value generated by the automotive sector's activity (millions of EUR)



Source: analysis by the Polish Economic Institute.

### Employment

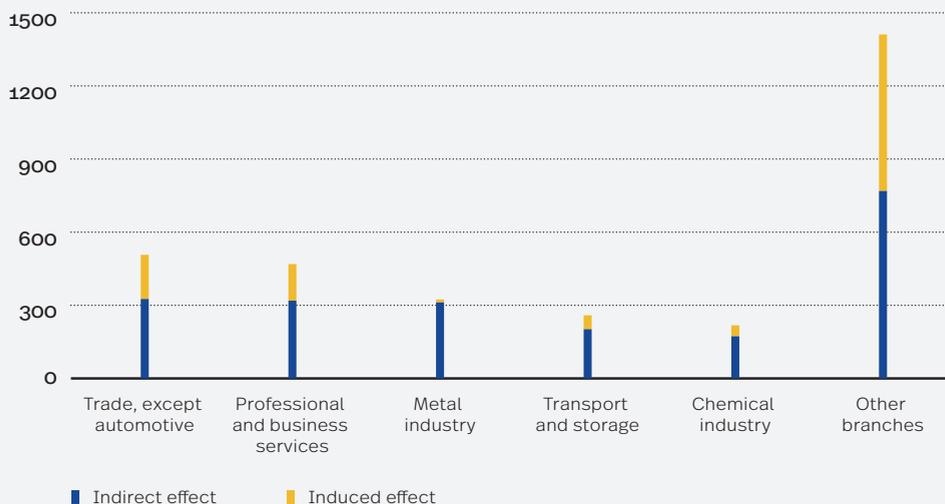
➤ **Chart 16.** Branches with the highest number of jobs retained due to the automotive sector's activity (number of jobs)



Source: analysis by the Polish Economic Institute.

## Salaries

Chart 17. Branches with the highest salary generated by the automotive sector's activity (millions of EUR)



Source: analysis by the Polish Economic Institute.

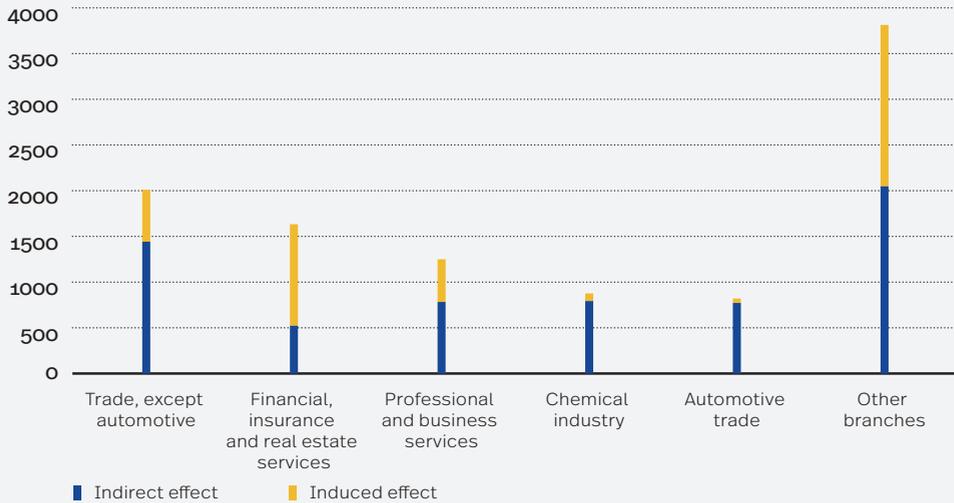
Table 2. Total effects in selected branches

 <p><b>Automotive</b></p> <p>value added: EUR 7.21 bn employment: 314,700 jobs salaries: EUR 2,200.18 m</p>	 <p><b>Trade, except automotive</b></p> <p>value added: EUR 1.91 bn employment: 65,969 jobs salaries: EUR 507.42 m</p>	 <p><b>Automotive trade</b></p> <p>value added: EUR 1.75 bn employment: 43,632 jobs salaries: EUR 212.82 m</p>
 <p><b>Professional and business services</b></p> <p>value added: EUR 1.56 bn employment: 44,611 jobs salaries: EUR 469.53 m</p>	 <p><b>Financial, insurance and real estate services</b></p> <p>value added: EUR 1.20 bn employment: 16,907 jobs salaries: EUR 202.31 m</p>	 <p><b>Metal industry</b></p> <p>value added: EUR 0.99 bn employment: 37,881 salaries: EUR 323.73 m</p>

## Czechia

### Value added

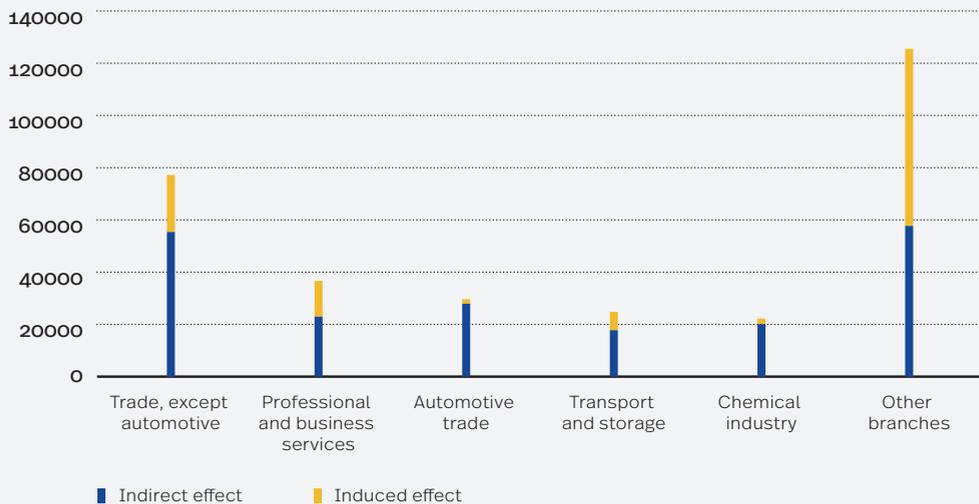
➤ **Chart 18.** Branches with the highest added value generated by the automotive sector's activity (millions of EUR)



Source: analysis by the Polish Economic Institute.

### Employment

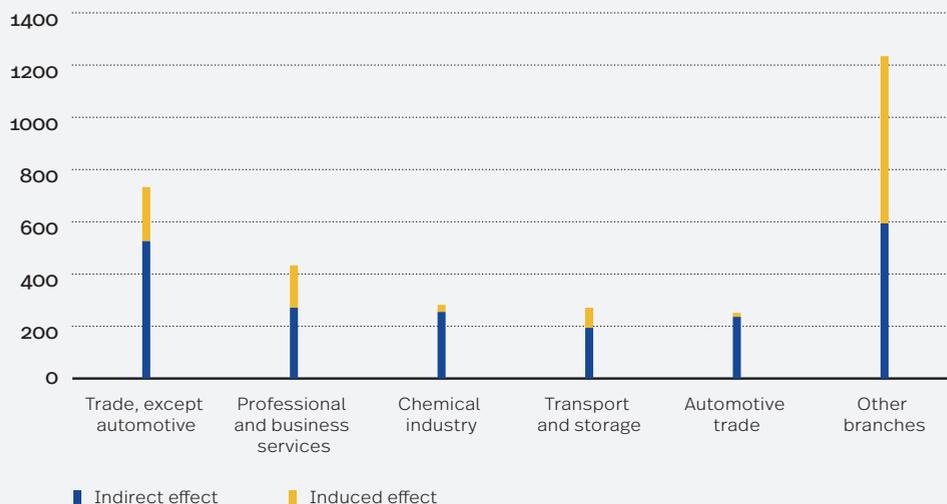
➤ **Chart 19.** Branches with the highest number of jobs retained due to the automotive sector's activity (number of jobs)



Source: analysis by the Polish Economic Institute.

## Salaries

➤ **Chart 20.** Branches with the highest salary generated by the automotive sector's activity (millions of EUR)



Source: analysis by the Polish Economic Institute.

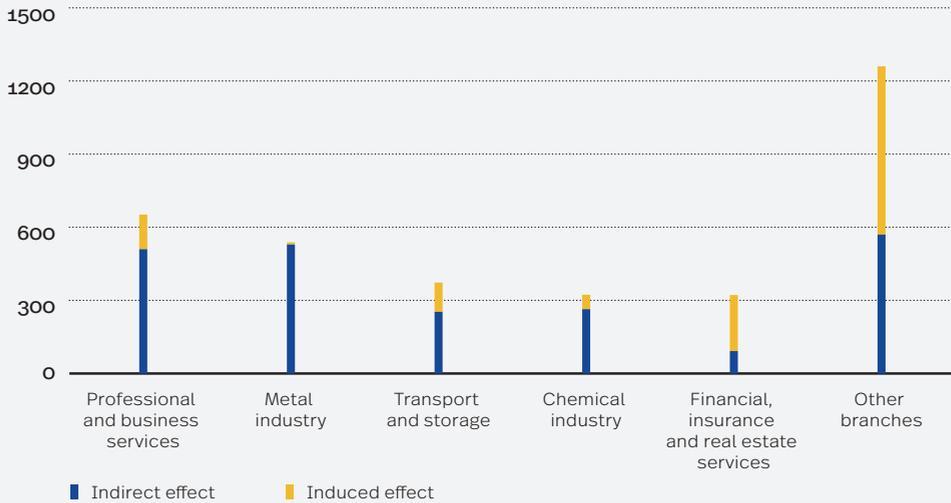
➤ **Table 3.** Total effect in selected branches

 <p><b>Automotive</b></p> <p>added value: EUR 9.70 bn                      employment: 198,350 jobs                      jobs salaries: EUR 3,026.00 m</p>	 <p><b>Trade, except automotive</b></p> <p>added value: EUR 2.01 bn                      employment: 77,200 jobs                      jobs salaries: EUR 732.46 m</p>	 <p><b>Financial, insurance and real estate services</b></p> <p>added value: EUR 1.63 bn                      employment: 14,453 jobs                      jobs salaries: EUR 179.85 m</p>
 <p><b>Professional and business services</b></p> <p>added value: EUR 1.25 bn                      employment: 36,685 jobs                      jobs salaries: EUR 433.36 m</p>	 <p><b>Chemical industry</b></p> <p>added value: EUR 0.88 bn                      employment: 22,215 jobs                      jobs salaries: EUR 282.30 m</p>	 <p><b>Automotive trade</b></p> <p>added value: EUR 0.82 bn                      employment: 29,673 jobs                      jobs salaries: EUR 250.98 m</p>

## Slovakia

### Value added

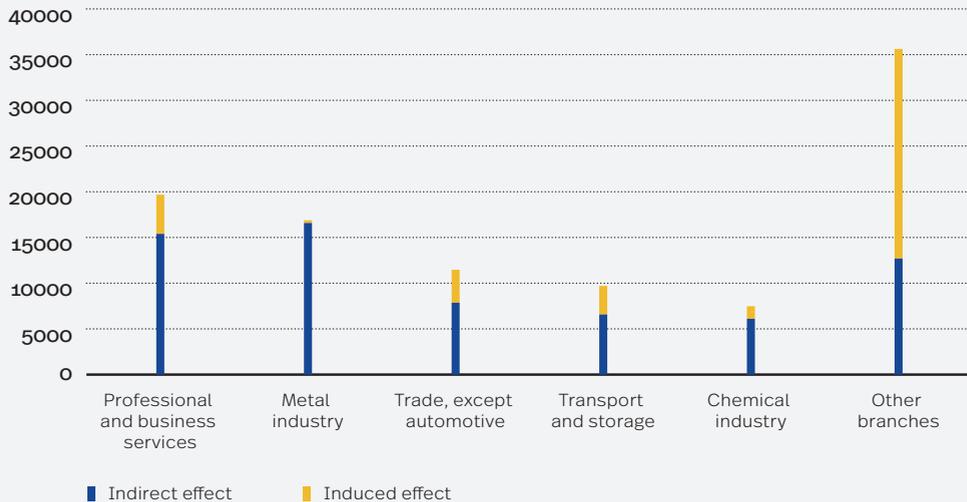
➤ **Chart 21.** Branches with the highest added value generated by the automotive sector's activity (millions of EUR)



Source: analysis by the Polish Economic Institute.

### Employment

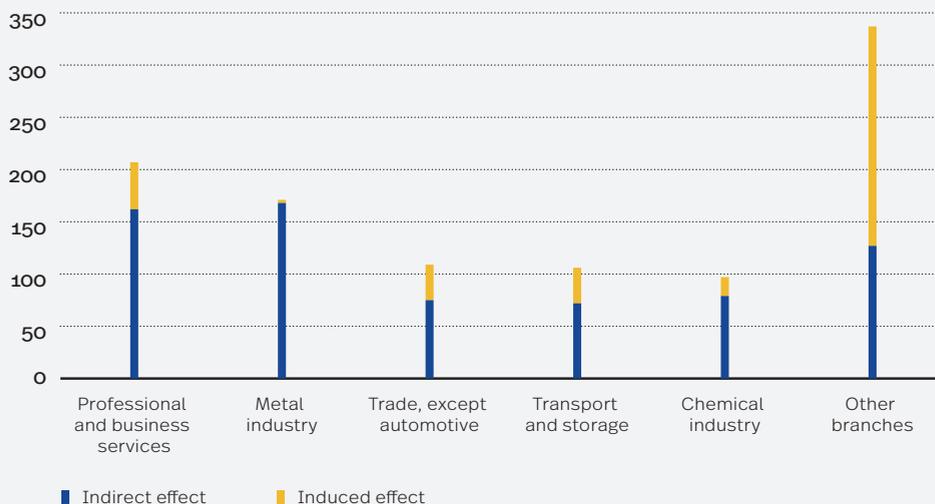
➤ **Chart 22.** Branches with the highest number of jobs retained due to the automotive sector's activity (number of jobs)



Source: analysis by the Polish Economic Institute.

## Salaries

Chart 23. Branches with the highest salary generated by the automotive sector's activity (millions of EUR)



Source: analysis by the Polish Economic Institute.

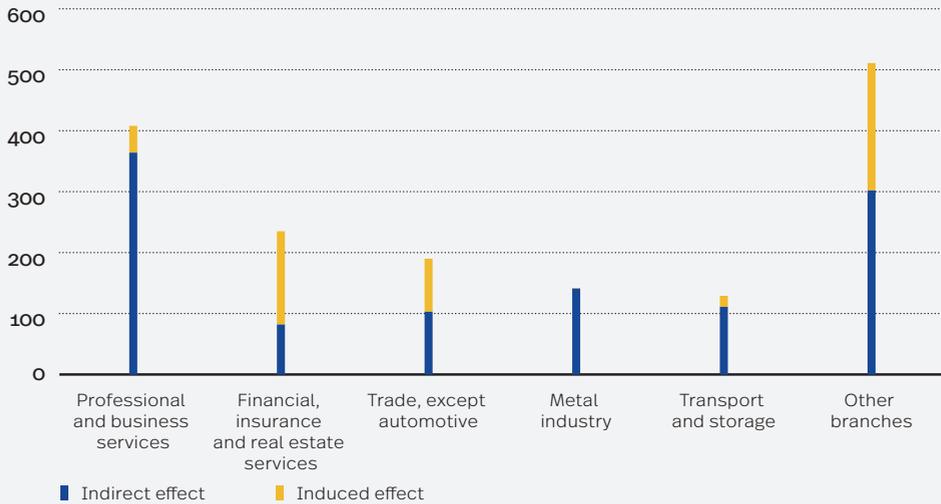
Table 4. Total effect in selected branches

 <p><b>Automotive</b></p> <p>added value: EUR 3.44 bn                      employment: 79,100 jobs                      jobs salaries: EUR 1,240.63 m</p>	 <p><b>Professional and business services</b></p> <p>added value: EUR 0.65 bn                      employment: 19,687 jobs                      jobs salaries: EUR 206.59 m</p>	 <p><b>Metal industry</b></p> <p>added value: EUR 0.54 bn                      employment: 16,883 jobs                      jobs salaries: EUR 171.08 m</p>
 <p><b>Transport and storage</b></p> <p>added value: EUR 0.37 bn                      employment: 9,700 jobs                      jobs salaries: EUR 106.39 m</p>	 <p><b>Chemical industry</b></p> <p>added value: EUR 0.32 bn                      employment: 7,480 jobs                      jobs salaries: EUR 96.44 m</p>	 <p><b>Financial, insurance and real estate services</b></p> <p>added value: EUR 0.32 bn                      employment: 3,086 jobs                      jobs salaries: EUR 41.80 m</p>

## Hungary

### Added Value

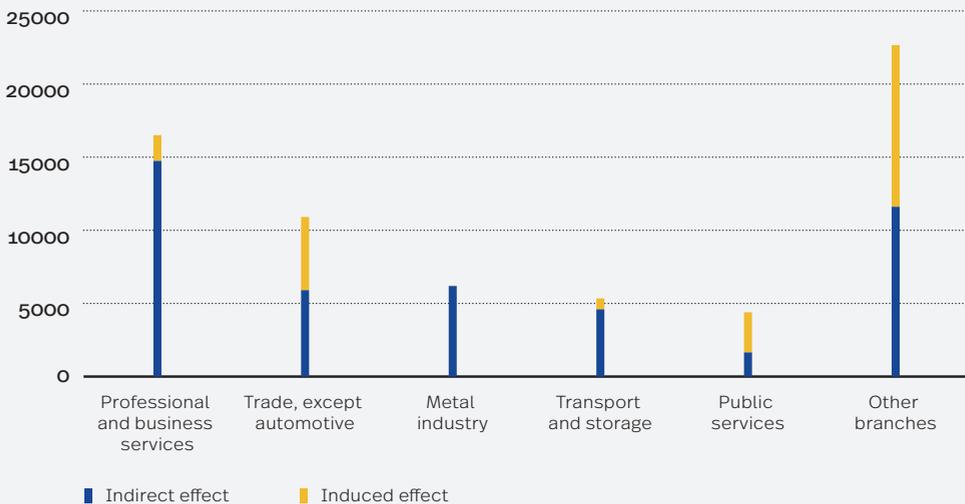
➤ **Chart 24.** Branches with the highest added value generated by the automotive sector's activity (millions of EUR)



Source: analysis by the Polish Economic Institute.

### Employment

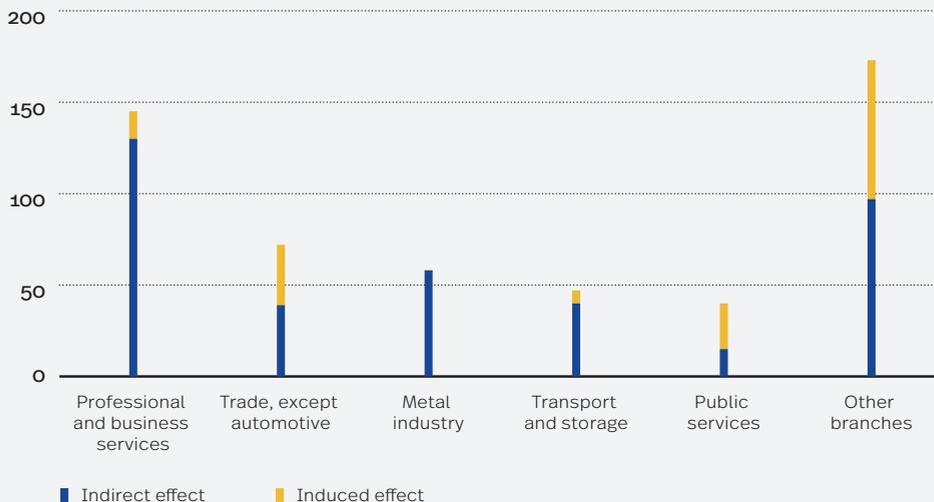
➤ **Chart 25.** Branches with the highest number of jobs retained due to the automotive sector's activity (number of jobs)



Source: analysis by the Polish Economic Institute.

## Salaries

Chart 26. Branches with the highest salary generated by the automotive sector's activity (millions of EUR)



Source: analysis by the Polish Economic Institute.

Table 5. Total effect in selected branches

 <p><b>Automotive</b></p> <p>added value: EUR 4.98 bn                      employment: 101,710 jobs                      jobs salaries: EUR 1,279.70 m</p>	 <p><b>Professional and business services</b></p> <p>added value: EUR 0.41 bn                      employment: 16,504 jobs                      jobs salaries: EUR 145.05 m</p>	 <p><b>Financial, insurance and real estate services</b></p> <p>added value: EUR 0.24 bn                      employment: 2,898 jobs                      jobs salaries: EUR 31.29 m</p>
 <p><b>Trade, except automotive</b></p> <p>added value: EUR 0.19 bn                      employment: 10,910 jobs                      jobs salaries: EUR 72.34 m</p>	 <p><b>Metal industry</b></p> <p>added value: EUR 0.14 bn                      employment: 6,222 jobs                      jobs salaries: EUR 58.04 m</p>	 <p><b>Transport and storage</b></p> <p>added value: EUR 0.13 bn                      employment: 5,344 jobs                      jobs salaries: EUR 46.74 m</p>

# The Visegrad (V4) countries' automotive industry in global value chains

Manufacturers involved in production (value) chains in the automotive industry can have backward and forward links in the value chain. Backward links mean that the producer receives parts and components used to assemble cars. Forward links mean that the producer supplies parts and components to manufacturers in other countries. The World Input-Output Database (WIOD Release 2016) was used to assess the V4's position in global value chains in the automotive industry<sup>5</sup>.

## Backward links in the value chain

One indicator allowing backward links in the value chain to be assessed is the foreign value added (FVA) content of exports. This indicator reflects the degree to which automotive exports are generated by value added created in other countries.

In 2000-2014, the share of FVA in the export of automotive products (motor vehicles, parts and accessories) from all the V4 countries increased. It grew the most in Czechia and Poland (by 11.3 pps) and less in Hungary and Slovakia, by 9.5 pps and 8.1 pps respectively (chart 27).

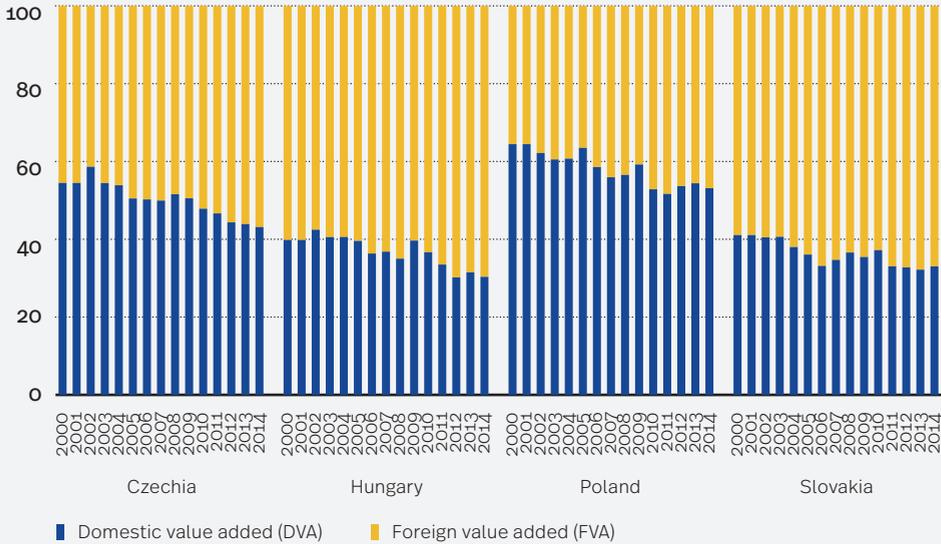
In Poland, FVA in automotive exports rose at the fastest pace before EU accession and in

the first years of membership. It stemmed from investment by automotive corporations in the manufacturing of motor vehicles based on imported parts and accessories, given the relatively low development of the Polish industry producing these. After EU accession, Poland was unable to attract investment for the construction of a vehicle production plant until as late as 2014<sup>6</sup>. Instead, it specialised in attracting investors for the production of auto parts and components, as manufacturing them created more domestic value added than car assembly. As the output of parts and components increased, their export increased. This resulted in a marked fall in the growth of foreign value added in Poland's automotive exports in the period since EU accession; in 2011, the trend was even reversed. Between 2011 and 2014, the share of foreign value added dropped by nearly 1.5 pps. In 2014, foreign value added accounted for 46.9% of Poland's automotive exports, the lowest percentage among the V4 countries. In Hungary, FVA represented almost 70% of its automotive exports, in Slovakia 67% and in Czechia nearly 57%. Hungary and Slovakia therefore had the strongest backward links in the value chain in the automotive industry. Exports from these two countries were strongly dependent on imported foreign content.

<sup>5</sup> The research method is described in the Appendix 1.

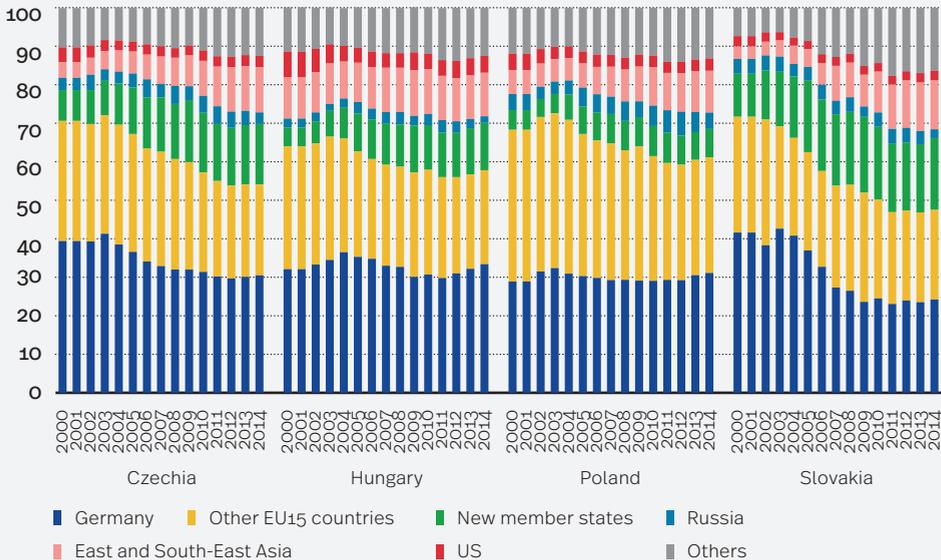
<sup>6</sup> After Poland joined the EU, the first vehicle production project was Volkswagen's investment in a plant manufacturing Volkswagen Crafter delivery vans near Września.

Chart 27. V4 automotive exports by origin of value added, as a percentage of gross exports



Source: Authors' calculations based on WIOD Release 2016.

Chart 28. Foreign value added in V4 automotive exports by country of origin, as a percentage of foreign value added



Source: Authors' calculations based on WIOD Release 2016.

The geographical composition of the foreign value added of automotive exports in the V4 countries was largely determined by the direction of FDI into the industry. The greatest contribution came from the EU15, mainly Germany (chart 28). German Volkswagen carried out several investment projects in the V4 countries in the manufacture of passenger cars, delivery vans and lorries, buses and engines, largely based on the import of German parts and components. Other major suppliers of imported inputs for automotive exports included France, Italy, Britain, Austria and Spain.

Between 2000 and 2014, the new member states' share in the creation of the foreign value added content of automotive exports from all the V4 countries increased. The highest proportions were in Czechia and Slovakia. This resulted from the intensive cooperation of automotive undertakings operating in the Czech and Slovak border regions, connected with the car assembly plants in Kolín and Nošovice in Czechia, as well as Trnava and Žilina in Slovakia.

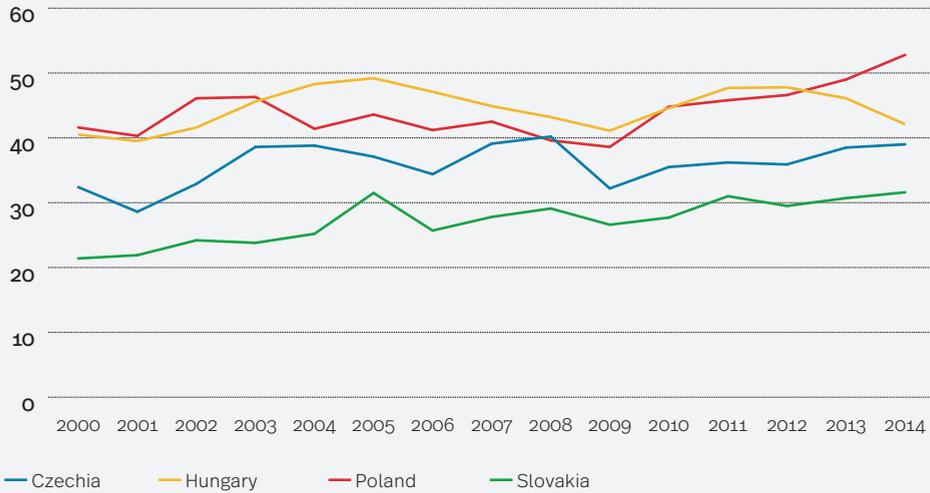
During the period in question, there was a distinct increase in the share of foreign value added content from East Asian countries, primarily Japan and South Korea, in Czech, Slovak and Polish automotive exports. This resulted from Japanese and Korean investments in these countries' automotive industries (e.g. the Kia and Hyundai factories in Slovak Žilina and Czech Nošovice). At the same time, the relatively high share of the foreign value added content from East Asia and South-East Asia in Hungarian automotive exports resulted from investments such as the launch of manufacturing Japanese Suzuki vehicles in Esztergom in 1992.

## Forward linkages in the value chain

Forward links in a country's value chain can be assessed by looking at the domestic value added created in the automotive industry and contained in other countries' exports relative to exports of domestic value added generated in the industry. It reflects the degree to which the value added created in a country's automotive industry is then absorbed in production and exported by other countries. Between 2000 and 2014, the indicator rose in all the V4 countries, although it fluctuated frequently (chart 29). It grew the most in Poland, by more than 11 pps. This means that, over this period, Poland strengthened its forward links in the automotive industry (i.e. towards recipients of parts and components) the most. The indicator rose particularly strongly after 2009 due to Poland's continuous specialisation in the manufacturing and export of auto parts and components. In 2014, as much as 52.8% (the highest percentage among the V4 countries) of Polish value added created in the automotive industry and exported from Poland was re-exported by other countries. The remaining part of exported value added was the value added contained in final goods – cars, absorbed in the country of destination.

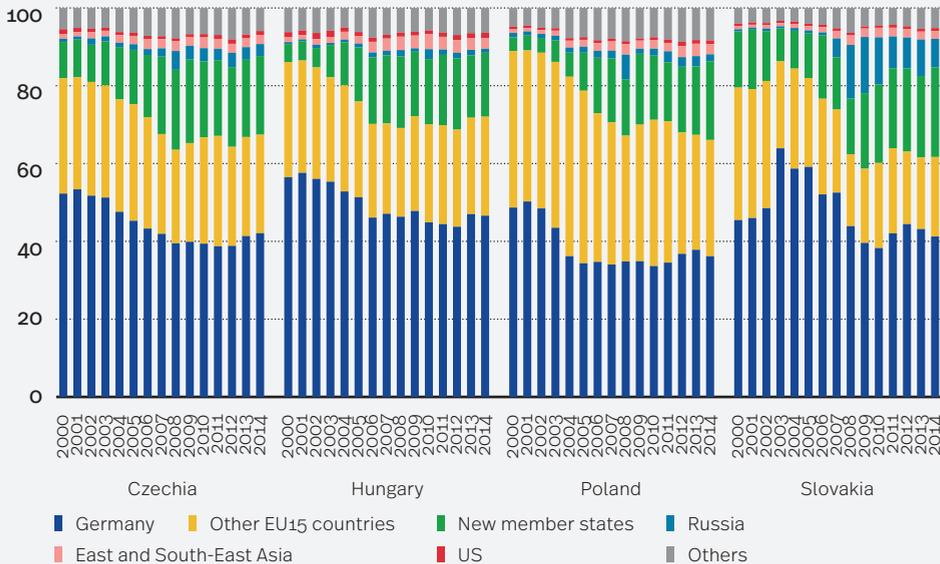
The largest recipient and re-exporter of the value added created in the V4 automotive industries was Germany. In 2014, its share ranged from 36% in Poland to 47% in Hungary (chart 30). Other countries from the EU15 also played a significant role, especially for Poland. Polish value added was contained in the exports of countries such as France, Britain, Italy and Spain. During this period, the value added created in the V4 countries was increasingly exported by the new member states.

Chart 29. Domestic value added created in the automotive industry and contained in other countries' exports relative to the export of domestic value added generated in the industry (%)



Source: Authors' calculations based on WIOD Release 2016.

Chart 30. Share of countries/country groups in export of value added created in the V4 automotive industry (%)



Source: Authors' calculations based on WIOD Release 2016.

## Summary

Assessing the benefits of participating in global value chains in the automotive industry must not be limited to the value of automotive exports. It should also account for the domestic value added content of those exports. In this regard, Poland ranks first among the V4 countries. In 2014, Polish value added accounted for more than 53% of Poland's automotive exports. Moreover, the domestic value added content has been on the rise since 2011.

The high domestic value added content of Polish automotive exports results from Poland's specialisation in previous years in attracting investors to the auto parts and components industry; manufacturing them creates more

domestic value added than car assembly. This type of specialisation would have been impossible without the investments by automotive corporations in vehicle assembly plants in Poland's southern neighbours. Polish producers have become major suppliers of parts and components for those factories.

Poland's stronger – compared to the other V4 countries – forward links in the automotive value chain present opportunities to increase the benefits of participation in GVCs. By supplying parts and components to a foreign assembly plant (e.g. in Germany, Czechia or Hungary), Polish value added can form part of a car exported to a third country (such as China or the US).



# New trends in the Automotive Industry

The analysis in the chapters above shows that the automotive industry plays an important role in the V4 countries' economies. Several megatrends are radically transforming mobility and should be seen as a significant challenge for traditional producers and their sub-suppliers. They are:

- the adoption of electric vehicles,
- the growing popularity of shared mobility,
- the advent of autonomous cars.

## Electric vehicles

Environmental concerns have made international organisations and governments push for the increased use of electric vehicles. In 2018, 2.1 m electric cars were sold, 64% more than in 2017. Their share in the global light vehicle market was 2.2%. Two-third were Battery Electric Vehicles, while one-third had Plug-in Hybrid Electric Motors. China accounts for 56% of sales and 63% of growth in the sale of EVs. European countries with high sales of EVs are Norway, Germany, Britain, France, Sweden and the Netherlands (Electric Vehicles World Sales Database).

Among cars with alternative engines, hybrids remain the most popular. Plug-in cars and fully electric vehicles are less popular. However, their sales are constantly rising, probably due to support mechanisms introduced by many governments, including in Britain, Denmark, China, Norway and Japan (ARP).

The successful adoption of electric vehicles hinges upon:

- stricter emission regulations,
- lower battery costs,

widely available charging stations

- governments' support policies.

According to several projections, electric vehicles could account for 10-50% of new vehicles sold by 2030.

## Carsharing

A shift in consumer habits is giving a rise to "shared mobility". In this model, cars are no longer bought; instead, they are used on demand.

In 2015, China and the US were the two largest markets for shared mobility, at USD 24 bn and USD 23 bn respectively. The European market was worth USD 6 bn. Shared mobility could grow by 15-28% per year in 2015-2030 (McKinsey, 2016).

For now, shared mobility accounts just for a fraction of total miles travelled. Limitations include the lack of shared mobility in rural settings. Moreover, carsharing currently seems to be the more expensive option, compared to carpooling. Still, shared-mobility solutions make sense for traveling to social events in urban areas.

## The rise of autonomous cars

The rapid growth in artificial intelligence, machine learning etc. will make it possible to develop autonomous vehicles in the near future. Autonomous cars will not require a driver's license or human intervention, so traveling by car will become accessible to new groups of people, such as people with disabilities.

Eliminating the cost of the driver is the major benefit offered by autonomous vehicles; roughly 45% of the costs of operating an

e-hailing (a model of carsharing) vehicle relate to the driver. According to McKinsey, up to 50% of passenger vehicles sold in 2030 will be highly automated and 15% fully autonomous, provided that regulatory challenges are overcome, technical solutions are fully developed and consumers are enthusiastic about the new technology (McKinsey, 2016).

### What do these trends mean for the automotive industry?

New trends in mobility will affect the traditional automotive industry in the following ways:

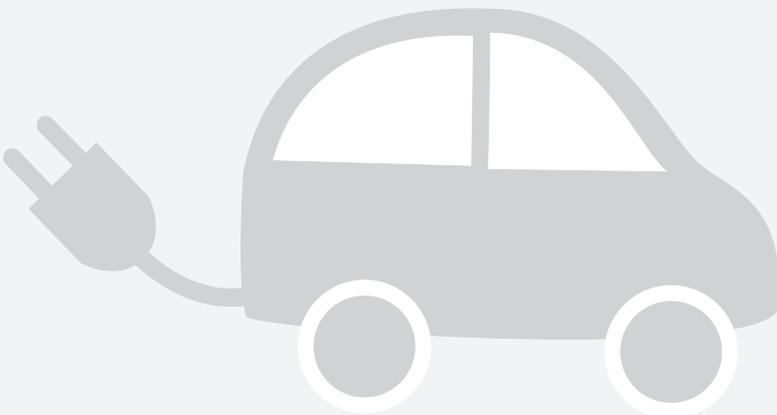
Traditional producers and their sub-suppliers will have to fight declining margins, while being forced to invest significantly in new technologies and solutions following new market trends.

Electric cars are much simpler than combustion cars: they contain half the number of elements (4000-5000) in a traditional car (around 9000). The development of electromobility could significantly reduce demand for parts, which might particularly affect the V4 countries.

The technological advancement of new cars could result in new players entering the automotive market, which further intensifying competition.

The new automotive trends make software a key differentiating factor. It could be a major challenge for traditional sub-suppliers, involving developing new competencies.

Increased investment and cost pressure will only be mitigated by the shorter life cycle of the cars used as part of shared mobility.



# Appendix 1. The Visegrad (V4) countries' automotive industries in global value chains – research method

This study was carried out using data from the World Input-Output Database (WIOD Release 2016), containing global input-output tables for 2000-2014 (44 countries and 56 sectors). Based on these, calculations were made using the input-output (IO) model. The basic equation is:

$$x = Ax + f,$$

where:

$x$  denotes the  $CG \times 1$  vector of gross output (with  $C$  the number of countries and  $G$  the number of sectors considered),

$A = [a_{i,j}^{r,s}]$   $\begin{matrix} r,s=1,\dots,C \\ i,j=1,\dots,G \end{matrix}$  denotes the  $CG \times CG$  matrix of technical input-output coefficients (costs) with each element denoting the input used in a particular industry in one country per unit of gross output,

$f$  denotes the  $CG \times 1$  vector of final output ( $C = 44$ ,  $G = 56$ ).

Transformations result in the equation referred to the Leontief model:

$$(I - A)x = f,$$

where:

$(I - A)$  denotes the Leontief matrix transforming the vector of gross output  $x$  into the vector of final output  $f$ ,

and subsequently in the following equation:

$$x = (I - A)^{-1}f = Lf,$$

where:

$(I - A)^{-1} = L$  denotes the  $CG \times CG$  matrix of material-intensity (or additional demand) coefficients, also referred to as the Leontief inverse.

To calculate the participation rate of a country in global value chains, the value-added trade flow matrix  $T$  was used, in the following form:

$$T = vLe^*$$

where:

$v$  denotes the  $2464 \times 2464$  matrix containing diagonal value added coefficients, i.e. value added created per unit of gross output,

$e^*$  denotes the  $2464 \times 2464$  matrix containing diagonal exports of individual countries by sector.

For three countries and one industry, the matrix of value added flows  $T$  formulated in the equation above is as follows:

$$T = \begin{pmatrix} v^1 L^{11} e^{1*} & v^1 L^{12} e^{2*} & v^1 L^{13} e^{3*} \\ v^2 L^{21} e^{1*} & v^2 L^{22} e^{2*} & v^2 L^{23} e^{3*} \\ v^3 L^{31} e^{1*} & v^3 L^{32} e^{2*} & v^3 L^{33} e^{3*} \end{pmatrix}.$$

This matrix allows us to assess both the origin of the value added contained in the exports of each country (and industry) and the distribution of the value added across countries. To determine the composition of exports by the country of origin of value added, we need to look at the columns in the matrix above; the directions of the distribution of value added in the exports of countries of destination are shown in the rows. Exports are composed of domestic value added and foreign value added.

The first column of matrix  $T$  includes elements describing the country of origin of the value-added content of exports of country 1. For example,  $v^1L^{11}e^{1*}$  denotes the value added created in country 1 that the country then exports to foreign markets. In turn,  $v^2L^{21}e^{1*}$  is the value added created in country 2 and contained in the exports of country 1. This is similar for  $v^3L^{31}e^{1*}$ . The value of domestic content in individual countries' exports can be seen on the diagonal of matrix  $T$  ( $v^1L^{11}e^{1*}$ ,  $v^2L^{22}e^{2*}$ ,  $v^3L^{33}e^{3*}$ ). The sum of elements in each column is equal to specific countries' gross exports.

The first row of matrix  $T$  (with the exception of  $v^1L^{11}e^{1*}$ ) shows which part of the value added exported by country 1 is re-exported by country 2 ( $v^1L^{12}e^{2*}$ ) and country 3 ( $v^1L^{13}e^{3*}$ ). In the literature, these are referred to as indirect value added exports. On a global scale, the sum of foreign content in particular countries' exports must be equal to the sum of particular countries' value added in third countries' exports (i.e. to the sum of indirect value added exports).

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