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Potential impacts of autonomous vehicles on the UK insurance sector



Potential impacts of autonomous vehicles on the UK insurance sector

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- The development and uptake of autonomous vehicles (AVs) is likely to be gradual. Nonetheless a survey of industry experts highlights the diversity of responses and suggests rapid uptake is possible. This reflects differing views on the extent of the many technological, ethical and regulatory hurdles that remain.
- Under the central forecast, based on the average of all responses, we would expect a contraction of the UK motor insurance market of 21% by 2040. In contrast capital requirements are only expected to fall by 12% as bodily injury claims make up an increasing proportion of an insurer's outstanding liabilities.
- For insurers a gradual introduction of AVs may allow time to adapt. However, questionnaire responses highlighted the need to transform aspects of the current insurance value chain, including claims management, underwriting and product development. We also expect future success to increasingly rely on partnerships with technology firms and manufacturers.

Overview

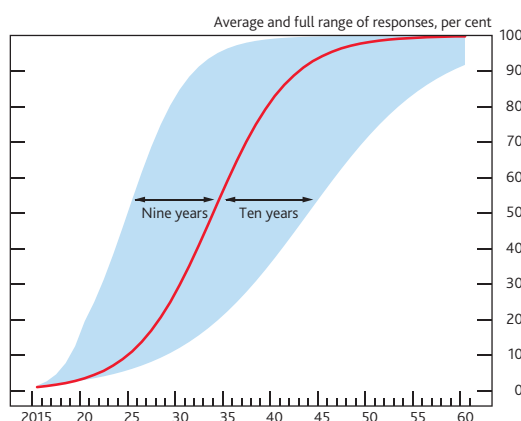
The development of autonomous vehicles (AVs)⁽²⁾ in the United Kingdom is likely to have profound effects. The automation of transport should result in higher productivity and lower costs for business, while for individuals AVs offer mobility for those currently unable to drive, reduced congestion and improved safety. The combination of lower travel costs and greater availability of vehicles for hire may also reduce the need for ownership.

In our first research dedicated to AV we consider the potential impact on the motor insurance market, which generates a total annual premium of £15.6 billion. We have used a questionnaire to engage with technology and insurance experts, translating their answers into a model that forecasts this insurance sector.

The average of questionnaire responses ('central estimate'), suggests that AVs will account for 80% of new vehicle sales in 2040. In general, technology firms expect adoption of AVs considerably sooner than insurers: the most optimistic and pessimistic responses differ in timing by almost two decades.

The central estimate indicates a 21% fall in market premium by 2040, suggesting a gradual introduction of AVs that

Summary chart Percentage of new vehicles per year sold that are autonomous



should allow the insurance industry to adapt. In addition to the rate of adoption, our research highlights how the nature of risks may change, with the expected benefit of fewer crashes offset to some extent by a rise in severity of infrequent large losses (eg cyber-attacks). As a prudential regulator, these shifts raise a number of questions including the ongoing suitability of the capital regime, and whether current reporting is sufficient to monitor key trends.

(1) The authors would like to thank the questionnaire respondents, as well as Megan Bell and Anirvan Choudhury for their help in producing this article.

(2) Throughout the article an AV refers to a vehicle at either level 4 or 5 automation as per the Society of Motor Manufacturers and Traders (SMMT) definition (meaning no manual intervention required for the driving task under specific circumstances (level 4) or at all times (level 5)).

Introduction

There are currently around 38.5 million vehicles⁽¹⁾ in the United Kingdom driving over 300 billion miles annually. Yet it is estimated that these vehicles are parked for 95% of the time⁽²⁾ and that drivers waste an average of 127 hours a year stuck in traffic in the most congested towns, cities and trunk roads.⁽³⁾

By addressing these issues, autonomous vehicles (AVs) can provide a genuine benefit, and it is therefore unsurprising that this technology has captured the media's imagination and attracted substantial investment in both the private and public sectors. This encompasses both retail and commercial uses, and links into a wider trend towards reduced asset ownership and the potential move to a 'sharing economy', particularly among the younger generation.

The Government has made it clear⁽⁴⁾ that it would like to secure the United Kingdom's position at the forefront of the development, construction and use of automated vehicle technologies, and highlights the following potential benefits:

- **Creating more free time:** the average driver in England spends 235 hours per year behind the wheel,⁽⁵⁾ all of which would theoretically become available for other activity (whether work or leisure) following a shift to AVs.
- **Improving road safety:** today over 90% of road traffic collisions are caused by human error.
- **Reducing emissions and easing congestion:** improved traffic flow with associated benefits in the level of emissions.
- **Enhancing mobility:** increasing transport options for those who currently cannot drive.

Motor manufacturers and technology firms also see the potential for a seismic shift in the way we travel with many having already invested heavily over a number of years. Some are bullish on the timelines for development, already releasing so-called 'autopilot' functionality. Others intend to make the leap to full autonomous capability, forgoing the interim technology. Despite these distinct approaches, one thing is common: manufacturers want to establish themselves as leaders in a revolutionised motor industry. It is also increasingly clear that the question is no longer if AVs are coming, but when.

The Prudential Regulation Authority's (PRA's) interest in AVs stems from the potential impact on the motor insurance industry. As the United Kingdom's prudential regulator for financial firms, it has a specific insurance objective — to secure

an appropriate degree of protection for policyholders. In practice this requires firms to hold a minimum level of capital (known as regulatory capital) above that required to pay claims, and to demonstrate that they are managed in a prudent manner.

For General Insurance supervisors the United Kingdom's motor insurance market is particularly relevant as it:

- Represents the largest and most competitive general insurance line of business, accounting for £15.6 billion gross written premium in 2015.⁽⁶⁾
- Is a compulsory product; which means that all UK drivers are required to purchase a minimum level of insurance cover. As a result, the failure of any large insurer could cause significant disruption to mobility and transportation in the United Kingdom.

The aim of this research was to enhance the Bank's understanding of the main areas of uncertainty, and to engage with a wide range of experts in this field. In this first piece of AV research we take a deeper look at the insurance sector to understand the potential market impacts and challenges in the years ahead. We then follow up with a discussion of broader societal and technological aspects of AV technology that may accelerate or act as a barrier to the introduction of AVs. The final section concludes by recognising the current limited scope of the research, and how future work could evolve to assist the Bank's broader remit of understanding the implications for GDP, and hence monetary policy, as well as financial stability.

(1) Department for Transport (2016), available at www.gov.uk/government/statistical-data-sets/all-vehicles-veh01.

(2) www.reinventingparking.org/2013/02/cars-are-parked-95-of-time-lets-check.

(3) TomTom research reported on <http://news.sky.com/story/many-drivers-spend-127-hours-a-year-in-traffic-10214621>.

(4) www.gov.uk/government/uploads/system/uploads/attachment_data/file/581577/pathway-to-driverless-cars-consultation-response.pdf.

(5) Civil Service Quarterly, available at <https://quarterly.blog.gov.uk/2015/03/19/the-future-of-driving-2/>.

(6) PRA returns plus an estimate for insurance provided by entities passporting into the United Kingdom.

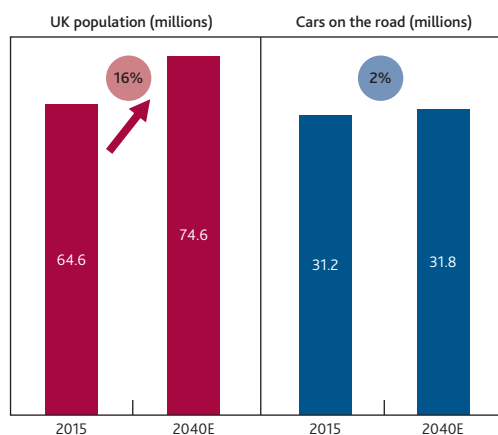
Forecasting the impact and challenges on the insurance industry

To assess the potential impacts of AVs on the insurance sector we developed a model that projects (i) the number of personal and commercial AVs in the UK car parc⁽¹⁾ up to 2040, and (ii) the consequent impact on the level of insured risk. **The central forecast, referred to as our projections throughout this article, is based on the average of the responses to our questionnaire and complemented with government projections for wider macro variables such as population growth.**

Two variables that materially influence our forecast are the vehicle replacement rate and the cost of severe bodily injury claims. In each case changes in Government policy can have a major influence which in turn could have implications for the impact on the insurance sector (the questionnaire and detailed model assumptions are available on request).

Our projections indicate that vehicle numbers are expected to remain broadly flat, while the UK population is expected to continue to grow (**Chart 1**).

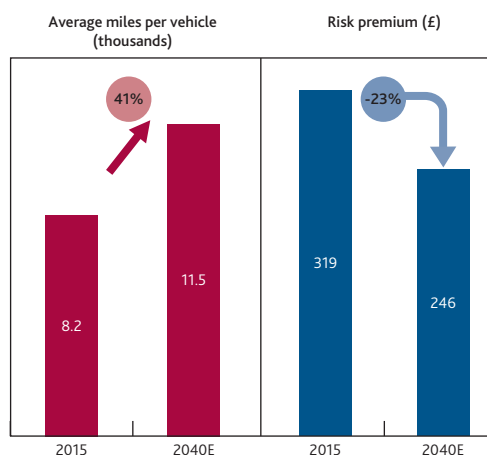
Chart 1 Population and vehicle growth



Average miles per vehicle are expected to increase significantly as AVs are worked harder. This is consistent with a shift towards a sharing economy allowing more efficient use of vehicles — which on average are parked for 95% of the time. However, the risk premium (the premium that a firm needs to charge per policy in order to meet the average cost of claims) is expected to decrease as a result of a reduction in claims frequency as safer AVs make up an increasing proportion of the car parc (47% by 2040) (**Chart 2**).

While some published forecasts imply that the introduction of AVs will effectively eliminate road traffic accidents, responses to our questionnaire suggest a less dramatic reduction in frequency, with the common claim types falling by up to two thirds.

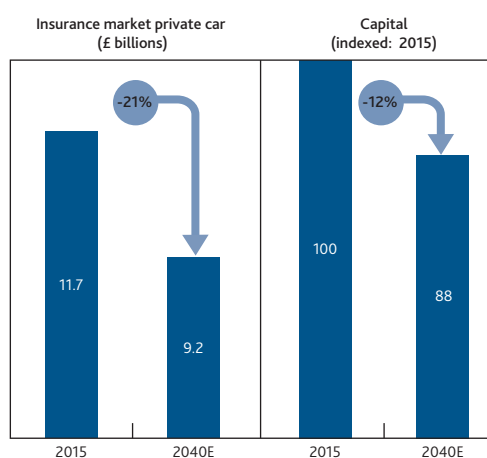
Chart 2 Average miles and the risk premium



In addition to the projected safety improvements from AVs, we have taken account of the transition between manual and full autonomous vehicles by assuming that the former also become steadily safer. By 2030 we project accident frequencies across all accident types to fall by c.30%. This is intended to allow for the increased penetration of partially autonomous technologies such as Advanced Driver Assistance Systems over this time frame and allows the model to implicitly account for a mixed car parc.

At a market level, the reducing risk premiums are partially offset by increased mileage; nevertheless the insurance market is expected to contract by 21% (**Chart 3**). In contrast, the capital benefit does not reduce to a similar extent, as the overall risk profile will increasingly be influenced by longer-tail bodily injury claims. The box on page 43 gives a more detailed account of bodily injury claims.

Chart 3 Market size and capital requirements



(1) Throughout the article we use the colloquial term 'car parc' to mean total cars licensed in the United Kingdom.

Bodily injury claims

Bodily injury claims are referred to as long-tailed as they typically take several years to settle, and may result in annuity payments to the claimant over several decades.

Settlement delays arise due to the involvement of a range of interested parties representing both claimant and insurer, such as lawyers and medical experts, in agreeing the size and nature of any award. For severe injuries, delays also arise due to the time required for the claimant's condition to stabilise and allow a meaningful assessment of the cost of treatment.

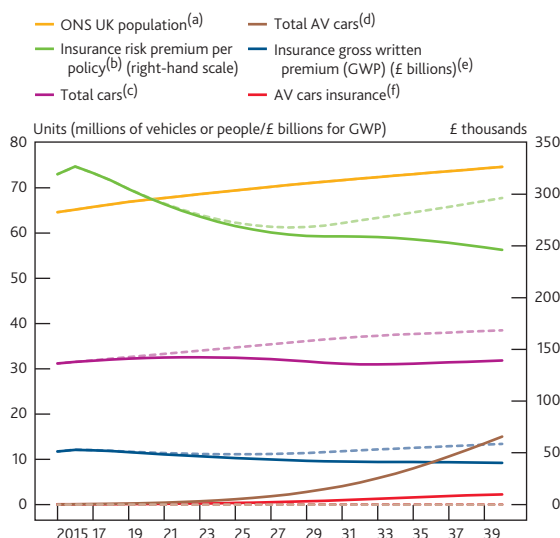
Claims awards can be settled either as a lump sum or as a periodic payment order. In the latter case insurers are required to pay an annuity to the claimant.

Large bodily injury claims that are settled as a lump sum are calculated using a discount rate set by the Lord Chancellor. On 27 February the Lord Chancellor announced that as of 20 March the discount rate would be reduced from 2.5% to -0.75%. This reflects the falling return on risk-free investments. The effect of this change will be to increase the size of the lump sum settlements of bodily injury claims and is likely to also reduce the number of claims that settle as a periodic payment order. However, in light of impending consultation that will revisit the process by which the discount rate is set, and the focus of the Bank's work on the longer-term view, we have decided not to revise our projections at this point in time.

A market contraction, such as that illustrated above, has the potential to disrupt the motor insurance sector. However, a key mitigant is the extent to which the market has time to adapt.

Our model projects that the impact of AVs will be felt gradually over this period. The solid lines in **Chart 4** represent the output from our model based on the mean of all questionnaire responses, whereas the dashed lines represents a 'base case' in which we assume that AVs do not emerge.

Chart 4 Year-on-year market projections



- (a) ONS UK population projections.
 (b) Amount per insurance policy expected to be spent paying claims.
 (c) Total of all autonomous and driven cars registered in the United Kingdom.
 (d) Total of all autonomous cars registered in the United Kingdom.
 (e) UK motor insurance gross written premium.
 (f) The sales of new AV cars.

Note: In all cases dashed lines represent the projections assuming that full AVs are not adopted during the forecast period.

The gradual change to the market is reflected by the expected reduction in the risk premium (shown by the green line) over time as AVs (brown line) make up an increasing proportion of vehicles.

In the near term we anticipate an initial increase in risk premium as shown in **Chart 4**. This arises due to current market conditions and changes in bodily injury claims inflation. However, in the medium to longer term we forecast a gradual reduction as driven vehicles (as well as AVs) become safer, thereby reducing overall insurance claims.

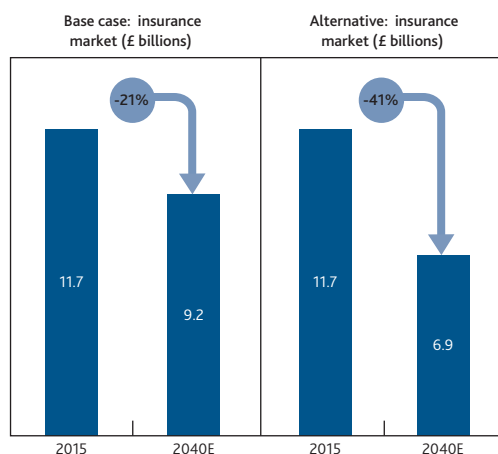
While the average suggested a gradual change, we note that some individual responses suggest a more rapid progression to the adoption of AVs — expecting AV sales penetration to increase from 25% to 75% of all vehicles sold in less than five years. However these respondents tended to forecast that the rollout of AVs for mass production would be at least fifteen years away — considerably later than our central estimate. This is consistent with the view that (1) mainstream AV rollout is only possible with significant changes in infrastructure that will take a longer time to deliver; and (2) when these changes are delivered there could be a rapid shift towards AVs.

An alternative view on the impacts on the size of the insurance market

Our base case forecasts have been estimated by taking an average of the questionnaire responses. However, to illustrate an alternative forecast we considered the impact of combining some of the more optimistic (from the perspective of AV adoption) feedback received. Under this scenario AVs are assumed to be adopted faster, travel more miles and be 20% safer than under the base case. In addition, driven vehicles are phased out more quickly and drive progressively fewer miles. In all cases the assumptions have been taken from responses received.

Under this alternative scenario we forecast the insurance industry to reduce 41% by 2040 — ie almost double the impact of the base case (Chart 5).

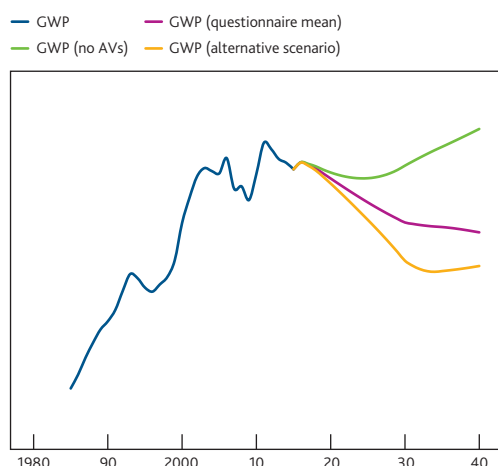
Chart 5 Base and alternative view of impacts on the size of the insurance market



Our projections in a historical context

Chart 6 provides historical context to the model forecasts, and highlights the expected contraction of the motor insurance market as AVs are adopted.

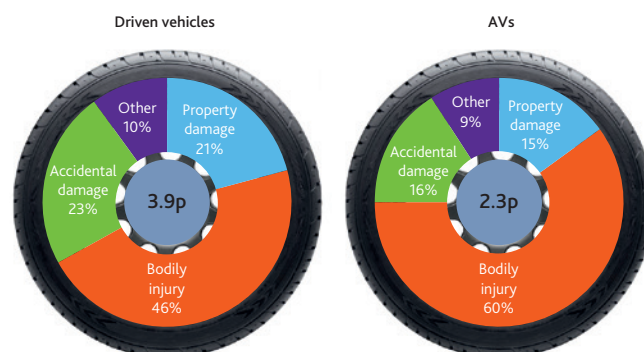
Chart 6 UK private car gross written premium historical and projections



The changing nature of insurance claims

Chart 7 illustrates how the loss profile for motor claims is expected to differ between a manual and autonomous vehicle, expressed as the financial loss per mile per vehicle. As the chart illustrates, we expect the risk to reduce by around 40%, with bodily injury claims representing an increasing share of the total claims cost. This primarily relates to two causes. The first, that AV technology will be more effective at reducing low-speed accidents, thereby removing many of the smaller bumper-to-bumper type incidents; and second, the value of treating severe bodily injury claims is expected to

Chart 7 Changing claims profile: financial loss per mile per vehicle



continue to increase relative to property damage and technology inflation.

Impacts on individual insurers

Our model was designed to project the financial impacts of AV technology on the insurance market as a whole rather than on individual firms. However, through our questionnaire we also captured the issues facing individual insurers. We conclude this section by highlighting some of the key themes covered by participants.

These issues will be increasingly relevant to the PRA's role as prudential regulator as they have the potential to fundamentally disrupt the motor insurance business model.

Who is liable and what the insurance product could look like

In projecting the quantitative impact of AVs on the market as a whole it is not necessary to consider potential changes to the nature of the insurance product — rather it is the overall trends in claims that matter (and the presumption that insurers will continue to pay for these costs). However, at an individual-insurer level changes to the insurance product can significantly alter who will ultimately foot the bill — will it be the retail insurer protecting the policyholder, which would represent a continuation of the current model; or the commercial insurer providing cover for the manufacturer or technology company?

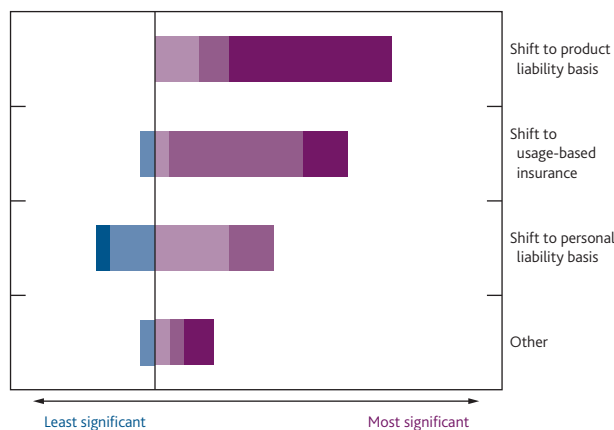
The Department for Transport (DfT) recognises that the role and responsibility of the vehicle, rather than the driver, will incrementally increase as AVs develop. As a result it has recently confirmed that it will extend compulsory motor insurance requirements to include the use of AVs.⁽¹⁾

⁽¹⁾ The Vehicle Technology and Aviation Bill states that where an accident is caused by an insured automated vehicle when driving itself the insurer is liable for that damage, subject to two specific exceptions. However imposition of liability on the insurer or vehicle owner does not affect any other person's liability in respect of the accident meaning that insurers may attempt to recover losses from vehicle manufacturers.

Under this approach the claimant 'will have a direct right against the motor vehicle insurer', suggesting a single policy model whereby existing retail motor insurers continue to own the customer relationship. The key change is that the insurer will have the right to recover costs from the vehicle manufacturer where the evidence points to product rather than human error.

Consistent with these recent developments, respondents to the questionnaire expect to see a shift from a personal to product liability basis for motor insurance as AVs enter the car parc. **Chart 8** illustrates feedback from the questionnaire. In each case respondents were asked to rank the most likely outcome. The darker the shade of red, the higher the ranking given by respondents.

Chart 8 Nature of the insurance product



Any future amendment to the legal requirements for cover could have implications for the existing motor insurance model, and as a result the Bank will maintain its dialogue with the DfT to understand any changes as they arise.

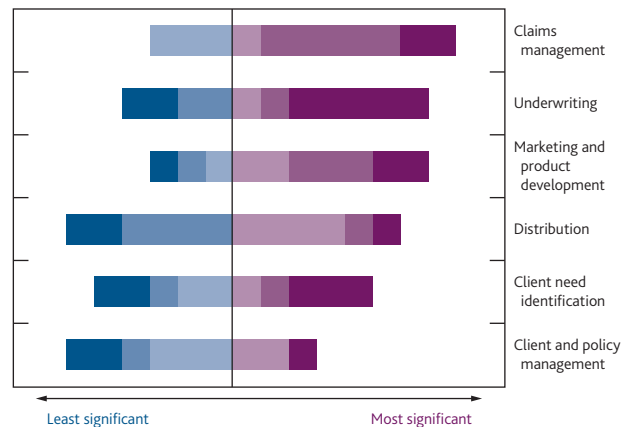
Chart 8 also highlights the expectation of a growth in usage-based insurance. This is consistent with the expected trend towards the sharing economy and reduced ownership of vehicles, but may present additional challenges for those insurers whose systems are primarily designed for annual policies.

Aspects of an insurer's business model most likely to be most impacted

Responses to our questionnaire suggest that the move to AVs will have a material impact on all areas of an insurer's business model. While claims management and underwriting were generally top of the list, most are expecting significant change in other core areas (**Chart 9**).

Claims management: AVs will increasingly rely on a complex integration of sophisticated algorithms across a diverse array of sensors. Establishing liability and identifying the root cause

Chart 9 Impacts on the insurance value chain



of an accident — for example component failure, software bugs, data transmission error — will become increasingly complex.

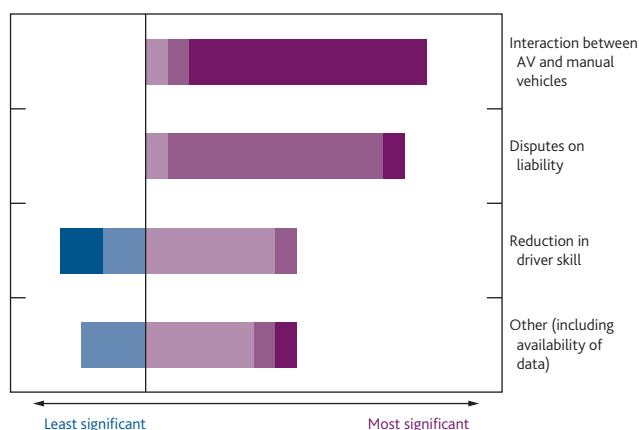
Underwriting: ongoing change in the car parc will make pricing of new motor insurance policies difficult as past data may not be a good guide to the future. Furthermore, while individual AVs are expected to be safer, a number of respondents highlighted the increased risk of more extreme loss events as a consequence of connectivity (eg due to cyber risk). The move to a mixed car parc, and the unpredictability of the interaction between manual and autonomous vehicles were also identified by respondents as future considerations for pricing.

Marketing and product development: there is increasing evidence of car manufacturers providing insurance and service contracts in a single package for the customer. Should this trend continue tie-ups between car manufacturers and insurers will become more common. This will change the structure of the insurance market so that insurers who do not reach agreements with motor manufactures face challenges in sustaining their business model. This trend may be accelerated where motor manufacturers believe insurance prices offered on the open market exceed the risks of their vehicle given its safety features.

Challenges in estimating future claims costs

For insurers the ability to accurately assess likely claims costs is essential in charging policyholders an appropriate premium for a given level of risk. As highlighted in the previous section, the absence of relevant historical data increases the risk of underestimating the potential claims. **Chart 10** highlights specific areas that are likely to increase this risk.

Interaction between AVs and manual vehicles: the unpredictability of the nature of the interaction between manual and autonomous vehicles may arise in part because AVs struggle to mimic human behaviours and *vice versa*. This may be particularly challenging if AVs attempt to follow

Chart 10 Transition challenges to AV

human conventions, such as a certain level of assertiveness in crossing busy junctions in built-up environments.

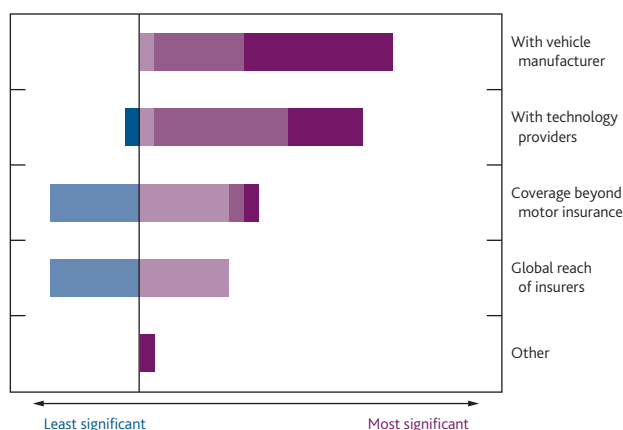
Disputes on liability: in follow-up discussions many participants raised the need for sharing vehicle data. 'Event data recorders' are already installed in many new vehicles, and store data which, for AVs, could be used to identify who was controlling the vehicle at the time of an accident and assist in determining the root cause of any accidents with a view to apportioning liability. The scale and nature of the data insurers will have access to has yet to be agreed and there is some tension between insurers and vehicle manufacturers on this point (with the latter citing privacy concerns). We also expect the forthcoming EU General Data Protection Regulation to influence the outcome.

In addition, our discussions identified challenges in managing costs if vehicle manufacturers take greater control of the supply chain for repairs (potentially necessary should the insurance model shift towards product liability).

Increasing importance of partnerships for insurers

Respondents agreed that insurers will need to consider establishing relationships with vehicle manufacturers (Chart 11). For example, a number of UK insurers are working with manufacturers on AV trials. Development of bilateral relationships can provide value to both parties: manufacturers can gain a greater understanding of the issues surrounding liability, as well as getting the benefit of insurers' underwriting experience and understanding of risk, while for insurers there is a benefit from getting closer to those developing AV technology, as it puts them in a better position to understand the impact on vehicle accident rates.

However, respondents were broadly split over whether manufacturers or insurers were most likely to own the customer relationship for insurance. Ownership of the customer relationship involves serving as the main point of contact for product sales, services, renewals and queries. It is likely to confer a commercial advantage as it affords

Chart 11 Importance of partners/tie-ups

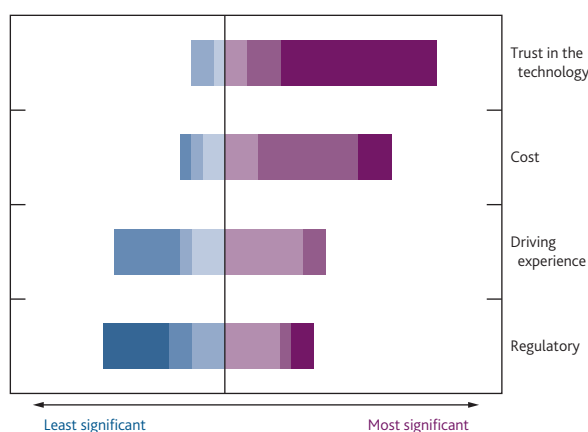
opportunities to sell products relating to the core service (including but certainly not limited to insurance).

Societal and technological aspects to the adoption of AVs

Societal aspects: barriers, ownership and use

In projecting forward possible financial impacts on the insurance industry it is important not to overlook the human element — for instance, will society readily accept AVs? Who will actually buy an AV and for what purpose? Will AVs change the behaviour of drivers as AVs and manual vehicles operate simultaneously on the roads?

Our model implicitly makes allowance for these factors. However, we acknowledge that this is an area that will need further consideration, and for which we may need to introduce explicit assumptions, as technology catches up in delivering truly end-to-end AVs for everyday use (Chart 12).

Chart 12 Societal barriers

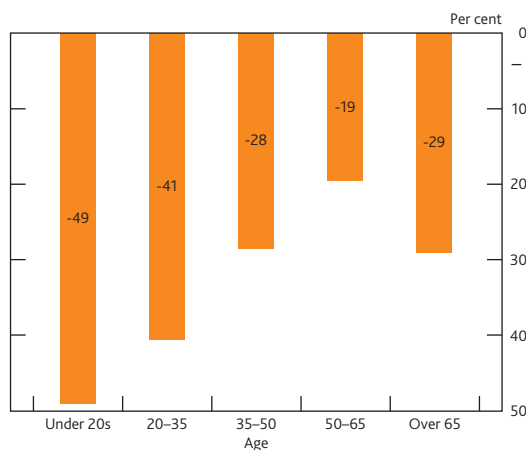
Trust was identified as the biggest inhibitor to the adoption of AVs. Some do not trust AVs to operate safely and ethically; this lack of trust is potentially exacerbated by high-profile

crashes including a fatality in the United States. Others cite a love of driving which means that they would be unwilling to cede control to a machine. Public views are likely to evolve as the technology develops and is better understood.

On the issue of future vehicle ownership, questionnaire responses suggest that this will decline as AVs emerge. In the past, on-demand transport has depended on vehicle ownership. However, as AVs emerge and the cost of using them reduces, journeys will become more affordable and reduce the benefits of ownership (both economically and in terms of convenience). Nevertheless, there is an existing market for new technology among high net worth individuals, who are expected to be early adopters and owners of AVs.

Questionnaire respondents also expect reduction in ownership to be inversely proportional to age (Chart 13). This relates in part to affluence, as the younger generation may have limited spending power to purchase their own vehicle, but also to changing generational attitudes. Through their familiarity with renting, rather than owning, services millennials are likely to be more amenable to a sharing-economy model. Furthermore the expected environmental benefits of AVs, with regard to congestion and emissions, may also increase their appeal.

Chart 13 Projected change in vehicle ownership by age



The over 65s are an exception to this trend, as a consequence of adoption by those who are currently unable to drive.

Technical aspects: barriers and changing nature of risk

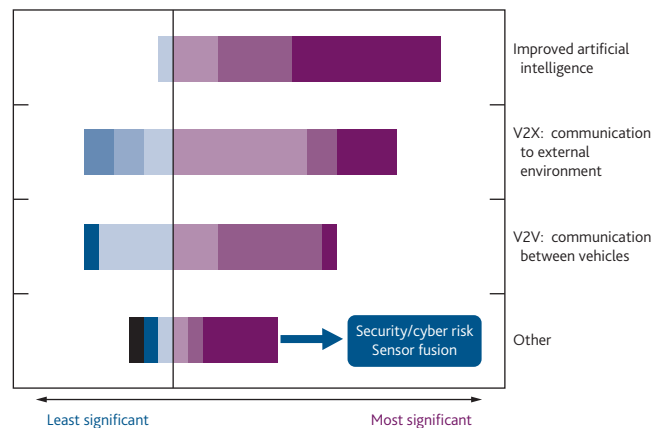
While the technology underpinning AVs is developing rapidly, our results suggest that there is still some way to go before it can support mainstream adoption of fully autonomous vehicles.

Questionnaire responses indicate that vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication, development of robust security protection against cyber risk, and sufficiently advanced artificial intelligence to deal with all

reasonably foreseeable scenarios (such as poor weather conditions and unpredictable behaviour by pedestrians) will be the key technological deliverables.

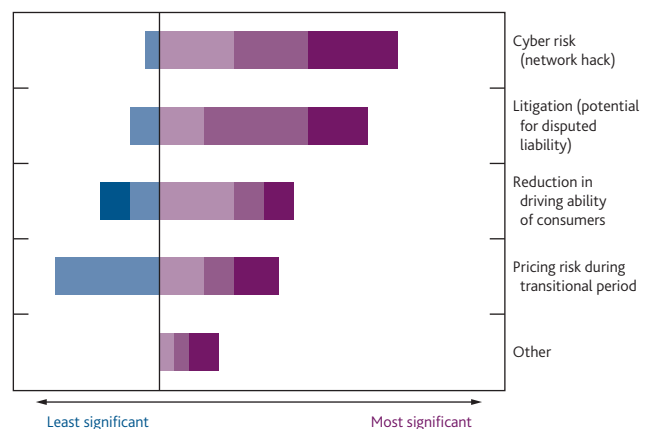
There is currently disagreement on the extent to which AVs will need to communicate with infrastructure and/or other vehicles (described as V2I and V2V respectively and collectively termed V2X) (Chart 14). The main advantage of connectivity for an AV would be to increase the level of available information about the surrounding environment, with commonly cited examples including speed limits, the trajectory of other vehicles, current and future weather conditions and the level of congestion on the planned route. If AVs were not connected they would need to rely solely on their in-built equipment for navigation (primarily sensors, such as LIDAR and cameras).

Chart 14 Technical barriers



The risk of cyber-attacks arises due to the connection of vehicles to external networks rather than as a function of their ability to operate autonomously. The risk is increased if vehicles are in near-constant communication via a wireless or telecoms network. Unsurprisingly, cyber risk was identified as the most significant new claim type expected to emerge as a result of AV development (Chart 15).

Chart 15 Emergence of new claim type/risks



The other emerging risk identified was litigation; this is expected to increase due to potential difficulty in assigning fault between driver and vehicle. These risks primarily arise as a consequence of a transitional period, during which the risk profile of the UK car parc changes as penetration of fully and partially autonomous vehicles increases and insurers need to make judgements on the level of risk in the absence of historical data.

Conclusion

This research provides the Bank with an initial framework for monitoring the rate at which AV technology will emerge and its corresponding potential impact on the insurance market. It has already facilitated discussion with a range of stakeholders across technology and insurance sectors, and the Bank is keen to maintain this dialogue. As the technology develops and the key inhibitors and accelerators to adoption of AVs becomes clearer, understanding the impacts on the insurance sector will be increasingly important to ensure regulation strikes the right balance between policyholder security and supporting technological innovation.

Our current forecast is that the motor insurance sector will reduce in size, but that this is likely to be a gradual shift over the next two decades. From a regulatory perspective we have identified specific areas that we will need to consider as this technology develops:

- **Evaluation of regulatory capital requirements:** changes to the insurance risk profile will pose challenges to firms when developing their capital models and stress tests. Limited availability of relevant historical data, particularly in the estimation of large infrequent loss events, will increase reliance on expert judgements. As the technology develops the Bank will seek to understand how insurers mitigate key risks identified in this research, which include cyber, litigation and the disruption arising from an expected shift of insurance to a product liability basis.
- **Evaluation of factor-based regulatory capital requirements:** the Bank will need to review the ongoing adequacy of the Solvency II solvency capital requirement (SCR) to reflect the risk profile of motor insurers. For

example, for those firms operating on standard formula, the underlying pan-European data used to calibrate the SCR will become increasingly inappropriate over time.

- **Reporting requirements:** from a practical standpoint, one area for the Bank to consider is whether to amend reporting requirements that reflect the future importance of product liability exposures (as this is not captured by the current Solvency II designations of 'motor liability' and 'motor other') and to support our ability to monitor trends.

Discussions and feedback from external stakeholders has also provided us with suggestions on how to refine our approach for the future, including:

- Amendments to sharpen our research questionnaire (for example, to clearly distinguish between benefits at the level of individuals and society as a whole and defining claim types by cause of accident rather than effect).
- Inclusion of ethical considerations (eg societal attitudes towards accidents caused by computer or mechanical, rather than human error).
- Deeper consideration of unanswered questions regarding protection against cyber risk and the risk of litigation.
- Expanding the scope to assist the Bank's broader remit of understanding the implications for GDP and hence monetary policy as well as financial stability.

We expect to refine our research as additional evidence or information on some of the key assumptions underlying our forecast become available. For instance:

- Data or additional research (as currently initiated by the DfT) that may assist or challenge the assumptions we have used.
- Government initiatives which accelerate the rate of adoption.
- Significant advancement in AV technologies.