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The future of mobility and its impact on the automobile insurance industry

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Abstract

Among the trends impacting most industries are new mobility concepts, digitalization, urbanization, rising environmental awareness, and demographic change. The automobile insurance industry, in particular, is strongly affected by new mobility concepts, including autonomous, shared, and electric vehicles, which are expected to increasingly impact the risk exposure and insurance demand in the future. Identifying and assessing the resulting risk and opportunity landscape from these trends thus becomes a major strategic challenge for insurers. The aim of this paper is to analyze the trends that impact the field of mobility and thus automobile insurers. Based on this, we derive a set of strategic response measures for insurers to enable them to be prepared for the future of mobility.

1 | INTRODUCTION

Digitalization, urbanization, rising environmental awareness, demographic change, and new mobility concepts are among the major trends transforming most industries (CRO Forum, 2018). In this context, automobile insurers especially face major strategic and emerging risks arising from new mobility concepts, including autonomous, shared, and electric vehicles, which are connected to each other and their environment. Monitoring the resulting risks, which can be either new or modified, is becoming increasingly important (e.g., cyber risks as

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related to new mobility concepts), but the innovative environment of future mobility concepts can also create new business opportunities (Rao, 2016; Sheehan, Murphy, Ryan, Mullins, & Hai, 2017). The aim of this paper is to provide a comprehensive overview of major future mobility trends and their impact on the automobile insurance industry, based on an extensive review of the academic and practitioner-oriented literature and including from outside the insurance industry, which has not been done previously, with the intent to provide insights into future risks and opportunities for automobile insurers.

While there are several academic articles that review mobility desires, patterns, and automobile trends, they generally do not comprehensively address the future of mobility and its specific consequences for the insurance industry at the same time. The academic research on the motor insurance business often deals with the highly competitive market conditions, market growth, and market profitability (e.g., Eling & Luhnen, 2008, 2010; Maichel-Guggemoos & Wagner, 2018). Attention has also been given to the consequences of individual major mobility “subtrends” or product designs with a focus on usage-based insurance (e.g., Guillen & Perez-Marin, 2018; Kraft & Hering, 2017; Sheehan et al., 2017; Weidner, Vanella, & Zuchandke, 2015; Wu, 2019). For instance, Sheehan et al. (2017) apply a Bayesian network to examine the potential consequences of autonomous driving for the motor insurance business and the changing risk landscape based on the five levels of automation defined by the Society of Automotive Engineers (SAE). Weidner et al. (2015) use a forecast model to study the (future) motor insurance demand in Germany based on the expected vehicle stock and conclude by identifying the direct and indirect effects on future motor insurance market potentials. Furthermore, Matley, Gandhi, Yoo, Jarmuz, and Peterson (2016) provide a categorization of consequences for the automobile insurance industry regarding customers, products and distribution, but without explicitly distinguishing between the responsible trends.

In this paper, we aim to contribute to the previous literature by comprehensively analyzing future developments in the field of mobility with special focus on the insurance-relevant new mobility concepts such as autonomous vehicles, electric vehicles, and shared mobility. We derive a “mobility ecosystem” of trends along with implications and strategic response measures from the perspective of automobile insurers. One main result is that a future insurance product design should take into account a potentially transformed risk landscape as well as a shift from private to commercial customers, along with the increasing importance of the point of sale (of a vehicle) within automobile insurance distribution models.

The remainder of this paper is structured as follows. Section 2 identifies automobile insurance-relevant trends. Section 3 analyzes potential consequences and strategic measures from the automobile insurance industry’s perspective and Section 4 summarizes the results.

2 | MAJOR TRENDS AND THE FUTURE OF MOBILITY

In what follows, we review the academic and practitioner-oriented literature based on a Web of Science search using the keywords “future” AND “mobility”, as well as Google Scholar and Google searches.¹ Overall, this led to 76 articles that serve as the basis for the identification of

¹We thus follow, for example, Milakis, Van Armen, and Van Wee (2017). Google and Google Scholar results are incorporated in order to analyze all unreleased academic or practitioner-oriented reports. As there has been little academic research on the overall future of the automobile insurance industry, we also analyze recent industry reports and studies.

relevant (mobility) trends and their impact on the automobile insurance industry. While new mobility concepts are among the major global trends (e.g., Corwin, Vitale, Kelly, & Cathles, 2015; Linden & Wittmer, 2018), one has to take into account other trends as well in order to comprehensively assess the impact of the future of mobility on the automobile insurance industry. In Table 1, we thus present an overview of insurance-relevant trends within the “mobility ecosystem”, which in addition to new mobility concepts also includes demographic change, digitalization, environmental awareness/increasing societal focus on sustainability, individualization, and flexibilization, as well as urbanization. The relevance of these trends for the future of mobility and thus the automobile insurance industry was determined based on the literature research and is substantiated by the arguments in Tables 1 and 2.

2.1 | New mobility concepts

Regarding new mobility concepts, we follow Linden and Wittmer (2018) by focusing on autonomous vehicles, electric vehicles, and shared mobility.²

With respect to autonomous vehicles, the SAE commonly distinguishes between five autonomy levels: no automation, driver assistance, partial automation, conditional automation, high automation, full automation (SAE, 2016). In a fully automated vehicle scenario, the driving task is completely performed by the system without the necessity for the driver (becoming a passenger) to monitor the driving environment (Corwin, Jameson, Pankratz, & Willigmann, 2016; Corwin et al., 2015; Sheehan et al., 2017). In this context, the literature places special importance on future autonomous vehicles that are operated in shared fleets, which would reduce private vehicle ownership rates while increasing the overall amount of passenger miles traveled by a vehicle (e.g., Menon, Barbour, Zhang, Pinjari, & Mannering, 2019; Milakis et al., 2017; Sprei, 2018; Zhang, Guhathakurta, & Khalil, 2018). However, the pace of these developments not only depends on further technological progress but also on nontechnological factors such as social adoption, the legal framework and further economic factors (Fraedrich, Heinrichs, Bahamonde-Birke, & Cyganski, 2019; Munich Re, 2016).³

As the society increasingly supports the protection of the environment and the efficient use of existing (limited) resources, electric vehicles with alternative drivetrain technologies become important for a sustainable mobility landscape (Donada & Perez, 2016; Krommes & Schmidt, 2017; Linden & Wittmer, 2018). However, Donada and Perez (2016) state that even if growth rates for electric vehicles are globally gaining in momentum, the overall proportion of electrified cars in automobile markets often does not exceed 1%. In this context, barriers to electric mobility such as a limited range of battery components and high initial costs need to be overcome.

²In contrast to Kuhnert, Stürmer, and Koster (2017), we do not include “connectivity” as a separate trend and instead subsume it under the trend of digitalization in line with Linden and Wittmer (2018).

³There are 57 entities with the permission to run autonomous vehicle tests in California as of August 2018 (California Department of Transportation, 2018). Original equipment manufacturers (OEMs) including Volkswagen, BMW, Mercedes Benz, Tesla, Nissan, Ford, and Honda, as well as technology firms such as the Google subsidiary Waymo or NVIDIA, are permit holders. A broad and fast-growing range of autonomous prototyping programs can also be observed, such as the ones initiated by Volvo or Tesla with selected groups in Sweden (Sprei, 2018, p. 240), as well as autonomous shared fleet tests by Uber, Lyft, or nuTonomy. In addition, with its Early Rider Program, Waymo announced a (beta) transit concept deploying autonomous vehicle technologies (Menon et al., 2019).

TABLE 1 Major trends and their relevance for the future of mobility

Trend	Relevance for the future of mobility
New mobility concepts: Autonomous vehicles	<ul style="list-style-type: none"> ▪ Five autonomy levels according to SAE from no to full automation^e ▪ Broad (societal) effects, for example, regarding road safety, power consumption, and air pollution^c ▪ Key barriers: liability concerns, data ownership, and data security,^{d,g} policymaking regarding approval for prototyping and public testing^g
New mobility concepts: Electric vehicles	<ul style="list-style-type: none"> ▪ Electric vehicles apply alternative drivetrain technologies to reduce greenhouse gas emissions^{a-c,e,g,h} ▪ Categories of electric vehicles include, for example, plug-in hybrid, range extender, fully electric^{e,f} ▪ Main barriers of widespread electric vehicle market penetration: sociocultural/driver acceptance,^{c,d,f} high purchasing prices,^{c-g} insufficient charging infrastructure,^{c-e} limited range due to restricted battery capacity (social phenomenon of range anxiety)^{d,e,g}
New mobility concepts: Shared mobility	<ul style="list-style-type: none"> ▪ Shared mobility models anticipate principles of sharing economy and collaborative consumption to avoid negative effects of car ownership, while still allowing flexibility and individuality regarding travel choices^{h,j} ▪ Resulting mobility paradigm: pure vehicle access partially replaces private vehicle ownership, as buying and thus owning an asset is no longer a primary customer need^{a,b,g} ▪ Popular concepts: car sharing,^{a-c,e,h,k} ride sharing^{b,d,e,i} ▪ Main drivers: inefficient utilization rates of privately owned cars, total cost of ownership (e.g., motor insurance costs, costs of maintenance, and operation), congestion and air pollution, lack of parking spaces (especially in urban areas)^{a,b,f,l}
Demographic change	<ul style="list-style-type: none"> ▪ Increasing demand for age-appropriate mobility solutions^{a-f,h} ▪ Tendency of increasing age of active mobility consumers^{b,c,f} ▪ Mobility needs/patterns of the elderly population characterized by short distances with longer travel times^f
Digitalization	<ul style="list-style-type: none"> ▪ Digitalization induces changes with respect to mobility behavior as well as regarding requirements concerning individual transportation^{b-g,i,k} ▪ Digital/mobile technologies imply the opportunity to develop new mobility concepts (including autonomous, shared and/or electrified vehicles) that are easily accessible (e.g., via smartphone) for the general public^{b-l}
Environmental awareness/ sustainability	<ul style="list-style-type: none"> ▪ Shift toward environmentally sustainable transportation modes and concepts (e.g., electric vehicles)^{a-d,f,g}
Individualization and flexibilization	<ul style="list-style-type: none"> ▪ Increasing focus on new mobility concepts enabling short-term accessibility and on-demand availability^{a-c,g} ▪ Mobility as a service, multimodality, and intermodality gaining in importance^{h-j} ▪ Increasing heterogeneity of mobility needs due to individualization^c
Urbanization	<ul style="list-style-type: none"> ▪ Accelerates issues such as need for efficient traffic organization, congestion, lack of car parks and air pollution in urban areas^{a,b,f,g,k}

TABLE 1 (Continued)

Trend	Relevance for the future of mobility
	<ul style="list-style-type: none"> ▪ Tendency to negatively affect private car ownership in urban areas, especially with respect to the young age group (amount of driving licenses, vehicle ownership, and vehicle usage pattern)^{c-h} ▪ Increasing demand for innovative/alternative mobility concepts especially in urban areas, focus on on-demand mobility solutions^{f,i,j,k}

New mobility concepts: Autonomous vehicles: ^aCorwin et al. (2015); ^bCorwin et al. (2016); ^cMilakis et al. (2017); ^dMunich Re (2016); ^eSAE (2016); ^fSheehan et al. (2017); ^gSkeete (2018); ^hSpri (2018).

New mobility concepts: Electric vehicles: ^aBergman, Schwanen, and Sovacool (2017); ^bCorwin et al. (2015); ^cDijk, Orsato, and Kemp (2013); ^dDonada and Perez (2016); ^eEgbue and Long (2012); ^fHasse et al. (2017); ^gLinden and Wittmer (2018); ^hVassileva and Campillo (2017).

New mobility concepts: Shared mobility: ^aBardhi and Eckhardt (2012); ^bCorwin et al. (2015); ^cCorwin et al. (2016); ^dFagnant and Kockelmann (2018); ^eHasse et al. (2017); ^fKim (2015); ^gLinden and Wittmer (2018); ^hNovikova (2017); ⁱRayle, Dai, Chan, Cervero, and Shaheen (2016); ^jShaheen and Cohen (2007); ^kSpri and Ginnebaugh (2018); ^lWilling, Brandt, and Neumann (2017).

Demographic change: ^aFocus and Christidis (2017); ^bKuhnimhof, Zumkeller, and Chlond (2013); ^cLinden and Wittmer (2018); ^dLyons and Davidson (2016); ^ePlazinic and Jovic (2018); ^fThiele and Schmidt-Jochmann (2015); ^gThompson, Baldock, and Dutschke (2018); ^hWeidner et al. (2015).

Digitalization: ^aEling and Lehmann (2018); ^bHasse et al. (2017); ^cHensher (2017); ^dJahn, Heyen, and Walder (2014); ^eKPMG (2015); ^fKuhnert et al. (2017); ^gLinden and Wittmer (2018); ^hMenon et al. (2019); ⁱMorgan Stanley and BCG (2016); ^jSpri (2018); ^kThiele and Schmidt-Jochmann (2015); ^lWilling et al. (2017).

Environmental awareness/sustainability: ^aBergman et al. (2017); ^bCRO Forum (2018); ^cFenton (2016); ^dHaustein and Nielsen (2016); ^eJahn et al. (2014); ^fLinden and Wittmer (2018); ^gThiele and Schmidt-Jochmann (2015).

Individualization and flexibilization: ^aHensher (2017); ^bKPMG (2015); ^cLinden and Wittmer (2018); ^dMorgan Stanley and BCG (2016); ^eMatley, Gandhi, et al. (2016); ^fMatouschek and Stricker (2013); ^gNovikova (2017); ^hThiele and Schmidt-Jochmann (2015); ⁱWilling et al. (2017); ^jZukunftsinstitut (2017).

Urbanization: ^aChatterjee et al. (2018); ^bCRO Forum (2018); ^cDelbosch and Curie (2014); ^dKlein and Smart (2017); ^eKuhnimhof et al. (2012); ^fLinden and Wittmer (2018); ^gMcDonald (2015); ^hMelia, Chatterjee, and Stokes (2018); ⁱNovikova (2017); ^jThiele and Schmidt-Jochmann (2015); ^kWilling et al. (2017).

Abbreviation: SAE, Society of Automotive Engineers.

A third major trend is shared mobility with the aim of creating and providing new mobility concepts, especially in urban areas in order to avoid the negative aspects of car ownership. In particular, flexibility and individuality are still ensured (Shaheen & Cohen, 2007), while congestion and pollution are reduced. Business models such as car sharing⁴ aim for an efficient usage of a vehicle during its lifetime, for example, acknowledging the fact that the average parking duration during the life cycle of a car (private ownership) is estimated to be up to 95% (Willing et al., 2017).⁵ Furthermore, instead of buying and thus owning an object, consumer needs are changing toward increasingly usage-oriented patterns (e.g., Bardhi & Eckhardt, 2012), which is partially reflected in a decrease in the “auto-orientation” of the young generation (Kuhnimhof, Buehler, & Dargay, 2011; Kuhnimhof et al., 2013). Apart from car sharing, another mobility model in the sharing economy is ride hailing, with Uber, Sidecar or Lyft as prominent providers (Clewlow & Mishra, 2017; McPeak, 2016).

⁴Bauwens, Mendoza, and Iacomella (2012) distinguish business-to-customer, peer-to-peer, and nonprofit car-sharing organizations. Business-to-customer solutions refer to station-based and free-floating car-sharing concepts that are offered via platforms. The services in these cases go back to the car-sharing engagement of OEMs, rental car companies or independent car-sharing providers. Car sharing can be considered as a niche market with positive long-term growth expectations in urban areas/cities (Clewlow & Mishra, 2017; Novikova, 2017; Shaheen & Cohen, 2007).

⁵Estimates on average car parking durations also include, for instance, sleeping times. Willing et al. (2017) refer for a critical evaluation to <https://www.reinventingparking.org/2013/02/cars-are-parked-95-of-time-lets-check.html>, accessed: 19/09/2019.

TABLE 2 Major trends (see Table 1) and their potential consequences for the automobile insurance industry

Downward pressure on premiums	Changing risk landscape	Changing product landscape: product recall, product liability, cyber risk, short-term, and on-demand coverage sale/with partners	Shift toward integrated bundles of products distributed at the point of sale/with partners
<p>New mobility concepts: Autonomous vehicles</p> <ul style="list-style-type: none"> ▪ Reduced accident rates versus higher costs of repair/replacement costs^{e-f} 	<ul style="list-style-type: none"> ▪ Potential to reduce accident risk (human errors as the major reason for traffic accidents and thus essential risk driver)^{b,e,f,h,i,k} ▪ In general shift from human mistakes toward software and hardware components failure: potential hacker attacks, malfunctioning software and hardware components, sensor failures, and communication errors between conventional and (future) automated vehicles^c 	<ul style="list-style-type: none"> ▪ Shifting risk landscape in the context of autonomous vehicles implies shift toward product recall, product liability, and cyber risk coverage^c 	-
		<ul style="list-style-type: none"> ▪ Higher proportion of fleet risks as autonomous vehicles may preferably be shared^{l,m} with risk of improper vehicle use as it is not owned by the driver (linked to fraud and moral hazard), high utilization rate of a single vehicle in terms of the number of drivers/users and travel time^l 	
		<ul style="list-style-type: none"> ▪ New mobility concepts may require new risk assessment methodologies, especially due 	

TABLE 2 (Continued)

Downward pressure on premiums	Changing risk landscape	Changing product landscape: product recall, product liability, cyber risk, short-term, and on-demand coverage	Shift toward integrated bundles of products distributed at the point of sale/with partners
	<p>to a lack of data (quantity and quality)^{b,f,g-j}</p> <ul style="list-style-type: none"> ▪ Enhanced fraud detection may reduce accident frequency^e ▪ Increasing risk of cyber attacks (as autonomous vehicles are connected)^g 	<ul style="list-style-type: none"> ▪ Increasing relevance of short-term and on-demand car sharing, ride sharing, and lease-to-share requiring (new) insurance solutions^{a,e} 	-
<p>New mobility concepts: Shared mobility</p>	<ul style="list-style-type: none"> ▪ Potentially reduced number of privately used (and thus insured) vehicles and more fleet providers with, for example, higher deductibles^{c,h,j} versus a new customer group (driving without own vehicle)ⁱ 	<ul style="list-style-type: none"> ▪ Fleet risks from sharing business models: high utilization rate of shared vehicles that are mainly operated in dense, urban areasⁱ ▪ Shared mobility concepts require adjusted risk assessment methodologies, for example, due to a lack of data (quantity and quality) and new risks from connectivity^{b,d,f-i} 	-
<p>Demographic change</p>	<ul style="list-style-type: none"> ▪ Decreasing or changing population figures with potentially negative impact on insurance portfolio size^b 	<ul style="list-style-type: none"> ▪ Increasing proportion of mature age groups with a demand for a high degree of (urban) mobility, up to advanced ages^a 	-

(Continues)

TABLE 2 (Continued)

	Downward pressure on premiums	Changing risk landscape	Changing product landscape: product recall, product liability, cyber risk, short-term, and on-demand coverage	Shift toward integrated bundles of products distributed at the point of sale/with partners
Digitalization	–	<ul style="list-style-type: none"> Emerging (cyber) risks due to increasing connectivity of shared/autonomous cars^a 	<ul style="list-style-type: none"> New digital technologies as enablers of new mobility concepts (e.g., smartphone-based access to shared vehicles)^{c,e,f} New products in the field of cyber or usage-based insurance in the context of shared/autonomous (and thus connected) cars^b 	<ul style="list-style-type: none"> Digital technologies enable increasing engagement in the field of automotive aftersales services by offering digital-based services: assistance/mobility guarantees (e.g., automated service reminders or e-calls in case of accidents)^{c–f} Digitalization as a driver of simplified consumption (“one-stop shopping”)^f
Environmental awareness/sustainability	–	<ul style="list-style-type: none"> Development of new sustainable mobility concepts (e.g., with alternative drivetrain technologies) requires insurance coverage with new types of risks^a 	<ul style="list-style-type: none"> Changing customer expectations regarding new mobility concepts (e.g., electric vehicles) that in turn require insurance^{a–d} 	–
Individualization and flexibilization	–	<ul style="list-style-type: none"> Individualization and flexibilization lead to more short-term access instead of long-term car ownership due to sharing, with potential 	<ul style="list-style-type: none"> Changing customer expectations regarding new short-term on-demand mobility concepts that in 	<ul style="list-style-type: none"> Increasing flexibilization of product components and customer interaction channels required^{b–d,f}

TABLE 2 (Continued)

Downward pressure on premiums	Changing risk landscape	Changing product landscape: product recall, product liability, cyber risk, short-term, and on-demand coverage sale/with partners	Shift toward integrated bundles of products distributed at the point of sale/with partners
<p>Urbanization</p> <ul style="list-style-type: none"> Potential negative impact of urbanization on vehicle ownership lowers automobile insurance business potentials^e 	<p>behavioral changes of a driver that potentially increase the claims frequency^e</p> <ul style="list-style-type: none"> Vehicle usage primarily in cities/dense traffic area causes a change in the automobile risk landscape (high traffic loads with potential impact on accident frequency)^e 	<p>turn require insurance coverage^{a-c,f}</p> <ul style="list-style-type: none"> Increasing relevance of car, ride sharing and lease-to-share specifically in urban areas with need for insurance coverage^{a-f} 	<ul style="list-style-type: none"> OEMs increasingly provide comprehensive and individualized automobile product bundles directly at the point of sale of a vehicle^{a,b}

New mobility concepts: Autonomous vehicles: ^aAnderson and Werner (2016); ^bCRO Forum (2017); ^cGDV (2017); ^dFastenrath and Keller (2016); ^eMatley, Carrier, Gandhi, Tomopoulos, and Peterson (2016); ^fMatley, Gandhi, et al. (2016); ^gMorgan Stanley and BCG (2016); ^hMunich Re (2016); ⁱRao (2016); ^jShaheen, Meyn, and Wipiewski (2003); ^kSheehan et al. (2017); ^lSkeete (2018); ^mSprei (2018).
 New mobility concepts: Shared mobility: ^aAIG (2018a); ^bCRO Forum (2017); ^cJahn et al. (2014); ^dMatley, Gandhi, et al. (2016); ^eNovikova (2017); ^fMunich Re (2016); ^gMorgan Stanley and BCG (2016); ^hRao (2016); ⁱShaheen et al. (2003); ^jWeidner et al. (2015).
 Demographic change: ^aThiele and Schmidt-Jochmann (2015); ^bWeidner et al. (2015).
 Digitalization: ^aAnderson and Werner (2016); ^bEling and Lehmann (2018); ^cJahn et al. (2014); ^dKPMG (2015); ^eMorgan Stanley and BCG (2016); ^fThiele and Schmidt-Jochmann (2015).
 Environmental awareness/sustainability: ^aJahn et al. (2014); ^bKPMG (2015); ^cMorgan Stanley and Stricker (2013); ^dMatouschek and Stricker (2013); ^eMorgan Stanley and BCG (2016); ^fShaheen et al. (2003); ^gThiele and Schmidt-Jochmann (2015).
 Individualization and flexibilization: ^aJahn et al. (2014); ^bKPMG (2015); ^cMorgan Stanley and BCG (2016); ^dNovikova (2017); ^eThiele and Schmidt-Jochmann (2015).
 Abbreviation: OEM, original equipment manufacturer.

Masuch et al. (2013) describe the future mobility landscape as a smart as well as a time- and cost-efficient combination of buses, trains, and ride or bike sharing as alternative modes of transportation. Overall, the increasing number of sharing services implies a downward trend for vehicle ownership (e.g., Elliot & Shaheen, 2011; Martin, Shaheen, & Lidicker, 2010).

2.2 | Demographic change

Within the “mobility ecosystem”, demographic change is of relevance due to an increasingly elderly population (Focas & Christidis, 2017; Linden & Wittmer, 2018; Thiele & Schmidt-Jochmann, 2015; Weidner et al., 2015) that is of special relevance for Western Europe and North America (Linden & Wittmer, 2018) with needs for specific mobility solutions, for example, up to higher ages and for short distances (Thiele & Schmidt-Jochmann, 2015).

2.3 | Digitalization

We follow the terminology in Eling and Lehmann (2018, p. 362), who refer to *digitization* as technical processes that are, for example, capable of digitizing (analog) data, while *digitalization* is associated with a wide-ranging economic and societal change. Digitalization is thus “the integration of analogue and digital worlds with new technologies that enhance customer interaction, data availability and business processes” (Eling & Lehmann, 2018, p. 363), which is also of relevance in the context of new mobility concepts. At the same time, it also induces a behavioral change such as a shift toward more digital consumption of customers, which also concerns mobility needs and mobility behavior in regard to individual transportation (e.g., Linden & Wittmer, 2018; Morgan Stanley & BCG, 2016).

2.4 | Environmental awareness/sustainability

An increasing societal awareness regarding the environment is also of relevance in our context, with extreme weather conditions, overfishing, air pollution, consumption of plastics, diesel emission, shortage of water, shortage of resources, and wildfires being emphasized as environmental key issues (CRO Forum, 2018), which supports an increasing prevalence of alternative drivetrain technologies and sustainable mobility concepts (e.g., Egbue & Long, 2012) such as shared mobility concepts that employ electric vehicles (Linden & Wittmer, 2018).

2.5 | Individualization and flexibilization

The trend of individualization and flexibilization captures the increasing need for individual lifestyle flexibility that impacts the organization of private life as well as professional working conditions (Linden & Wittmer, 2018; Zukunftsinstitut, 2017). Against this background, the future of mobility is also increasingly heterogeneous with a growing number of short-term and on-demand mobility concepts to satisfy individual needs. In this context, “multimodality” refers

to different kinds of transportation modes that are generally available during journeys, while a combination of different transportation modes during one journey is referred to as “intermodal mobility” (Hensher, 2017; Willing et al., 2017). “Mobility as a service” also becomes more important, driven by new digital technologies (Hensher, 2017; Willing et al., 2017), and is also highly relevant for automobile insurance product components (KPMG, 2015; Matouschek & Stricker, 2013; Morgan Stanley & BCG, 2016; Thiele & Schmidt-Jochmann, 2015).

2.6 | Urbanization

Lastly, urbanization refers to the increasing concentration of population in dense, urban areas (Chatterjee et al., 2018; CRO Forum, 2018; Linden & Wittmer, 2018), which can imply a (potentially) lower number of privately owned vehicles in urban areas (Thiele & Schmidt-Jochmann, 2015) due to, for example, inefficient traffic organization and a lack of parking facilities (e.g., Chatterjee et al., 2018). At the same time, these developments also lead to increasing demand for alternative mobility concepts that aim to solve the issues of individual transportation in urban areas (e.g., Linden & Wittmer, 2018; Novikova, 2017).

3 | POTENTIAL CONSEQUENCES OF MAJOR TRENDS AND STRATEGIC RESPONSE MEASURES FROM THE PERSPECTIVE OF AUTOMOBILE INSURERS

To assess the potential consequences of the trends shown in Table 1 and to identify strategic response measures, we additionally evaluate recent practitioner-oriented studies. Table 2 displays the results.⁶ In what follows, each consequence is discussed in detail, followed by a list of potential strategic response measures from the perspective of the automobile insurance industry.

3.1 | Downward pressure on future automobile insurance premiums

Even though the automobile insurance industry is already often characterized by strong competitiveness and pressure on margins (e.g., Weidner et al., 2015), the growth potential from the conventional automobile insurance business might come under further pressure due to the developments resulting from the trends laid out in Table 1. In particular, while the overall consumption of mobility is generally expected to increase (Linden & Wittmer, 2018; Zukunftsinstitut, 2017), the number of vehicles privately owned and conventionally used is expected to drop in the long run (e.g., Hasse et al., 2017; Kuhnert et al., 2017). Younger age groups are thereby discussed as dominant stakeholders to use mobility concepts that increasingly complement or replace conventional vehicle use and ownership in urban areas (Kuhnimhof et al., 2012; McDonald, 2015; Melia et al., 2018). Consequently, as one main effect, a significant downward pressure on future automobile insurance premiums is expected (e.g., Matley, Carrier, et al., 2016; Matley, Gandhi, et al., 2016; Sheehan et al., 2017; Weidner et al., 2015), stemming from (a) the effects of the demographic change due to the inherent reduction

⁶Note that electric vehicles are not included as they appear to be only of minor relevance to the automobile insurance industry, as accident severity rates, due to the additional fire and explosion risk potentials, do not increase in a relevant way according to Jahn et al. (2014).

of the number of insured vehicles (Thiele & Schmidt-Jochmann, 2015; Weidner et al., 2015) and (b) the trend toward autonomous and shared vehicles.

With respect to the second point, a prevalence of autonomous vehicles affect accident frequency (positively) and severity (negatively), overall expecting a reduction in premium volumes: On the one hand, advanced driver assistance systems such as automated braking systems and enhanced accident prevention technologies reduce the intensity of an accident (e.g., in regard to bodily injuries) (Matley, Carrier, et al., 2016). On the other hand, repair and replacement costs due to cost-intensive vehicle parts and accessories may increase. Overall, accident frequency is expected to decrease, but with a remaining degree of uncertainty (Fastenrath & Keller, 2016; GDV, 2017; Matley, Carrier, et al., 2016; Matley, Gandhi, et al., 2016),⁷ which may result in lower motor insurance premiums as the penetration rate of autonomous vehicles increases (Matley, Carrier, et al., 2016; Matley, Gandhi, et al., 2016).⁸

The sharing economy also has two effects. Due to the potentially reduced number of privately used and therefore insured vehicles, the increasing adoption of shared mobility concepts would also have a negative impact on premium growth, which, however, could be dampened by the attraction of occasional drivers as (new) insureds (Jahn et al., 2014; Rao, 2016; Weidner et al., 2015).⁹ Also, commercial fleet providers including car-sharing organizations typically apply self-insurance strategies with comprehensive coverage waivers or high deductibles (Jahn et al., 2014; KPMG, 2015; Matley, Gandhi, et al., 2016; Shaheen et al., 2003). The combined effect of autonomous vehicles that are operated in shared fleets would thus intensify a reduction in premium volumes (Matley, Carrier, et al., 2016). Jahn et al. (2014) further point out that insurers have to increasingly negotiate with professional fleet providers.

Thus, the market environment becomes even more competitive (Jahn et al., 2014; KPMG, 2015), and it is even more vital for automobile insurers to define their value for different stakeholders, including drivers, vehicles owners, and vehicles in the transformed “mobility ecosystem” (e.g., Matley, Gandhi, et al., 2016).

To counteract the downward pressure on premiums, based on the literature we identify the following strategic response measures that automobile insurers should consider implementing:

- Offer key competences in the field of self-insurance strategies and product liability concerning technical underwriting or risk assessment¹⁰ (market potential according to KPMG (2015): up to 7.5 bn euros until 2030; Jahn et al. (2014): up to 9 bn euros until 2030)
- Evaluate ability to engage (more) in the automobile fleet insurance business with commercial customers with respect to underwriting expertise, claims management, and appropriate pricing strategies¹¹
- Establish omnichannel distribution strategy and business-to-business distribution (e.g., via providers of autonomous vehicles)¹²

⁷The GDV (2017) comprehensive discusses the potential effects of autonomous driving on claims expenditure until 2035, where the forecast distinguishes between fully comprehensive coverage and motor third-party liability products.

⁸Matley, Carrier, et al. (2016) forecast that enhanced traffic safety, due to the continuously expanding market penetration of advanced driver assistance systems, could trigger a decrease in motor insurance premiums up to 30% until 2040 (reference year: 2016).

⁹An autonomous vehicle that is operated in an autonomous fleet can replace up to nine conventional vehicles (Rao, 2016).

¹⁰See Jahn et al. (2014) and KPMG (2015).

¹¹See Jahn et al. (2014), KPMG (2015), Matley, Gandhi, et al. (2016), Morgan Stanley and BCG (2016), and Rao (2016).

¹²See KPMG (2015) and Rao (2016).

- Employ digital technologies to enhance customer experience and loyalty, for example, robo-advisory, engagement in social media, and online channels¹³
- Maintain competitiveness by reducing costs, for example, by means of a more efficient and effective design of (internal) processes (e.g., partly automated and enhanced claims processing)¹⁴ and by optimizing existing (conventional) automobile insurance business,¹⁵ for example, by exploiting standardized and fully developed IT infrastructures as important competitiveness factors¹⁶
- Evaluate new business opportunities (partnering strategies, new product strategy; see the following discussion of separate consequences)¹⁷

3.2 | Changing risk landscape

Closely related to the previous consequence is the changing risk landscape. In particular, as described above, autonomous driving impacts the frequency and severity of losses in the automobile insurance industry (e.g., Matley, Gandhi, et al., 2016; Sheehan et al., 2017). It also comes with new emerging risks, such as potential hacker attacks,¹⁸ malfunctioning software and hardware components, sensor failures, and communication errors between conventional and (future) automated vehicles, which influence future product design as well as the risk exposure covered by the insurer (GDV, 2017). Apart from that, enhanced fraud detection due to more data about the vehicle during an accident can positively contribute to a reduction in accident frequency rates (Matley, Carrier, et al., 2016).¹⁹

The risk landscape is also impacted by shared vehicles and the resulting fleet risk, which pose further challenges for the automobile insurers, as it considerably differs from that of privately used and owned vehicles (Jahn et al., 2014; Rao, 2016; Thiele & Schmidt-Jochmann, 2015). In particular, the former is predominantly determined by the size of the sharing community in terms of members and the scale of the fleet in terms of vehicles. In addition, the risk exposure of insurance companies increases, as car sharing insurance coverage is mainly required in dense urban areas with high traffic loads, and due to risks resulting from behavioral changes of drivers (individualized on-demand short-term access with car sharing) that potentially increase the claims frequency, for example, unauthorized users renting a vehicle and fraud (Shaheen et al., 2003).

Further challenges arise in case of an increasingly elderly population with potentially higher accident rates (Thiele & Schmidt-Jochmann, 2015) as well as new coverage in the field of, for example, alternative drivetrain technologies (Jahn et al., 2014) and risks resulting from behavioral changes of drivers (short-term access with car sharing) that potentially increase the claims frequency.

¹³See Schanz and Sommerrock (2016).

¹⁴See CRO Forum (2017) and Morgan Stanley and BCG (2016).

¹⁵See Thiele and Schmidt-Jochmann (2015).

¹⁶See KPMG (2015), Morgan Stanley and BCG (2016), and Thiele and Schmidt-Jochmann (2015).

¹⁷See KPMG (2015), Matley, Gandhi, et al. (2016), Morgan Stanley and BCG (2016), and Thiele and Schmidt-Jochmann (2015).

¹⁸For instance, the connected systems of autonomous vehicles can be hacked, implying an interference with driving functionalities or the misuse of personal (driving) data (Munich Re, 2016).

¹⁹Matley, Carrier, et al. (2016) estimate that 13–17% of reported motor insurance claims are false (amount/cause of damage).

A major challenge regarding the resulting risk landscape concerns limited access to historical claims experiences and a lack of historical data, which is why insurers are forced to further develop their risk assessment methodologies (AIG, 2018a; Matley, Gandhi, et al., 2016; Rao, 2016). In this context, Anderson and Werner (2016) highlight the importance of insurers to be engaged in telematics products. Even if the market potential of newly developed products is uncertain, it represents an important method to access driver and therefore customer data. As alternative way of collecting data, other noninsurance market participants such as OEMs, telecommunication firms, providers of mobile applications, or map providers often already collect these data in a very comprehensive way (exploiting the existing connectivity between devices, for instance), without suffering losses from automobile insurance claims as in case of collecting data from insuring a conventional rental car company. The main challenge for insurers herein is to validate the provided data (AIG, 2018a).

The literature suggests several strategic response measures for the automobile insurance industry to more efficiently deal with risks and exploit opportunities associated with the future changed risk landscape:

- Employ advanced data analytics approaches to optimize risk analyses,²⁰ for example, by employing vehicle attributes instead of risks associated with individual (human) driving qualities²¹
- Identify and continuously assess mobility trends as a fundamental aspect of profitable underwriting²²
- Ensure sufficient resources and underwriting quality in case of fleet business²³
- Interdisciplinary underwriting expertise on both private and commercial business lines as a future key competence²⁴
- On-board diagnostics as components of autonomous (connected) vehicles can help to improve claims settlement (reduction of legal costs).²⁵

3.3 | Changing product landscape: Product recall, product liability, cyber risk, short-term, and on-demand coverage

One consequence of the changing risk landscape described in the previous subsection is a change in the product landscape, shifting toward product recall, product liability, cyber risk, short-term, and on-demand coverage.

Future liability structures are expected to fundamentally change, as mobility concepts associated with autonomous vehicles induce a shift from erring human operators toward machine-driven defects (CRO Forum, 2017; Matley, Carrier, et al., 2016; Matley, Gandhi, et al., 2016; Munich Re, 2016; Rao, 2016; Sheehan et al., 2017).²⁶ Combined with an increasing relevance of shared

²⁰See Morgan Stanley and BCG (2016) and Schanz and Sommerrock (2016).

²¹See Matley, Gandhi, et al. (2016) and Sheehan et al. (2017).

²²See KPMG (2015), Jahn et al. (2014), and Thiele and Schmidt-Jochmann (2015).

²³See Jahn et al. (2014).

²⁴See AIG (2018a).

²⁵See Rao (2016).

²⁶Munich Re (2016) specifies that in case of an SAE automation level 4, where the driving task is mainly undertaken by the vehicle, insurance products covering product recall and product liability events will gain in importance, along with cyber risk coverage (see also Anderson & Werner, 2016).

mobility concepts, which are mostly characterized by online platform solutions, the literature thus expects a shift from private to commercial automobile insurance products, mainly due to (a) an expected increasing prevalence of autonomous vehicles operated in fleets, (b) the stepwise liability transfer to OEMs, suppliers and software providers (e.g., AIG, 2018b; Sheehan et al., 2017), and (c) lower vehicle ownership rates (AIG, 2018a), where especially the younger generation is said to perceive owning a vehicle as less and less fundamental (KPMG, 2015; McDonald, 2015).

Moreover, Tables 1 and 2 emphasize the increasing relevance of demand-oriented and user-centered mobility solutions (e.g., short-term/on-demand accessibility especially in urban areas). Optimized journey times and travel expenses, as well as the level of comfort, become important determinants for preferred modes of individual transportation (Milakis et al., 2017; Novikova, 2017; Zhang et al., 2018). In general, recent mobility studies (e.g., Linden and Wittmer, 2018) highlight that advanced digital technologies are crucial for future on-demand mobility concepts, for example, by allowing easy, smartphone-based access to shared vehicles. Processes that are provided online facilitate implementation and coordination between users and shared mobility platforms, and therefore lead to an enhanced consumer experience (Novikova, 2017; Shaheen & Cohen, 2007). The resulting flexible, shared (urban) mobility concepts require a shift toward more customer-oriented, on-demand motor insurance products with flexible insurance coverage (Jahn et al., 2014; Munich Re, 2016; Rao, 2016).

Thiele and Schmidt-Jochmann (2015) furthermore point to the demographic change associated with an increasing proportion of mature age groups demanding a high degree of flexible mobility concepts up to advanced ages, in turn implying that the motor insurance customer group of insured seniors (in terms of age) would, at least to a certain extent, gain in importance. Thus, taking appropriate measures in product design including amended actuarial risk ratings, as well as suitable distribution options which take into account transformed mobility needs for each age group, becomes a strategic necessity in order to maintain automobile insurance business in the long term (also Weidner et al., 2015).

Strategic response measures for automobile insurers to address the potential change in the product landscape toward product recall, product liability, cyber risk, short-term, and on-demand coverage include:

- Increase engagement in product recall and product liability²⁷
- Increase engagement in automobile cyber and IT security (e.g., to avoid hacker attacks)²⁸
- Develop flexible range of products for on-demand/demand-driven new mobility concepts (autonomous, electric, shared)²⁹ that can, for example, employ usage-based insurance³⁰
- Focus (also) on senior customers with different needs regarding mobility at higher ages (and different risk exposures)³¹

²⁷See AIG (2018b), Anderson and Werner (2016), CRO Forum (2017), KPMG (2015), Morgan Stanley and BCG (2016), Munich Re (2016), and Sheehan et al. (2017).

²⁸See AIG (2018b), Anderson and Werner (2016), CRO Forum (2017), KPMG (2015), Morgan Stanley and BCG (2016), Munich Re (2016), and Sheehan et al. (2017).

²⁹See Jahn et al. (2014).

³⁰See Anderson and Werner (2016), Rao (2016), and Thiele and Schmidt-Jochmann (2015).

³¹See Thiele and Schmidt-Jochmann (2015).

3.4 | Shift toward integrated bundles of products distributed at the point of sale/with partners

Several studies describe an increasing relevance of integrated bundles of products that not only cover automobile risks, for example, bodily injury or property liability, but also additional services related to the usage of autonomous or electric vehicles as well as shared mobility (Matouschek & Stricker, 2013; Morgan Stanley & BCG, 2016; Rao, 2016; Thiele & Schmidt-Jochmann, 2015), for example, (digital-based) services related to damage or vehicle breakdown events (Jahn et al., 2014). In this context, KPMG (2015) emphasize the tendency of OEMs to increasingly provide comprehensive and integrated product bundles, directly distributed via the point of sale of a vehicle. The packages include products and services with financing, leasing, maintenance, or integrated insurance coverage, often provided by in-house insurance services of OEMs, based on cooperation models with automobile insurers acting as their counterparts (Jahn et al., 2014; KPMG, 2015). The white-label product provider role is thereby critically recognized by Thiele and Schmidt-Jochmann (2015) due to the insurer's lack of customer interface access.

Against this background, we identify the following strategic response measures in the literature:

- Strategic partnership with OEMs to access customer interface³²
- Strategic positioning at the point of sale (e.g., by offering integrated bundles of products that combine the risk-bearing function with additional service components)³³
- Develop new (digital) mobility service offerings (e.g., infotainment services) at conventional customer touchpoints (financing, maintenance, accident/breakdown, guarantee)³⁴
- Increase cooperation at the point of sale between OEMs, shared mobility organizations (e.g., car-sharing/ride-sharing providers) or other firms, for example, credit card firms, telecommunication firms, telematics providers, data aggregators³⁵

4 | SUMMARY

In this article, we examined the impact of the future of mobility on the automobile insurance business and derived a list of strategic response measures. For automobile insurers, one main challenge arises due to the fact that the scale of expected changes is not purely determined by insurance parameters (Jahn et al., 2014). To comprehensively understand future challenges in more detail and to determine response measures, it is necessary to develop a detailed awareness of the complex “mobility trend” and its relationship with other major trends.

Based on the selected literature, we first explained the relevant trends that are of relevance for future mobility concepts. As automobile insurance-relevant trends, we identified demographic change, digitalization, environmental awareness and sustainability, individualization and flexibilization as well as urbanization based on a literature review. We further focus on the

³²See KPMG (2015) and Thiele and Schmidt-Jochmann (2015).

³³See Jahn et al. (2014), KPMG (2015), Matley, Gandhi, et al. (2016), Morgan Stanley and BCG (2016), Thiele and Schmidt-Jochmann (2015), and Rao (2016).

³⁴See Jahn et al. (2014), KPMG (2015), Morgan Stanley and BCG (2016), and Thiele and Schmidt-Jochmann, (2015).

³⁵See KPMG (2015), Matley, Gandhi, et al. (2016), and Morgan Stanley and BCG (2016).

three major trends regarding new mobility concepts: autonomous driving, electric mobility, and shared mobility. Our results show that the majority of the literature expects the multiple trends to have a significant downward pressure on the future level of motor insurance premiums. An in-depth understanding of trends is especially vital in order to properly assess the underlying risk structures for each level of automation, shared mobility concepts or alternative driving technologies, in order to ensure long-term profitable business. In particular, there appears to be an increasing need for insurers to amend existing underwriting models and actuarial methods to adequately take into account the changed risk landscape. Risk exposure due to autonomous driving substantiates the increasing future need for product recall and product liability coverage. An appropriate database with respect to quantity and quality is also important. Furthermore, integrated product bundles, based on cooperation models and offered at the point of sale, are gaining momentum. However, the presented developments are not only about a transformation in terms of products and the required shift toward more customer-oriented, on-demand motor insurance products. An increasing number of vehicles operated in fleet units is leading to a shift from private toward commercial insurance lines. Customer groups, in turn, potentially move from private individuals toward commercial fleet providers, an expected development that is strongly emphasized in both the academic and the practitioner-oriented literature.

If the outlined trends, especially shared and electric vehicles, are categorized as niche markets and the market launch of autonomous vehicles is considered as a highly uncertain (or even unlikely) future vision, there would hardly be a need for automobile insurers to consider a transformation of their business model. However, these trends should not be underestimated and should be subject to future research; in the least, autonomous vehicles, along with the consumer-focused mobility concepts, cause a significant change regarding overall road safety, with potentially reduced premium volumes, in the long run. The environment is thus forcing automobile insurers to develop innovative insurance solutions in order to create new business opportunities. The strategic measures depend on size, portfolio mix, and business scope as well as expertise in order to provide appropriate insurance coverage to different stakeholders within the future mobility landscape.

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