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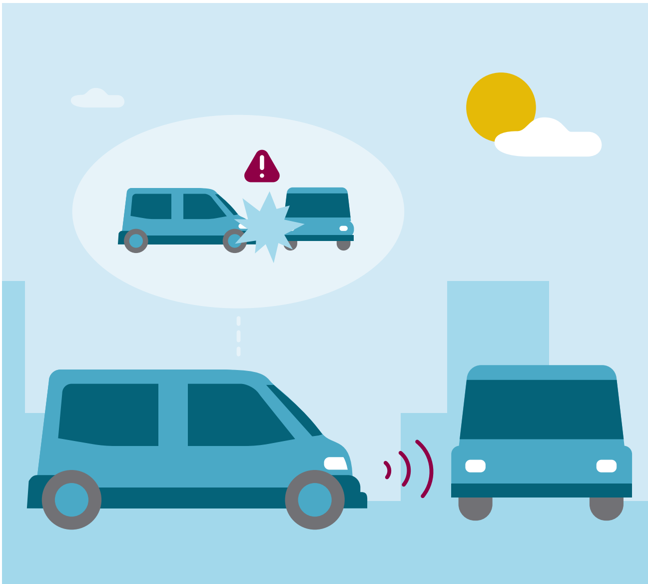
IMPLICATIONS OF AUTOMATED VEHICLES ON THE MOTOR MARKET: the German model

INTRODUCTION

Automated vehicles (AV) are keenly anticipated for the benefits they are expected to bring to society: greater safety, fewer traffic accident victims, improved access to mobility, and more efficient traffic flow resulting in reduced emissions. The increasing use of automated vehicles will change the insurance landscape permanently, with the lower likelihood of accidents greatly reducing premiums in motor insurance. With an expectation of widespread use of fully autonomous vehicles, those which provide the highest level of safety, some studies estimate this reduction at more than 70% of the market premium volume by 2050[1]. However, to assess the implications of automated vehicles on a specific market, the time horizon and severity of the ultimate impact must be separately estimated. The time horizon depends on the penetration rate of automated vehicles in the underlying motor portfolio; the severity impact for insurers also depends on this penetration rate and on the new risk premiums, which will be lower than the risk premiums for conventional vehicles. In addition to this, the different stages of this technological progress – commonly referred to as levels of automation – must also be considered, along with their corresponding efficiency. In the earlier stages, technological capability is quite low, only affecting the risk of accidents to a limited extent. But in the later stages, technological performance is projected to surpass human limitations and eradicate human error, which is the main cause of road traffic accidents. That being said, nobody really knows if or when such technological perfection will actually be reached.

This article analyses the penetration of the different levels of automation and the corresponding change in motor premiums for a sample market. Germany is chosen as the observed market due to its mature motor portfolio and its characteristics. Because 8% of the existing motor vehicles are capable of level 2 automation[2], the German motor portfolio is already fairly exposed to this emerging risk. In addition, due to market drivers such as Germany's legislation and the developing infrastructure, it is assumed that Germany's motor market will experience a swifter transformation than those of other countries.



Although the key assumptions described in the following can of course be transferred to other markets, the country-specific characteristics of each market may influence the weighting and importance of these assumptions.

1 – KPMG, The Chaotic Middle: The Autonomous Vehicle and Disruption in Automobile Insurance. 2017.
2 – DAT, DAT Report 2017. 2017.

AUTOMATED *VS.* AUTONOMOUS DRIVING

In 2013 the Society of Automotive Engineers (SAE) proposed levels of automation to create a common classification system and to establish a common understanding of the technological progress of automated vehicles[3]. According to this differentiation, the transformation of a conventional vehicle into an entirely automated vehicle will take place over six levels of automation, in which level 0 represents conventional vehicles and level 5 fully automated, or autonomous, vehicles. In accordance with these levels, the dynamic driving task is gradually shifted from the human driver to the automation system. Although the terms "automated" and "autonomous" are sometimes used interchangeably, they do not have the same meaning. As proposed by the SAE, the designation depends on the degree of technology in the vehicle. If there is no or only limited technology used to assist the driver, this is considered as a conventional vehicle with an automation level of 0-1. If a vehicle depends on an onboard computer that uses automation to determine and implement driving algorithms, but no artificial, self-learning intelligence nor cloud-based "hive mind" is implemented, such vehicle is deemed to have an automation level of 2-3[4].

By implication, truly autonomous behaviour is therefore expected in levels 4 & 5, where the systems are capable of full-time performance of all aspects of the dynamic driving task, fully monitoring the driving environment with no need for human interaction. The current status quo is that level 2 automated vehicles are available and Audi will introduce level 3 automation within the new A8 this year[6]. Level 4 automation currently only exists within prototypes, which are tested under strict observation and are not yet publicly available. In this paper, the six levels of automation are divided into three classes (levels 0 & 1, 2 & 3 and 4 & 5).

DID YOU KNOW?

Since 2001, having the same understanding and definition of a risk has become a crucial issue for the insurance sector. For automated vehicles, the literature mainly differentiates between automation levels according to the SAE. However, legislators do not necessarily follow this path: in the United Kingdom, the Vehicle and Technology Aviation Bill does not clearly distinguish between the automation levels. This leaves the bill ambiguous in terms of how to apply it to the respective levels of automation. In Germany, the legislator has even chosen another designation for the respective automation levels (e.g. level 4 is referred as "full automation" which corresponds to level 5 according to the SAE). These approaches provide potential for misunderstandings, because foreign parties may not understand the legal situation correctly in the respective countries.

0	1	2	3	4	5
The driver constantly performs all aspects of the dynamic driving task. No systems intervene - only those that warn the driver.	The system can take over **eitheir** steering **or** acceleration / deceleration. The driver must continuously carry out the other.	The system can takes over **both** steering **and** acceleration / deceleration in a defined use case.	The system can takes over both steering and acceleration / deceleration in a defined use case. It is capable of recognizing its limits of notifying this driver.	The driver can hand over **the entire driving task** to the system in a defined use case.	The system can take over the entire dynamic driving **task in all use cases.**
The driver must constantly monitor the drive.	The driver must constantly monitor the drive. He must be ready to resume full control immediately.	The driver must constantly monitor the drive. He must be ready to resume control immediately.	The driver must constantly monitor the drive, but be ready to resume control within a given time frame if the system so requests.	The driver would not be required at all during these cases - neither for monitoring, nor as backup.	The driver is no longer required at all.

FIGURE 1: LEVELS OF AUTOMATION ACCORDING TO SAE

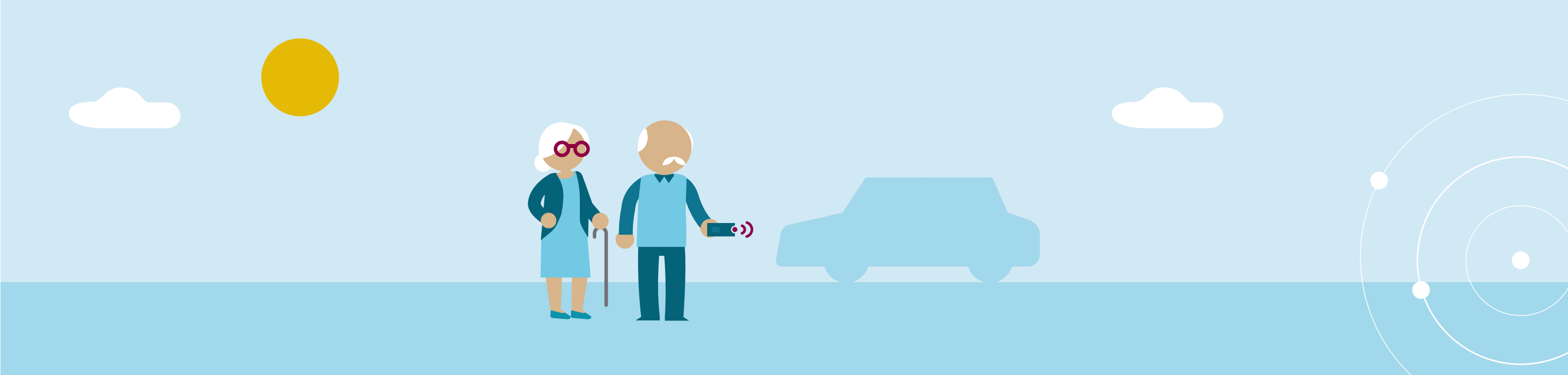
Source: 2025AD[5]

3 – SAE, Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems-J3016. Society of Automotive Engineers: On-Road Automated Vehicle Standards Committee; SAE Pub. Inc., Warrendale, PA, USA, 2013.

4 – The Insurance Institute of Canada, Automated Vehicles, Implications for the Insurance Industry in Canada. 2016.

5 – 2025AD. Definition: Levels of AD. 2015. Accessed: 16.12.2016; Available from: https://www.2025ad.com/latest/the-levels-of-automation/

6 – Intel, Intel Inside New Audi Autonomous Car System. 2017.



PENETRATION OF AUTOMATED VEHICLES IN GERMANY

It is difficult to determine the time horizon in which fully automated vehicles will ultimately impact the underlying market. Due to the uncertainties surrounding automated vehicles, determining a certain and discrete scenario for the penetration of automated vehicles is impossible. To overcome this issue, the concept of a "range of futures" is used, which assumes that each possible scenario can be captured within two boundary values[7]. For the penetration of automated vehicles, these boundary values are derived from the historical penetration of anti-blocking systems (ABS) and electronic stability programs (ESP) in the German motor portfolio. The penetration of ABS was slow, and it took 20 years until ca. 40% of the underlying motor portfolio was penetrated. Conversely, ESP penetrated roughly 80% of the motor portfolio in the same time horizon and is therefore a suitable example of rapid penetration. Hence, the penetration of ABS represents the minimum and the penetration of ESP the maximum boundary value. For the existing automated motor portfolio in Germany, which represents roughly 8% of the overall vehicles, the penetration of automation levels 2&3 is forecast on the basis of these boundary values[8]. Moreover, a delayed introduction in the respective vehicle class segments is also expected and considered in the model: when first put into production, level 2 automation was mostly available for high luxury cars; now it is available for mid-range cars too. It is assumed that the next levels of automation will follow, with a time horizon based on historical reference values.

DID YOU KNOW?

The time horizon and severity impact of automated vehicles is influenced by the specific characteristics of each country. In addition to market acceptance driven by a clear legal framework, the lack of required digital infrastructure is a major constraint. Nevertheless, some countries like the Netherlands, Singapore, the US, Sweden and the UK (partly) meet the requirements for mainstream adaption of automated vehicles. Therefore, it is assumed that these countries will be among the first to gain relevant experience with the transformation caused by the automation of vehicles.

Therefore, it is presumed that the technology will be only available for high luxury cars in the beginning, for mid-range cars after 4 years and for compact models after 7 years. This delayed introduction is driven by the costs of the technology involved, which are usually significantly higher when a product is first put on the market in comparison to a later stage. As an example, the price of the first built-in GPS navigation system in production vehicles was USD 2,000 in 1995. Nowadays, these costs are roughly one-tenth of the indexed original price. By implication, the acceptance and availability of automated vehicles will increase over time as the technology becomes cheaper, making sensors, electronic control units, etc. affordable and creating a precondition for mainstream adaption.

DID YOU KNOW?

A clear legal framework is a key driver of the acceptance and penetration of new technology. Surveys show that for the majority of participants the issues of liability and guilt must be defined by law before purchasing an automated vehicle[9]. In Germany, automated vehicles up to automation level 4 are properly governed by the law. The 8th law amending the Road Traffic Act prescribes that the driver is still liable in terms of liability for presumed fault and the vehicle owner/ keeper remains liable in the sense of strict liability[10].

7 – Proff, H., Entscheidungen beim Übergang in die Elektromobilität: Technische und betriebswirtschaftliche Aspekte. 2015: Springer-Verlag.

8 – DAT, DAT Report 2017. 2017.

9 – ADAC. ADAC-Umfrage „Autonomes Fahren". 2016 Accessed: 15.05.2017; Available from: https://www.adac.de/_mmm/pdf/Umfrage%20Autonomes%20Fahren%20Nov%202016%20adac.de_281295.pdf.

10 – Bundestag. Achtes Gesetz zur Änderung des Straßenverkehrsgesetzes. 2017 Accessed: 20.06.2017; Available from: https://www.bgbl.de/xaver/bgbl/start.xav?start=%2F%2F*%5B%40attr_id%3D%27bgbl117s1648.pdf%27%5D#__bgbl__%2F%2F*%5B%40attr_id%3D%27bgbl117s1648.pdf%27%5D__1516351777807

Automation levels 4 & 5 are characterized by a high degree of uncertainty in terms of both the market and technological drivers; besides the unclear jurisprudence, the lack of required digital infrastructure is one of the major constraints. According to ABI Research, highly automated vehicles need at least "5G" internet access, which corresponds to roughly 1.200 MB per second but is not yet available[11]. As reported by the German initiative "5 steps to 5G", the 20 largest cities in Germany should have the required stable and broad network access by the year 2025[12]. Based on historical values of the past ten years, the privately used vehicles of these cities represent 14.6% of the German motor portfolio and 23.6% of newly registered cars in Germany. Assuming a steady improvement of the network after 2025 in the larger cities only, the penetration of automation levels 4 & 5 stagnates at a certain point. This is because highly automated features cannot work properly in smaller cities and in the countryside, which are characterized by slow and unstable internet connection. The penetration of automation levels 4 & 5 in these areas is not expected in the medium-term, which means that the motor portfolio of the largest cities represents the maximum penetration of highly and fully automated vehicles in Germany. Combining this assumption with the ones mentioned above, the penetration for automation levels 4 & 5 can be estimated. In contrast to that, the penetration of automation levels 0 & 1 is the complementary set of the penetration of levels 2 & 3 and 4 & 5 with the further assumption that newly registered cars are equipped with the latest technology and that only levels 0 & 1-vehicles are withdrawn from the German motor portfolio.

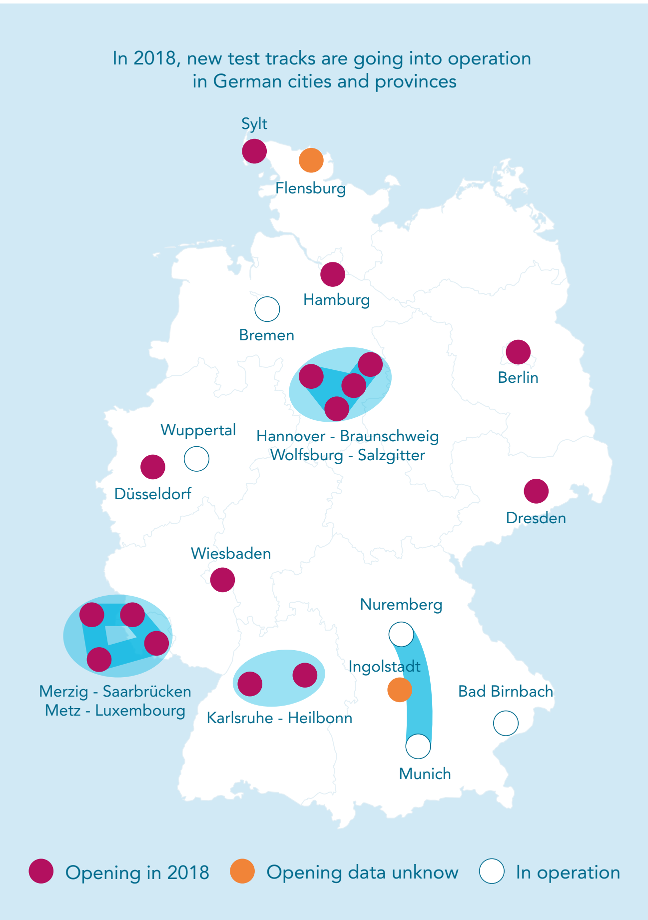


FIGURE 2: NEW TEST TRACKS FOR AUTOMATED DRIVING
Source: GDV.DE, 2017

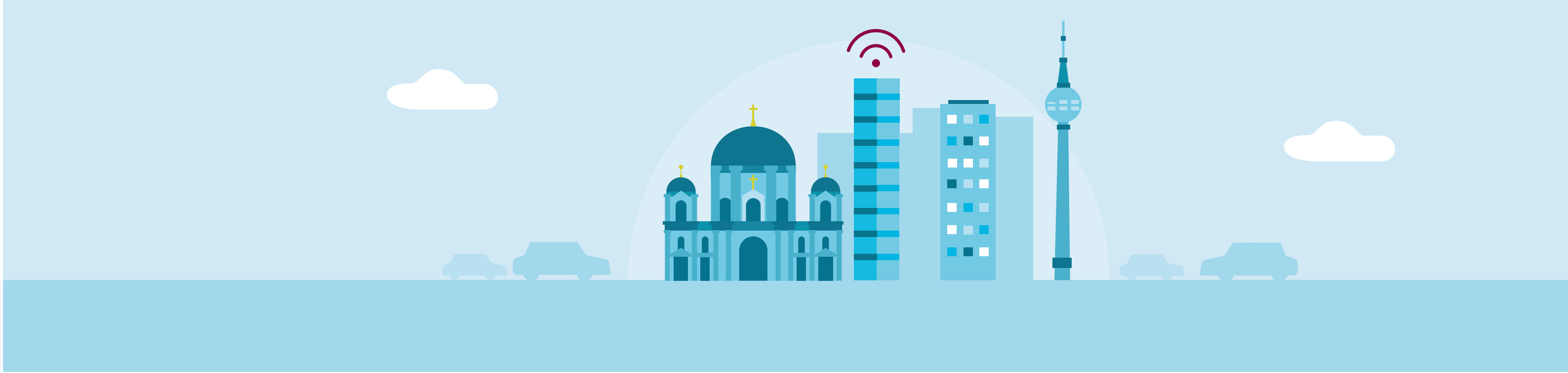
DID YOU KNOW?

With the advent of automated vehicles, the reliability of testing is becoming increasingly important for automated vehicles. Accidents caused by the vehicles, such as the widely reported Uber accident, could temper the acceptance of this technology. In Germany, automated vehicles are thoroughly researched and tested[13].

11 – ABIresearch. Role of 5G in Automotive and Transportation. 2016 Accessed: 15.05.2017; Available from: https://www.abiresearch.com/market-research/product/1024467-role-of-5g-in-automotive-and-transportatio/.

12 – Federal Ministry of Transport and Digital Infrastructure. 5G Strategy for Germany. 2017 Accessed: 15.08.2017; Available from: http://www.bmvi.de/SharedDocs/EN/publications/5g-strategy-for-germany.pdf?__blob=publicationFile.

13 – GDV. Diese Städte und Regionen werden 2018 zu Teststrecken. 2018. Accessed: 03.04.2018; Available from: https://www.gdv.de/de/themen/news/diese-staedte-und-regionen-werden-2018-zu-teststrecken-25874



According to Figure 3 besides, after 2034 the entire German motor portfolio should be capable of at least level 2 automation. Hence, the transformation of the German motor market is expected to take place within the next 22 years (at the latest). From 2034 onwards, advanced driving assistance systems are believed to be commonly available and fully distributed in the portfolio, increasing the overall safety level of road traffic. However, most automated vehicles will only have an automation level of 2 or 3. By 2040, less than 30% of vehicles are expected to be capable of automation levels 4 & 5. This prognosis is mainly driven by the assumption that the broad, stable network required for levels 4 & 5 is only available in bigger cities. In rural areas, only vehicles at automation levels 2 & 3 are expected to operate. However, if the required 5G-network is publicly available sooner, which is anticipated to happen in Sweden for example, the higher automation levels should penetrate more rapidly. Overall, the penetration of automated vehicles and the disappearance of conventional vehicles will directly influence the required risk premiums for motor insurance, due to the anticipated reduction in loss frequency.

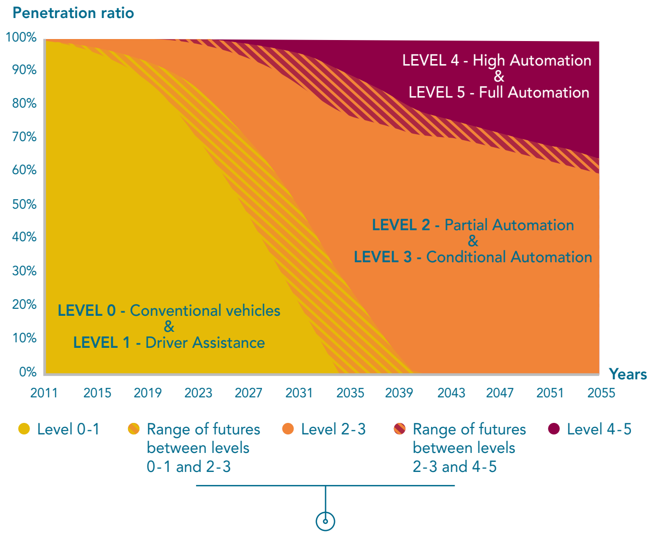


FIGURE 3: PENETRATION OF AUTOMATED VEHICLES IN THE GERMAN MOTOR PORTFOLIO

Source: SCOR; own evaluation

CHANGE IN GERMAN MOTOR INSURANCE PREMIUMS

To assess the severity impact of automated vehicles from an insurer's point of view, the anticipated premium reduction must be determined. In this regard, the premium reduction is defined as the difference between the new required risk premium for automated vehicles and the forecasted risk premium for conventional vehicles at market level. This change in premium depends on the penetration mentioned previously and the reduced likelihood of accidents. This "new" loss frequency can be derived from actual mitigatable and avoidable claims, as well as from the degree of technological perfection involved. By analysing the accident categories from police/statistical records, mitigatable and avoidable accidents like "errors when overtaking" or "speeding" are identified and evaluated. Depending on the system's capabilities, the accident frequency is gradually adjusted according to the different levels of automation. In addition, a distinction between the types of coverage and the influence of automated features on this cover provides a baseline from which to assess future claims costs. For level 2 automation, there is no significant impact on the claims costs for partial cover, and this trend continues even for the higher levels of automation. The only exceptions are theft and collision with animals: automated vehicles are easier to locate and retrieve due to their onboard GPS-system, and collisions with animals can be greatly reduced thanks to safety features such as emergency braking systems. However, these two exceptions make up ~27% of claims costs for partial cover, but less than 5% of the total claims cost for motor insurance cover in Germany. Conversely, starting at level 2, the implemented systems influence risk premiums for fully comprehensive cover which is mainly driven by the cost of collisions with other vehicles. As stated by the National Highway Traffic Safety Administration in the US, the onboard safety features of the Tesla autopilot decreased the accident rate by 40%[14]. In this context, the combination of lane-guard, lane-change and other driver assistance systems significantly influences the risk of accidents, thereby reducing claims costs for fully comprehensive cover. This trend will continue for higher levels of automation, where the dynamic driving task will be optimally executed by the system, eradicating human error. There will be a similar impact on Motor Third-Party Liability (MTPL) cover. Accidents

14 – Muoio, D. Tesla is pushing the insurance industry to prepare for massive disruption. 2017. Accessed: 18.11.2017; Available from: http://uk.businessinsider.com/how-tesla-self-driving-cars-are-changing-insurance-industry-2017-5?r=US&IR=T

will increasingly be mitigated or avoided as the level of automation progresses and eliminates the major driver of MTPL claims. The risk premium will therefore decrease due to the reduced likelihood of accidents.

Nonetheless, this development has counterbalancing effects, the most important being the increase of Casco value due to the greater complexity of the cars. As stated in a study by Liberty Mutual, the total cost of a low speed collision for the same vehicle model (2014 and 2016 4-door entry-level luxury sedan) increases by 92.3% overall, because the 2014 model is not equipped with the same technology as the 2016 model. Hence, the increase in costs is mainly caused by the damaged parts (i.e. distance sensor and LED headlamps) which are 130% more expensive to replace in the 2016 model than in the 2014 model. Labour costs inflate the claim by a further 18%, because more highly trained specialists are needed to carry out the repairs[15]. The use of higher-value products and the required expertise to understand the new technology will be a counterweight to the reduced probability of accident occurrence, because of the increase in expected loss severity. Besides this trend, technology risks are evolving due to the interconnectivity of automated vehicles with the driving environment, commonly referred to as V2X-communication. Tech risks include cyber exposure, where automated vehicles are affected by external hazards that, among other things, exploit the weak spots of the systems.

DID YOU KNOW?

The Internet-of-Things (IoT) simplifies daily life and makes it more convenient, but also provides threats to its users. Hackers are increasingly focusing on unprotected IoT-devices to exploit system weaknesses and gain access to the transmitted data. These IoT-devices such as air-conditioning systems and CCTV are often not considered to be a threat and hence, do not include IT-security measures and standards. Using a thermometer from a fish tank that was connected to the network, hackers stole 10 gigabytes of data from a casino in North America[16].

They also include internal risks such as the possible misinterpretation of the driving environment by the onboard systems, software bugs, defective sensors, etc. resulting in new kinds of claims. These new types of technology risks are incorporated through an "IT risk premium", a safety loading on top of the projected claims costs for fully comprehensive cover and MTPL. This IT risk premium is expected to decrease over time, assuming that IT security measures and standards improve (e.g. cryptographic systems). In the meantime, the required safety loading will partly counterbalance the reduced loss frequency. Besides these counterweights, there are certain residual risks in each level which cannot be eliminated. These residual risks can emanate from factors such as duty of care or environmental pollution, or from non-avoidable accidents that will still occur even for level 5 automation (e.g. sliding off an icy road). Therefore the need for compulsory MTPL coverage will not entirely disappear or be shifted onto the manufacturer, as partly anticipated in the literature.

The capability of automated vehicle systems is measured in terms of technological perfection: the degree of technological perfection indicates the efficiency level of the system and its required improvement over the following years. The implementation of continuous improvement can already be seen in automated vehicles in which over-the-air software updates have become commonplace. Based on the development of historically important technologies such as the internet and augmented or virtual reality, it takes at least 10 years to reach the highest degree of technological perfection in which no improvement is needed anymore. This time horizon depends on the complexity of the system in question and increases in accordance with this complexity. In the transition period, identified claims are adjusted with the degree of technological perfection. The premium reduction for MTPL, as well as for partial and fully comprehensive cover, can be determined based on steady increases in system efficiency and understood in terms of actual avoidable and mitigatable claims. This information is compared to the "as-if" motor market premium, which is based on a forecast with no introduction of automated vehicles at all. In this context, it is assumed that the decrease in risk premium will be reflected relatively quickly in the market premium. The calculated change in premiums is based on the penetration scenarios mentioned above and the weighted average of the overall reduced premiums.

15 – Liberty Mutual Insurance. Fourth Quarter and Full Year 2016 Results. 2017. Accessed: 06.04.2017; Available from: https://www.libertymutualgroup.com/about-liberty-mutual-site/investor-relations-site/Documents/Q4_2016_Earnings_Presentation.pdf

16 – Williams-Grut, O. Hackers once stole a casino's high-roller database through a thermometer in the lobby fish tank. 2018. Accessed: 19.04.2018; Available from: https://www.businessinsider.de/hackers-stole-a-casinos-database-through-a-thermometer-in-the-lobby-fish-tank-2018-4?r=US&IR=T

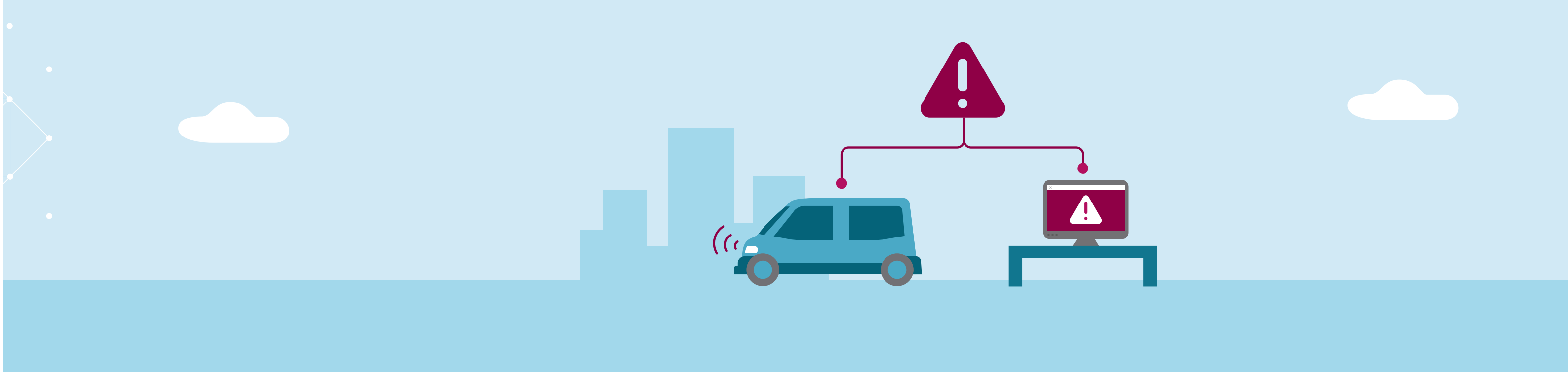


Figure 4 below provides the anticipated values for the years 2025, 2034 and 2040:

FIGURE 4: CHANGE IN % OF FORECASTED GERMAN MOTOR MARKET PREMIUMS FOR RESPECTIVE COVER

Source: SCOR; own evaluation

Figure 4 states that, until 2025, no significant reduction in the German premium volume for Motor Own Damage (MOD) and MTPL is expected. However, in the years 2034 and 2040, when a high degree of technological advancement is achieved which substantially reduces the risk of accidents, the required risk premium (and hence the market premium) is significantly reduced. At these stages, the German motor market is strongly penetrated by automated vehicles with automation levels of 2 & 3, and partly penetrated by levels 4 & 5 vehicles. In contrast to this trend, the anticipated IT risk premium initially counterbalances the reduction in the MTPL and MOD premiums – for example it offsets roughly 8% of the projected German motor market premium volume in 2040. However, this reduction in insurance premiums is not as extensive as the literature anticipates. In 2025, the premium reduction is expected to stand at around 1.5% combined for MOD, MTPL and related technology risks, while in 2040, the reduction is assumed to be nearly 30% compared to the forecasted "as-if" motor premium. This is because, in 2040, most vehicles in Germany are expected to only be capable of levels 2 & 3 automation. As stated before, while significant, these automation levels do not influence claims costs enough to massively reduce the required risk premiums. Therefore, the severity impact of automated vehicles on the German market may be less than in other countries, due to the low penetration of automation levels 4 & 5.

CONCLUSION

In conclusion, automated vehicles do not represent the end of the motor insurance industry, but they will permanently change it due to a transformed risk landscape. For (re)insurers, challenges arise not just from the gradual shift from the human driver to the automation system, but also from the reduced likelihood of accidents. Hence, it is crucial for (re)insurers to determine the time horizon as well as the severity impact of automated vehicles on a given market. As proposed above, the time horizon can, inter alia, be derived from the historical penetration of significant safety features such as ABS and ESP. The severity impact, however, depends on the penetration rate and the required risk premium for the respective automation levels.

This new risk is quickly becoming reality, and some motor portfolios may already contain significant numbers of vehicles capable of level 2 automation. The current portfolio composition and the pace at which further transformation will take place differs from market to market. For Germany, the transformation is expected to reduce overall motor market premiums by nearly 30% within the next 22 years. At that point in time, the whole German motor portfolio is projected to be capable of at least level 2 automation. However, due to the relatively low proportion of highly and fully automated vehicles, the severity impact of this emerging risk is not as great as anticipated in the literature[17].

NONETHELESS, TO AVOID COMPLACENCY AND TO STRATEGICALLY PREPARE FOR THE POTENTIAL IMPACTS, INSURERS NEED TO DISTINGUISH BETWEEN THE RESPECTIVE AUTOMATION LEVELS AND THEIR INFLUENCE ON THE DIFFERENT TYPES OF COVER.

By taking this differentiated approach, insurers can ensure homogeneity within the portfolio and provide an adequate underwriting approach, customized for each level of automation.

17 – KPMG, The Chaotic Middle: The Autonomous Vehicle and Disruption in Automobile Insurance. 2017.

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