

German Automakers in Lead of Innovation Excellence

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Abstract

This paper presents the innovation performance of German automakers and the automotive industry. The importance of this industry for economic growth, employment, sustainability and for Germany as an appropriate location for industry will be pointed out. The need for research and innovation (R&I) can be derived from that, because innovativeness is the basis for the lead. The research question deals with the innovation excellence as a booster for success and profitability as well as the reason for a high impact on economy. The innovativeness of the automotive industry will be demonstrated with selected figures. Important aspects of innovation management will be explained. Methodologically, empirical, analytical and theoretical approaches are used. Statistical data, topical literature, surveys, and logical conclusions will lead to justified arguments.

It can be stated that the German automotive industry provides an important contribution to the economy in terms of spending money for R&I, employment, investment and expenses for buying parts from suppliers on the input side. On the output side however profitability is created through new products with higher value and higher sales volume at lower cost position. So innovation helps to increase prosperity of companies, employees and economy.

Keywords: automaker; excellence; innovation; research; lead

1. Introduction

Innovativeness is the basis for competitiveness, profitability and sustainability of companies. The need for research and innovation (R&I) is driven by shortened product life cycles, increasing rivalry on the markets rising and competitive pressure. Furthermore there are strong signals readily identifiable, which notify a radical technological and structural change going along with a downturn in the automotive industry. In addition to that the Corona pandemic disease compelled a shutdown of complete car factories in Germany.

To start with, the current state of the performance and the outcome of innovation efforts will be highlighted using selected figures of the output side. Secondly, specific issues of innovation management will be highlighted and substantiated with empirical data. Last, but not least statistical performance data indicating serious purpose of innovation management on the operational side will be displayed.

The contribution to science is to demonstrate the outstanding innovation performance of German automakers and where it comes from. These factors of success should be focused to guide this industry through adverse conditions.

Companies are generally in need of new products to attract customers. Research and innovation management is the source, where innovations come from to find their way into

innovative products (Hofbauer & Sangl 2018). The more attractive, the more are customers willing to pay for. This is the only way to differentiate from competitive offers. The same principle applies to industries and national economies. Innovativeness is a mandatory prerequisite for growth and sustainability of companies in competitive markets (Hofbauer et al. 2009). Innovations are also crucial for the competitiveness of countries and thus determining the standard of living of the people and wealth of nations (Hofbauer & Sangl 2017).

The German automakers are highly innovative, accordingly there is a high competitiveness and profitability to be noticed. But experts can already observe strong signals of structural and technological change. There is little doubt that the German automotive industry is heading into problems. These problems could lead into a severe crisis of German economy. Worldwide sales volume of the automotive industry dropped 5% at mid-year 2019. The domestic market in Germany declined by 9.3% in 2019. German car manufacturers lost 20% of export in the two most important markets China and the US (Kröger 2019). The forecast for 2020 indicates a decline as well. Due to Corona pandemic and a complete shutdown there was a decline of 20% in the first quarter 2020 compared to first quarter of previous year. Automakers and suppliers had to react and already dismissed people and announce more layoffs for 2020.

For the time being there are numerous challenges like electrical and digital revolution, strict engine exhaust regulations, diesel scandal and moreover the imminent threat of an economic downturn. Global trade wars on the markets, driving bans in cities, insufficient electrification infrastructure and missing conviction of customers about e-mobility deteriorate the situation on the demand side. Summing up there are huge challenges coming up and the automakers have to react in a proper way to achieve quickly competitiveness in these new areas. Otherwise a downfall of this important industry may be the consequence, if the innovativeness won't be sustained. There are a lot of urgent tasks, and automakers need support and money for innovation. R&I-budgets are immediately needed for alternative fuel, for optimization of conventional power drives and extension of electrical mobility as well as for the digitalization of the factory and the car itself. Furthermore competitors from other industries like google, amazon, apple, uber are going to penetrate the mobility market and attack traditional automakers. They earned a lot of money in their respective businesses and the cash reserves are in search of new business opportunities in mobility areas. Their capital strength is a major advantage to cover huge budgets for research and innovation (R&I).

The reasoning for this article is to analyse and present the innovativeness of German automakers and their suppliers. From this follows the question of research: Is there an outstanding innovativeness of German automakers? In order to answer this question quantitative and qualitative arguments will be used. Statistical data will demonstrate measures and comparisons, which help to answer properly the question of research.

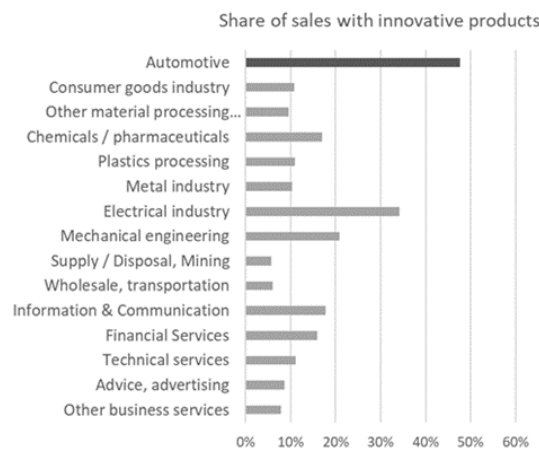
The benefit of this paper is the presentation of the German automakers combined with a singular systematic matching of innovativeness and impacts of innovation application. The purpose is to identify the essential sources for innovativeness and success and the relation to the outcome of innovation activities. Comparisons with other industries will be made in order to prove the question of research.

2. Initial Situation and Outcome of Innovation Performance

The outcome of innovation performance shows various results of innovation activities. Regarding quantitative reasoning about output factors, there are sales volumes, respectively share of sales with innovative products, advantages concerning cost reductions and protection

of intellectual property in terms of patents. One of the most convincing fact is that the sales structure of German automakers industry accounts for nearly 50% of innovative products. Exactly 49.6% of total sales with roundabout 423 bn EUR is achieved with innovations. This is a noteworthy output of invested innovation input. In German industry in total only 15.5% of total sales volume is generated with innovations, the remaining 84.5% of sales volume on industry average is generated with established products. The comparison in figure 1 shows the share of sales with innovative products for the different industries in Germany. As already lined out, the automotive industry has a share close to 50%. Here the automotive industry is in the lead with a big gap to the electrical industry as the second one.

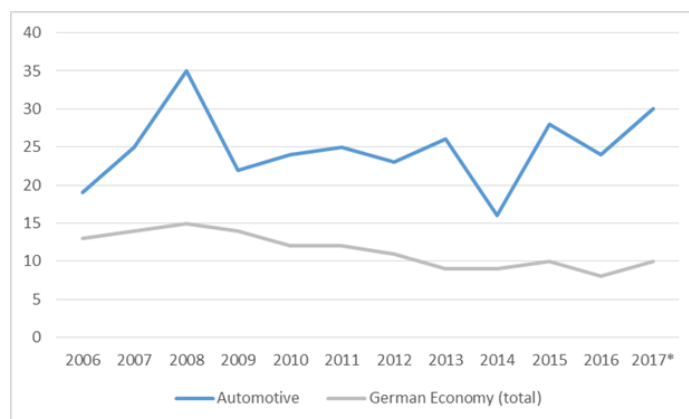
Figure 1: Share of sales with innovative products for different industries



Source: ZEW 2019b

Innovativeness is required for profitability. Thus not only the cash inflow from the sales volume is important, but also the cost position and corresponding expenses. Companies have to monitor their cost position very detailed and strive for cost reductions. This is why huge amounts are spent to achieve cost reductions. Figure 2 displays the proportions of innovation-related cost reductions for automotive industry and German economy in total.

Figure 2: Proportions of innovation-related cost reductions (%)



Source: ZEW 2019a

This fact underlines the significance of innovation management for the competitiveness. The value added of innovative products should be increased and the cost position should be reduced. The spread in between is called margin and this in turn is a reliable indicator for profitability.

Further important outcomes of innovation activities are knowledge and know-how. Therefore the number of patent applications is a suitable indicator for successful R&I. The patent applications in Germany showed an increase from 59.444 up to 67.895 from 2010 until 2018 (DPMA 2019). Thereof 12,273 applications arose from the transport sector in 2018. This was a plus of 5.8% in comparison to previous year.

The numbers indicate a rising innovation activity as well as an increasing technological progress comparably increasing with technological value added. Patents help to protect the know-how of a company and this support to gain competitiveness is an important precondition for value creation. The top 3 automotive companies for patent application in Germany were (DPMA 2019): Robert Bosch GmbH with 4,230, Schaeffler Technologies AG & Co. KG with 2,417, and Ford Global Technologies, LLC with 1,921 applications.

The innovation index of the top 5 automotive companies worldwide (Center of Automotive Management 2018) shows on the first place Volkswagen with an index of 195, followed by BMW Group with 115, Daimler with 101, Toyota with 62 and on fifth place Tesla with 58. The index is a composite of degree of innovation, originality, customer value and level of maturity.

All these indicators and arguments demonstrate a high level of innovativeness for the German automotive industry. These facts support the thesis that the automakers are in lead and far ahead of other industry sectors in Germany and abroad. The statements also indicate that the German automakers are definitely committed to active research and innovation and prepared for global growth. The key points of success are: perfectly managed innovation processes, executed in cooperation with external innovation partners and to apply immediately for patents to protect intellectual property. Thus it can be summarized, that the results of innovation activities of German automakers are well above average.

3. Problem Definition and Question of Research

The scientific problem of this article can be defined as how to detect and identify innovativeness. Innovativeness is inevitable for the sustainability of companies. There are various indicators to measure innovativeness. The Global innovation index 2019 shows the rankings of the most innovative countries worldwide (World Intellectual Property Organization 2019). The scores are determined through factors like business sophistication, level of human & capital research and creative outputs. The rankings show Switzerland on the first place with a score of 67.24, followed by Sweden (63.65) and the US (61,73). Germany is ranked on 9th place with a score of 58.19 (100 = most innovative).

A more detailed insight is provided on the level of branches and companies. R&I management is one of the most important entrepreneurial functions. The outcome in terms of new products or applications are essential requirements for prosperous enterprises. An innovative enterprise may be characterized by means of: targeting global growth, entering new markets, new product introduction, development of additional benefits, increase of market share as well as enlargement of sales and profit (Hofbauer & Sangl 2018). Innovations substantiate competitive advantage (Hofbauer et al. 2009).

Empirical studies of successful and leading companies show that there are some core elements required for success. These issues can enable and enhance innovativeness (Sangl & Hofbauer 2017). Excellent process management is basic amongst others. The following elements are supposed to be critical for their outstanding performance. They can be characterized as strategic or operational (Frietsch et al. 2015): The strategic issues are commitment to active research and innovation and striving for global growth as a corporate goal. On the operational side there are excellent process management, scheduled knowledge management, systematic scientific cooperations, and efficient patent application for know-how protection.

But there are also various obstacles, which prevent to exercise promising strategies and to execute successful operations. The reasons are twofold: external and internal causes. External impacts are caused by different players and circumstances, like competitors, customers, suppliers, economic situation, technological change, legislation, standardization requirements or others. The companies in a specific industry sector have only limited possibilities to influence or even change these parameters coming from outside the company. They have to react properly and adapt their strategies and business operations due to the changed constellation. Basic management literature and scientific investigations advise to detect and identify weak signals at the right time and to respond before problems arise. Currently there are obvious signals to observe for the German automakers. Internal actions and parameters of performance however can be influenced and controlled by the companies in own responsibility. The companies have to develop competitive strategies and optimize their business operations according to the market and environmental constellation. Based on the innovativeness this means mainly the ability to perfectly manage the innovation process. It is a matter of fact that innovations are unique and always associated with risk and expenditures when they are developed and introduced for the first time. But innovations are the decisive prerequisite for growth and sustainability of companies in present and future markets. Therefore the innovation management processes should systematically initiate and support R&I (Hofbauer & Sangl 2018). In order to do this, a systematic innovation management process is required (Hofbauer & Wilhelm 2015). On the one hand it needs a creative environment to generate various promising innovative and productive ideas. And on the other hand a precisely managed innovation management process is an essential prerequisite for successful realization.

With regard to assumed innovativeness of German automakers, the analysis is about the dimensions of innovation input and outcomes. The basic hypothesis of this paper is, that the German automakers are far ahead of average with respect to innovation management and corresponding results. Thus the main question of research can be formulated as follows: Do the German automakers have an exceptional innovativeness? And in case that this question is approved, the causative question is about the reasons of extraordinary innovative performance.

This article pays attention to the research question under consideration of above mentioned key points. In case of provided evidence of innovativeness, a strong recommendation will be given to support a leading innovation position in times of radical change, discontinuities, downturn and rising competition.

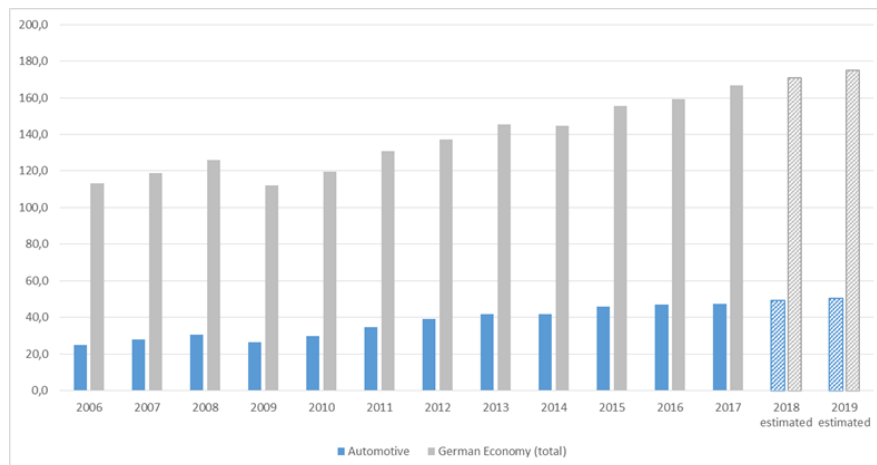
Chapter 4 will show empirical data of selected practices of innovation management in the automotive industry.

4. Reasoning of Innovativeness of German Automakers

Innovations in terms of products and services are essential for competitiveness and profitability. The analysis of the innovation activities of the German automakers show that there is a substantial and considerable outcome in terms of sales volume, share of sales with innovations in comparison to other industries as well as patent applications. On the other side there also must be huge and extensive factor allocations on the input side. Both sides of German automakers have a significant impact on companies and economy (Hofbauer & Sangl 2018a).

The meaning of innovation activities will be displayed in terms of facts and figures. Large budgets are invested in the search of innovations and there is a huge impact of new products on the profitability and competitiveness of an enterprise. The overall expenditures of the German automakers for innovation are displayed in figure 3. The short bars show the expenditures of German automakers for each year. The long bars show the figures of the German economy in total. The scale and all numbers are in bn EUR. After the crisis in 2009 one can see a steady increase of the expenditures. From 2011 onwards the progression of the automotive industry (short bars) was above average of the German industry in total.

Figure 3: Innovation expenditures of German automakers (bn EUR)



Source: ZEW 2019a

The meaning of innovation activities will be displayed in terms of facts and figures. Large budgets are invested in the search of innovations and there is a huge impact of new products on the profitability and competitiveness of an enterprise. The total innovation expenses for German enterprises amounted in total 166.9 bn EUR in 2017. These figures show that the innovation expenses are a serious economic factor, though representing only a fraction of 3.14% of total sales. The forecast is estimated with an increasing tendency up to 172.5 bn EUR (2018) and 175.9 bn EUR (2019) (ZEW 2019a).

A closer look on all companies in Germany provides more insight about activities. In total there are 106.700 innovative companies identified. This counts for a share of 36.0% of all industrial companies. Table 1 shows also figures about product and process innovation as well as novelties and cost reduction.

Table 1: Innovators in Germany (bn EUR)

	in 1.000	percentage
Total number of companies	296.6	100.0
Companies with innovation	106.7	36.0
... with product innovation	74.4	25.1
... with process innovation	71.2	24.0
focus on novelty	22.2	7.5
focus on cost reduction	29.9	10.1

Source: ZEW 2019b

The results of these innovation activities for German companies show a huge impact of innovation activity on economy (Hofbauer & Sangl 2018a). In 2017 total sales with innovative products scored the amount of 822.5 bn EUR, this figure increased 14.5% compared to previous year and represents 15.5% of total sales (ZEW 2019a). The automakers nearly reach 50%.

In order to analyze the top position of Germany and to explore the position of innovative companies, a breakdown according to branches is additionally useful. The intensity of innovation describes the percentage of innovation spendings of total sales of all companies within a specific branch. Table 2 shows the figures according to the German innovation survey, a publication of the *Centre for European Economic Research* in Mannheim (ZEW 2019b). The branches show different percentages due to their different market conditions and requirements. The branches vehicle manufacturing (10.2%), electrical industry (8.7%) and chemical/pharma (6.9%) have the highest shares.

Table 2: Intensity of Innovation according to branches in Germany

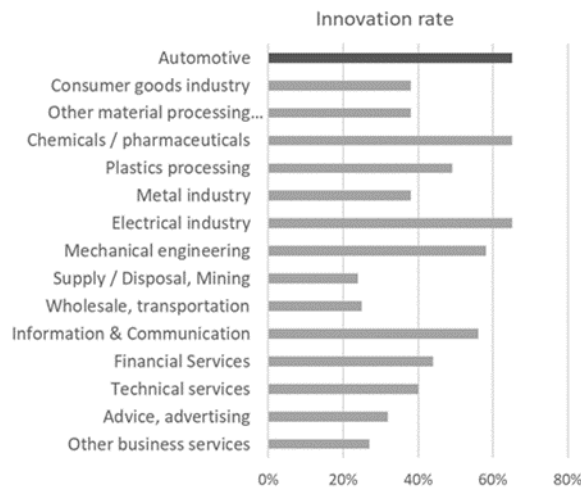
vehicle manufacturing	10.2%	textil, leather, clothes	3.3%	food and tobacco industry	1.4%
electrical industry	8.7%	glass industry	2.6%	consulting and advertising	1.2%
chemical/pharmaceutical industry	6.9%	rubber industry and polymer processing	2.6%	water and disposal sector	0.8%
technical/R&D services	6.7%	transport industry	2.3%	business services	0.6%
telecommunication industry	6.6%	metal production and processing	2.2%	energy, mining and mineral oil industry	0.6%
engineering industry	5.6%	media services	2.1%	financial service industry	0.5%
furniture industry, toy sector, repair industry	3.3%	timber and paper industry	1.5%	wholesale sector	0.2%

Source: ZEW 2019b

Thus we can conclude, that the German core industries vehicle manufacturing, electronics and chemical/pharma hold the top position in the field of innovation.

Figure 4 shows the comparative innovation rate of different branches in Germany. The innovation rate displays the percentage of innovative companies within the respective industry. One can see, that the automotive industry is among the three leading innovative industries, namely automotive, chemicals/pharmaceuticals and electrical industry. Automotive scores exactly for 62.3%.

Figure 4: Innovation rate of German branches in %

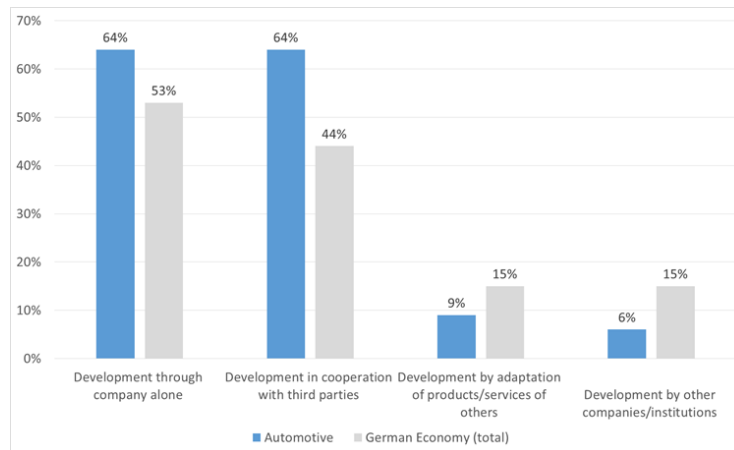


Source: ZEW 2019a

The comparison pinpoints that there is a wide range between the different sectors, but this is quite normal as the innovation intensity represents the degree of competition and even the profitability of the business.

Figure 5 shows different participants in the development of innovations.

Figure 5: Participants in development of innovations



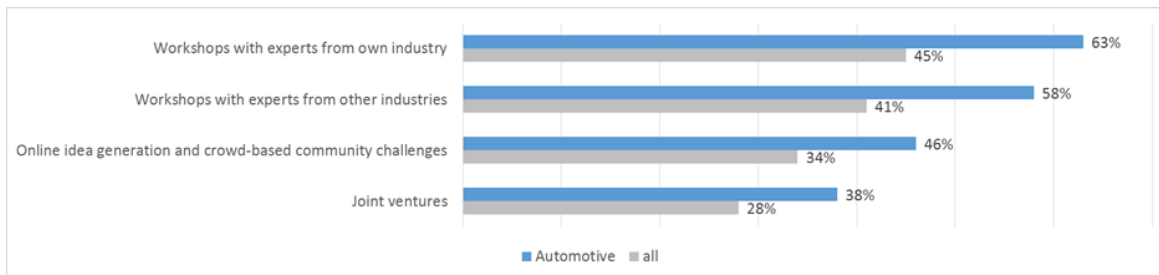
Source: ZEW 2018a

With regard to innovativeness it is also important to analyze qualitative criteria like the openness of companies or industries in general. Figure 5 shows different development partners for innovations within the automotive industry, showing who is involved in the process.

To open the innovation process is an important issue to take advantage in competitive markets. Companies face increasing competition with pressure to innovate. Thus they are forced to push innovation activities with higher budgets, because innovations are drivers for profitable growth, competitiveness and sustainability. New technologies as well as cost and time pressure have changed the practice of innovation activities. Closed innovation has changed into open innovation. Figure 5 discloses that there are as much innovation projects done together with third parties as on a stand-alone basis (multiple choices possible). In comparison to total industry on average the automotive industry in Germany is about one third ahead of the other sectors with regard to open innovation.

There are many ways to execute open innovation and utilize ideas from outside. Figure 6 shows four different ways to collect ideas. Workshops with experts from own industry, experts from other industries, joint ventures and online/crowd based creation. From that figure can be derived that the automotive industry is again far ahead of German industry on average.

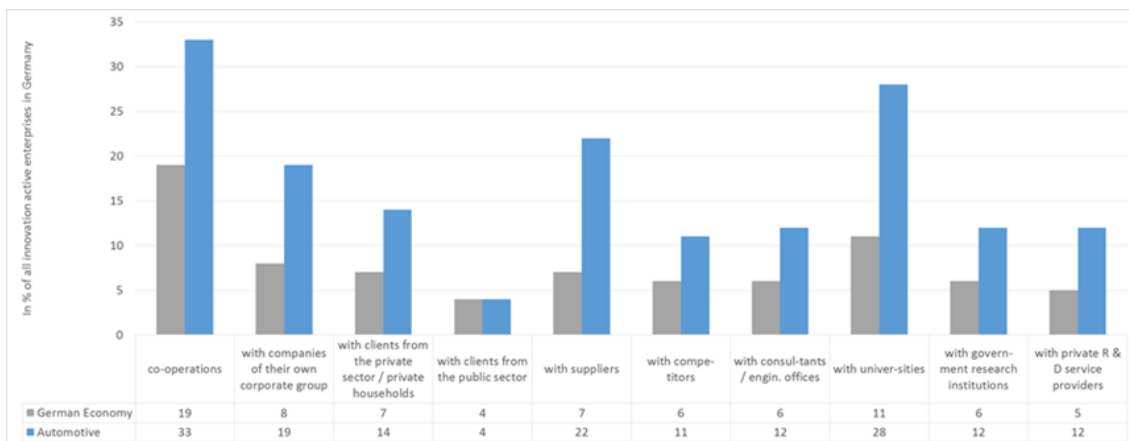
Figure 6: Selected sources of new ideas from outside the company



Source: ZEW 2018b

Figure 7 shows the variety of cooperation partners from outside for automotive industry versus German economy in total.

Figure 7: Selected sources of new ideas from outside the company

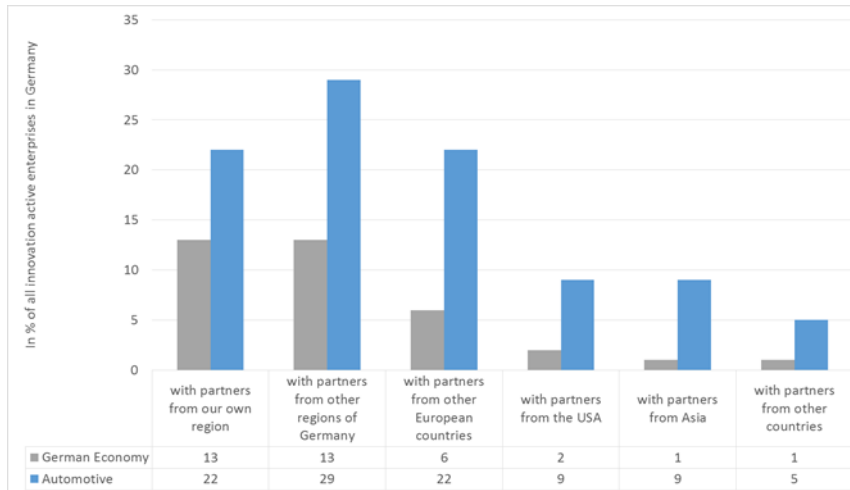


Source: ZEW 2018b

From figure 7 one can derive that the German automotive industry has already opened to external sources of innovation.

Figure 8 provides information about the geographical origin of innovation partners. The distribution gives strong advice that the German automotive industry is ahead in global cooperation, too.

Figure 8: Cooperation partners with regard to geographical origin



Source: ZEW 2018b

All the outlined arguments in this chapter strongly suggest that the innovation performance in the automotive industry is far above average. The innovation management is well organized and is up to date utilizing expert knowledge also from outside and including all tools to accelerate the R&I activities within a perfectly managed innovation process. Summing up this chapter of qualitative criteria, it can be stated that also in view of these issues the German automakers are in lead with their innovation activities.

5. Conclusion

Innovations in terms of new products and services are essential to create value for the company and for the customer. Innovation activities are vital for successful companies and prerequisites for establishing competitive advantage and value added. This paper deals with the significance of innovation in general and the accomplishment of the German automakers in particular. The indication of a disruptive change especially for the German automotive industry is in evidence. A variety of influencing factors merge to a situation of radical change. Big trouble seems to be inescapable. This article gives attention to the research question in order to detect a leading innovation position, which is worth to be defended in times of discontinuities and rising competition. The arguments based on statistical data show that there are outstanding results achieved by the German automakers. Corresponding efforts on the input side were highlighted in this elaboration as well.

The factors of success of innovation management have been outlined on a theoretical basis. These factors also apply to the German automakers. Remarkable issues are a strictly managed innovation process and the targeted appliance of open innovation techniques. The

evaluation indicates that the German automotive industry is well positioned for national and global competition.

In the empirical part the current situation of the German automotive industry was pointed out in several dimensions. Statistical evidence was given with absolute and comparative figures. The overall assessment shows an outstanding performance of the German automakers, in comparison to domestic industries as well as in comparison to car manufacturers abroad. Table 3 illustrates in summary the range between the automotive industry and the average of all sectors based on selected figures.

Table 3: Range of innovation measures on average in Germany

	automotive industry	all industries on average
share of innovative companies	62.3%	36.0%
innovation intensity as expenses in % of sales	10.2%	3.14%
share of sales with innovative products	49.6%	15.5%

Source: own graph, based on ZEW 2019a, 2019b

In consideration of the formulated research question and careful assessment of arguments, it can be stated that the German automakers have an exceptional innovativeness and outstanding innovation power. The question about the reasons of extraordinary innovative performance has been answered with qualitative and quantitative arguments. The key points are the excellence in executing process management, including internal and external knowledge management with the support of cooperations and protecting quickly the outcome in terms of intellectual property.

Summing up it can be concluded that this innovation power is key for the German economy in regard to innovativeness, employment, prosperity, competitiveness and in the end for the welfare of the nation. So it can readily be deduced that there is a huge and urgent need for action to support this industry.

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