ANCAP SAFETY

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Ms Michelle Landry MP
Chair - Standing Committee on Industry, Innovation, Science and Resources
House of Representatives
PO Box 6022
Parliament House
CANBERRA ACT 2600

Dear Ms Landry,

Thank you for the opportunity to give evidence at the Public Hearing into the Social Issues Relating to Land-Based Driverless Vehicles in Australia in Canberra on Wednesday 24 May 2017.

During the Hearing, ANCAP took on notice to provide the Committee figures of possible cost savings associated with crash reductions resulting from fitment of autonomous emergency braking (AEB) systems.

Research published by the Monash University Accident Research Centre (MUARC) in 2015 presented estimated social savings in fatal and serious injuries due to AEB technology. This research suggested potential savings of between $108 million and $297 million over the period 2011-2020, if forward collision warning systems with AEB were fitted to all new light vehicles supplied in Australia from 2014.

A copy of the MUARC research paper, *Retrospective and Prospective Changes in Secondary Safety of the Australian and New Zealand Vehicle Fleets and the Potential Influence of New Vehicle Safety Technologies,* is enclosed for your information.

It is important to note that this research is based on technology and information in service at the time of the study and, with technology developing at a rapid rate, ANCAP expects even further trauma reductions from more advanced autonomous systems, which will form the foundation of the fully autonomous, or 'driverless' vehicle.

Kind regards,

[redacted]

Mr James Goodwin
CHIEF EXECUTIVE OFFICER

15 JUNE 2017

RETROSPECTIVE AND PROSPECTIVE CHANGES IN SECONDARY SAFETY OF THE AUSTRALIAN AND NEW ZEALAND VEHICLE FLEETS AND THE POTENTIAL INFLUENCE OF NEW VEHICLE SAFETY TECHNOLOGIES

by

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Title and sub-title: Retrospective and prospective changes in secondary safety of the Australian and New Zealand vehicle fleets and the potential influence of new vehicle safety technologies

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Abstract:

Safety of the vehicle fleet is a function of both secondary safety (the ability of vehicles to protect their occupants and minimise harm to other road users) and primary safety (arising from crash avoidance safety features). This project estimated the impact of improvements in secondary safety of the Australian and New Zealand vehicle fleets on fatalities over the years 2000 to 2010 and projected the future benefits expected to 2020 under two scenarios: *business as usual* (where secondary safety improvements continue following current trends) and stalled safety (where secondary safety ceases to improve in vehicles manufactured in the future). The future safety effects of primary safety improvements in the fleets were estimated resulting from increased fitment of existing and emerging new technologies: Electronic Stability Control (ESC); Autonomous Emergency Braking Systems (AEBS); Fatigue Warning Systems (FWS); Lane Departure Warning Systems (LDWS); and Lane Change Warning Systems (LCWS).

Over the years 2000 to 2010, the average crashworthiness of the Australian light vehicle fleet has improved by 27% representing a saving of around 2,000 deaths over the time period. Improvement in the crashworthiness of the New Zealand fleet has also been significant with an improvement in average crashworthiness of 18%. This equates to a saving of 313 lives over 2000-2010. The estimated saving in fatal and serious injuries through projected future improvement in secondary safety of the Australian light vehicle fleet in 2020 compared to 2010 was between 950 and 1,470 resulting from improvements in secondary safety of 25%-38%. The corresponding fatal and serious injury improvements in the New Zealand fleet from 2010 to 2020 were estimated to be between 18%-20% leading to aggregate savings of 1,002 fatal and serious casualties to light passenger vehicle occupants.

The results of this study provide a basis for prioritising crash avoidance technologies with the greatest potential. All of the technologies considered offer the potential for future crash savings. *Autonomous Emergency Braking Systems (AEBS)* and ESC were the technologies offering the greatest road trauma savings and were most cost effective although the likely benefits are less than that predicted from secondary safety improvements.

Key Words:
Electronic Stability Control, Autonomous Emergency Braking Systems, Fatigue Warning Systems, Lane Departure Warning Systems, Lane Change Warning Systems, Vehicle Safety, modelling, crashworthiness.

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Preface

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Contributor Statement

Laurie Budd	Data preparation and analysis, preparation of report manuscript
A/Prof Michael Keall	Data preparation and analysis, study design, preparation of report manuscript
A/Prof Stuart Newstead	Project management, study concept and design and manuscript review

Ethics Statement:

Ethics approval was not required for this project.

Contents

EXECUTIVE SUMMARY

Improving vehicle safety is a primary focus for meeting road safety targets in Australia and New Zealand. Previous research has identified constant improvements in occupant protection performance in a crash (crashworthiness or secondary safety) of new light vehicles entering the fleet. This study quantifies how crashworthiness improvements in new light vehicles have contributed to improvement in the average crashworthiness of the whole light vehicle fleet over the years 2000 to 2010 and the resulting reductions in deaths and serious injuries. Based on improvements over these ten years, the study then estimated further road trauma savings expected from continued improvement in the crashworthiness of the light vehicle fleet over the years 2011-2020.

In recent years, focus on vehicle safety has shifted from preventing vehicle occupant injuries in the event of a crash to preventing the crash occurring in the first place (crash risk or primary safety) through the development vehicle based technologies. Electronic Stability Control (ESC) is a notable example of such a technology which evaluation has shown to be highly effective in reducing crash risk. A number of emerging crash avoidance technologies are now being made available in new vehicles in Australia and New Zealand which have the potential to further reduce serious road trauma through reducing crash risk. The final aim of this study was to estimate the potential contribution emerging vehicle crash avoidance technologies will make to reducing serious road trauma in Australia and New Zealand. In doing so the study aimed to identify which technologies should be adopted with the highest priority based on expected trauma reductions and economic benefits.

Analysis in this study was based on data and output from the Used Car Safety Ratings (UCSR) research program including data on the crash involved light vehicle fleet in Australia and New Zealand over the years 2000-2010. Secondary safety performance of the crash involved light vehicle fleet was estimated through applying the crashworthiness ratings from the UCSR by vehicle make and model and year of manufacture. Future trends in vehicle secondary safety were estimated by projecting the likely crashed vehicle fleet, its market group composition and crashworthiness profile to 2020. Potential benefits of emerging vehicle crash avoidance technologies were estimated by applying estimated effectiveness of these technologies based on prospective evaluations to the projected crashes vehicle population to 2020. Crash avoidance technologies considered were: Electronic Stability Control (ESC) (for all vehicles in New Zealand and light commercial vehicles in Australia), Autonomous Emergency Braking Systems (AEBS), Fatigue Warning Systems (FWS), Lane Departure Warning Systems (LDWS) and Lane Change (Blind Spot) Warning Systems (LCWS/BSWS).

RETROSPECTIVE EFFECTS OF VEHICLE SAFETY IMPROVEMENTS

Analysis in this study has identified a strong trend to improving cross sectional secondary safety of the light vehicle fleet ratings over the crash years 2000 to 2010 in both Australia and New Zealand. Over the years 2000 to 2010, the average crashworthiness of the Australian light vehicle fleet has improved by 27% as shown in Figure E1. This represents a saving of around 2,000 deaths over the time period. Figure E2 shows the number of observed vehicle occupant deaths in Australia over the period 2000-2010 along with the number that would have been expected if the cross sectional secondary safety of the Australian vehicle fleet had remained the same as in 2000.

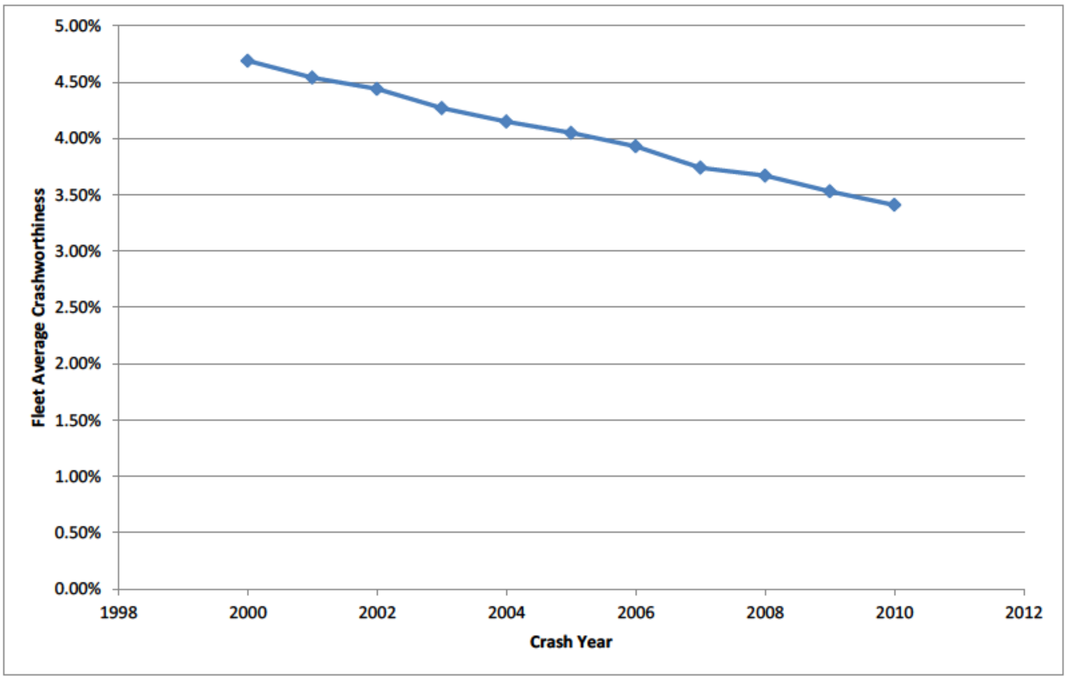


Figure E1: ***Change in average crashworthiness of the Australian vehicle fleet by calendar year.***

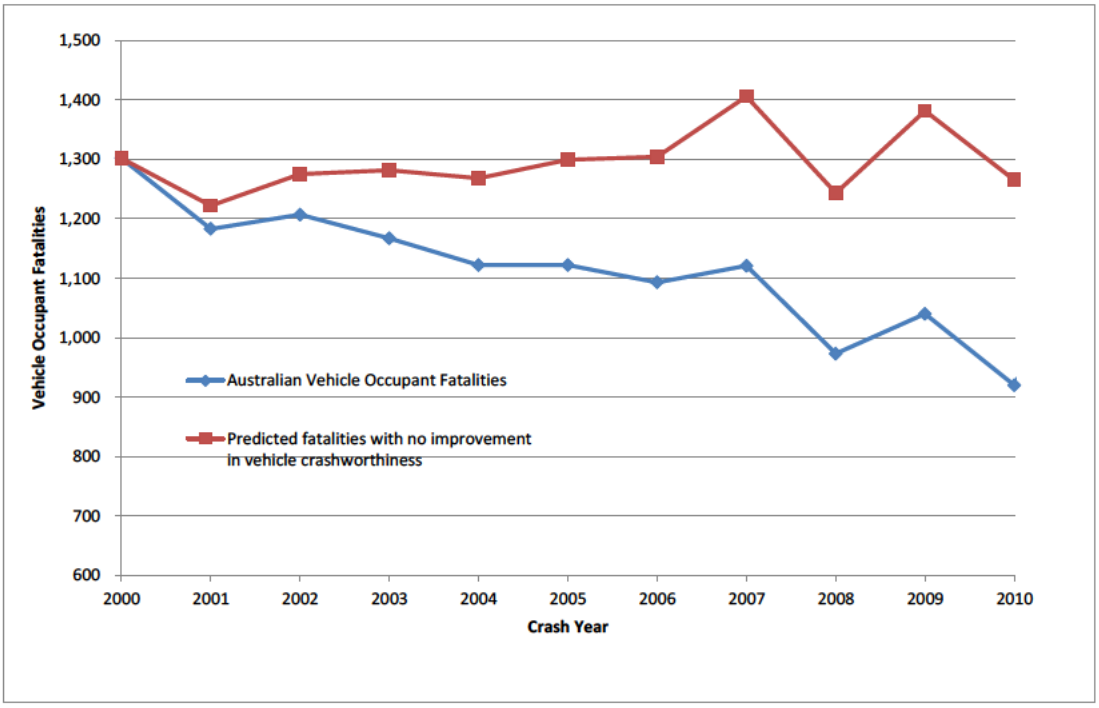


Figure E2: ***Estimated effects on vehicle occupant fatalities of vehicle fleet crashworthiness improvements in Australia.***

Improvement in the cross sectional crashworthiness of the New Zealand fleet has also been significant with an improvement in average crashworthiness of 18% as shown in Figure E3. This equates to a cumulative saving of 313 lives over 2000-2010. Figure E4 shows the observed number of vehicle occupant fatalities over the period 2000-2010 along with the numbers expected had the cross sectional safety of the light vehicle fleet remained at 2000 levels.

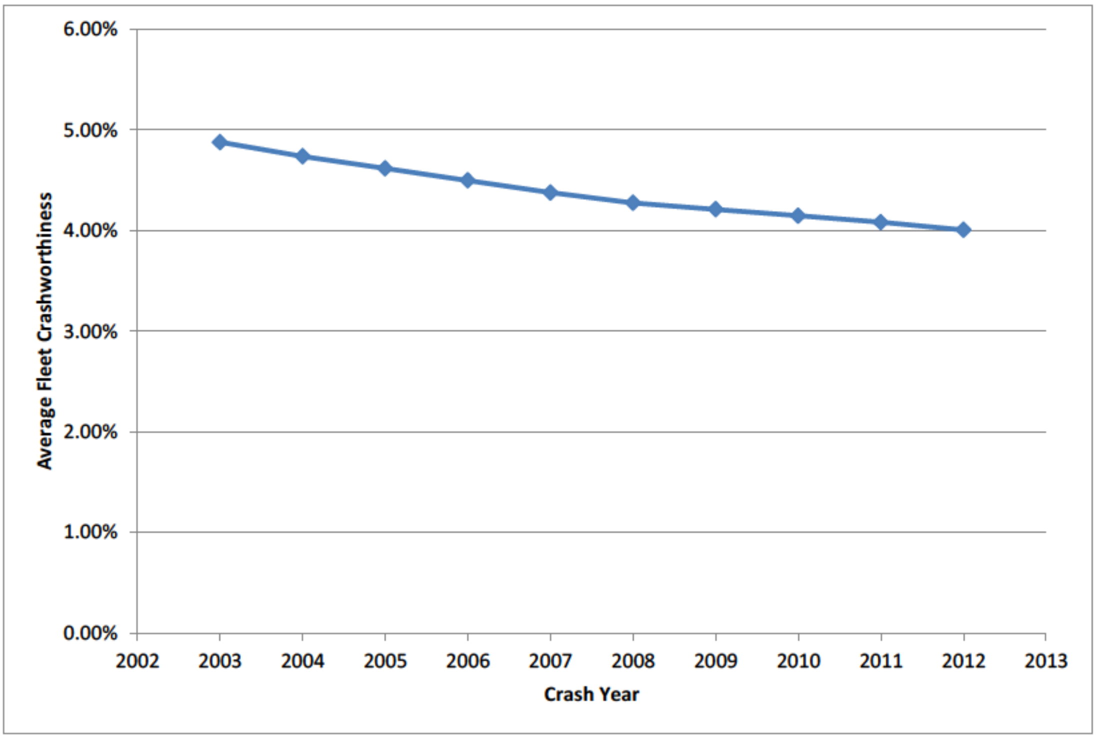


Figure E3: ***Change in average crashworthiness of the New Zealand vehicle fleet by calendar year.***

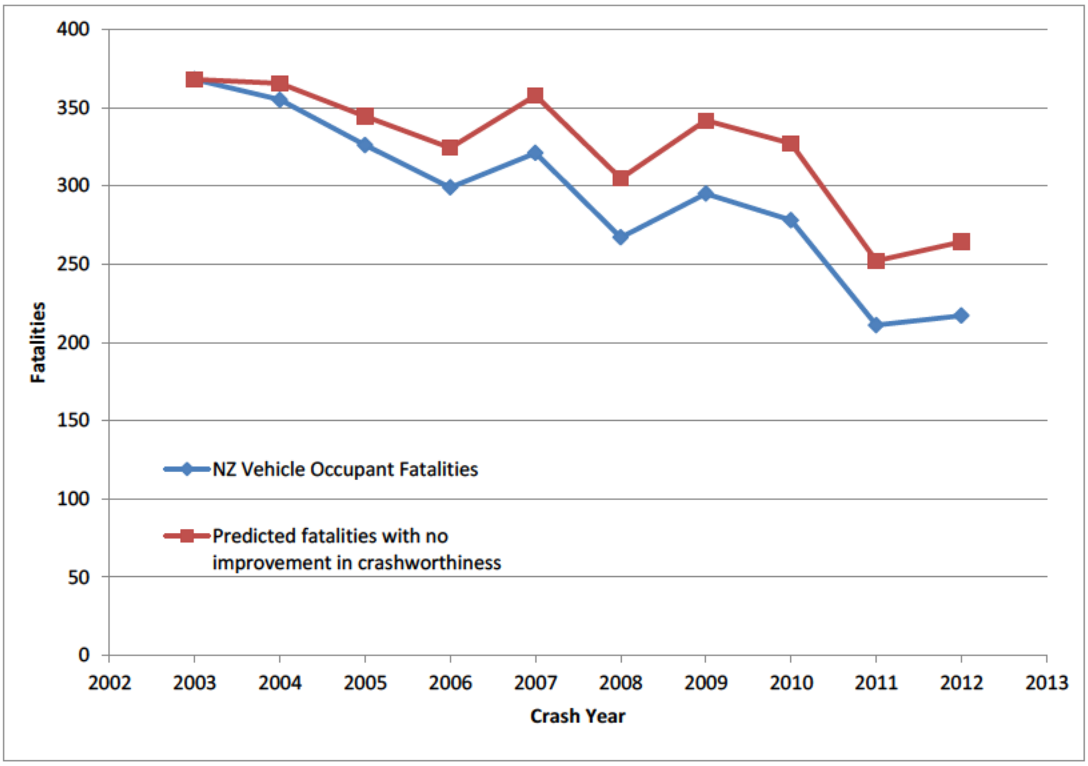


Figure E4: ***Estimated effects on vehicle occupant fatalities of vehicle fleet crashworthiness improvements in New Zealand.***

Improvement estimated for the Australian and New Zealand fleets can be largely attributed to gradual penetration of safer newer vehicles into the fleet; however patterns in the overall age profile of vehicles, and the trends in market group mix have also played their part.

PROJECTED FUTURE ROAD TRAUMA SAVINGS DUE TO SECONDARY SAFETY IMPROVEMENTS

The future expected trend in light vehicle secondary safety due to secondary safety improvements was estimated to 2020 using projections for injury crashes and fleet mix involving light passenger vehicles. Future crashworthiness improvements were modelled under two scenarios:

1. *stalled crashworthiness* at 2010 new vehicle levels where the average crashworthiness of new vehicles entering the fleet over the period 2011-2020 were assumed to be the same as those entering new in 2010; and

2. *business as usual* where crashworthiness improvements for vehicles entering the fleet over the years 2011-2020 were assumed to improve at the same rates as observed over 2000-2010.

Future trauma savings due to vehicle secondary safety improvement were estimated by comparing the projected safety of the 2020 crashed vehicle fleet to that of 2010.

Table E1 shows the estimated number of crashed light vehicles along with fatal and serious injuries and the economic cost of those injuries resulting from these crashes in Australia in 2010 and projected in 2020. Costs were estimated using injury costing data from the Australian Commonwealth Bureau of Infrastructure Transport and Regional Economics (2009).

Table E1: ***Baseline 2010 and 2020 year vehicle fleet crashed passenger vehicles, occupant fatal and serious injuries and cost of injuries in 2010 AU$ (BITRE, 2009).***

	2010	2020	
		A (Business as usual)	B (Stalled crashworthiness)
Crashed vehicles	91,422	86,981	
F&S injuries	3,821	2,350	2,870
Cost	$1,656,121,346	$688,264,103	$840,563,686

Table E2 shows both the absolute and percentage difference in 2020 crashes vehicles and resulting fatalities, serious injuries and costs compared to 2010 derived from Table E1 under both projected crashworthiness scenarios.

Table E2: ***Estimated savings in vehicles involved in injury crashes, fatalities and serious injuries and injury costs in 2020 compared to 2010.***

		Absolute Savings (2010-2020)		Percentage Savings (2010-2020)	
		A (Business as usual)	B (Stalled crashworthiness)	A (Business as usual)	B (Stalled crashworthiness)
ALL	vehicles	4,441		5%	
	F&S Injuries	1,470	950	38%	25%
	Cost	$967,857,243	$815,557,660	58%	49%

The saving in fatal and serious injuries through projected future improvement in secondary safety of the Australian light vehicle fleet in 2020 compared to 2010 was 950 under the scenario of *stalled crashworthiness* and 1,470 if crashworthiness continues to improve according to past trends. These benefits result from improvements in secondary safety of 25% and 38% respectively in 2020 compared to 2010. The annual economic benefit of these reductions was estimated to be between AU$815M and AU$968M. Figure E5 shows the estimated cross sectional crashworthiness of the Australian light vehicle fleet relative to 2010 for each of the years from 2011-2020 which underlies the estimates provided in Tables E1 and E2.

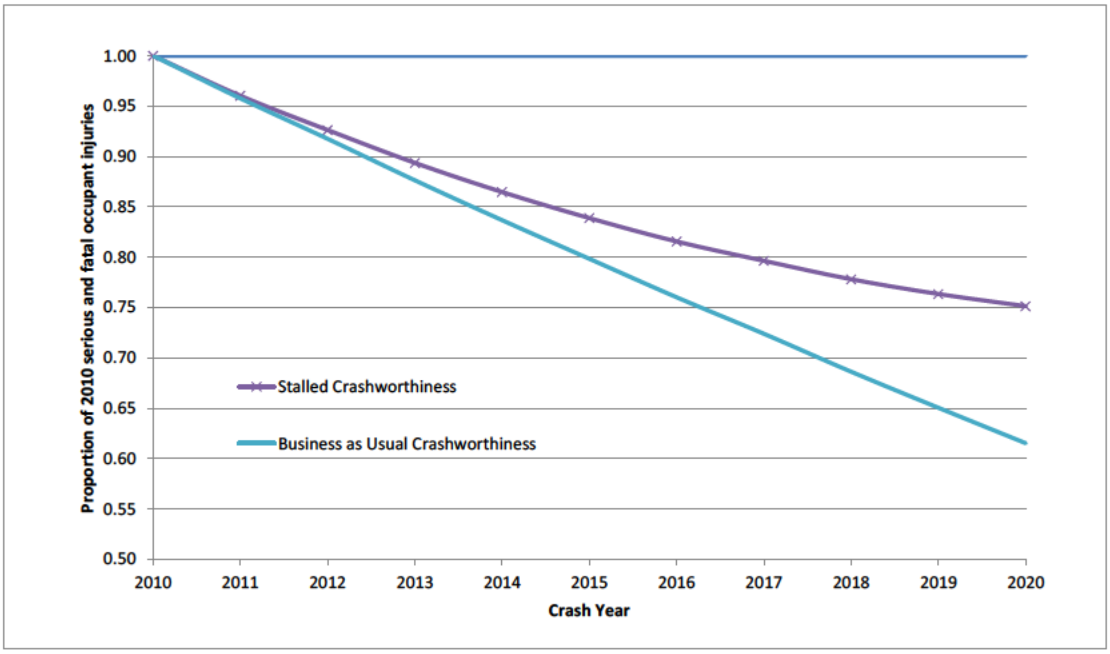


Figure E5: ***Proportion of 2010 fatalities and serious injuries expected in 2011 to 2020 due only to vehicle secondary safety improvements, Australia.***

The corresponding projected fatal and serious injury improvements in the New Zealand fleet from 2010 to 2020, resulting from improved crashworthiness of the fleet, were estimated to be 18% and 20% respectively under the two main scenarios considered. Changes for each year from 2011-2020 relative to 2010 for New Zealand are shown in Figure E6. A further projection scenario was considered in New Zealand where the age profile of the fleet and the proportion of small cars reverts to those observed in the year 2000 (the New Zealand light vehicle fleet has been getting progressively older and smaller over time which resulted in the projected benefits under the two main scenarios providing less road safety benefits than estimated for Australia). This additional scenario estimated crashworthiness benefits of around 32% to 2020.

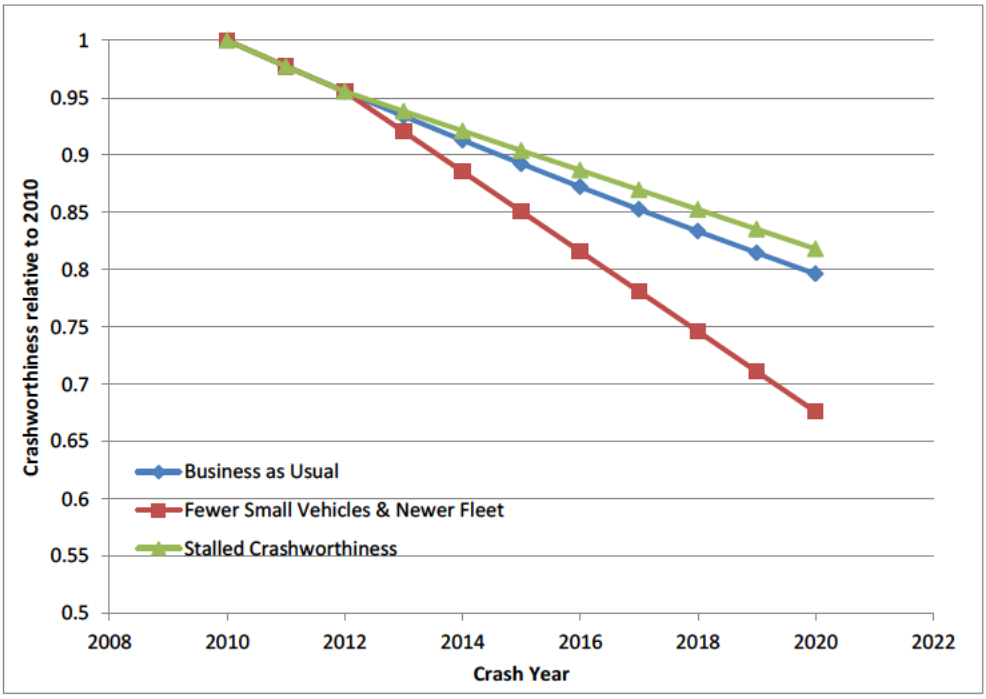


Figure E6: ***Projected proportionate serious and fatal injury savings due to changes in crashworthiness of the New Zealand light vehicle fleet under 3 different future vehicle crashworthiness scenarios: 2010-2020.***

Figure E7 estimates the cumulative savings in deaths and serious injuries to 2020 in the New Zealand fleet under the two main scenarios for vehicle crashworthiness improvement. If New Zealand crashworthiness improvement trends continue as in the past over the period 2011-2020, there are predicted to be aggregate savings of 1,002 fatal and serious casualties to light passenger vehicle occupants due to crashworthiness improvements in 2011-2020 relative to the year 2010. This represents an economic saving of between NZ$500M and NZ$600M respectively using New Zealand's willingness to pay based crash injury cost estimates.

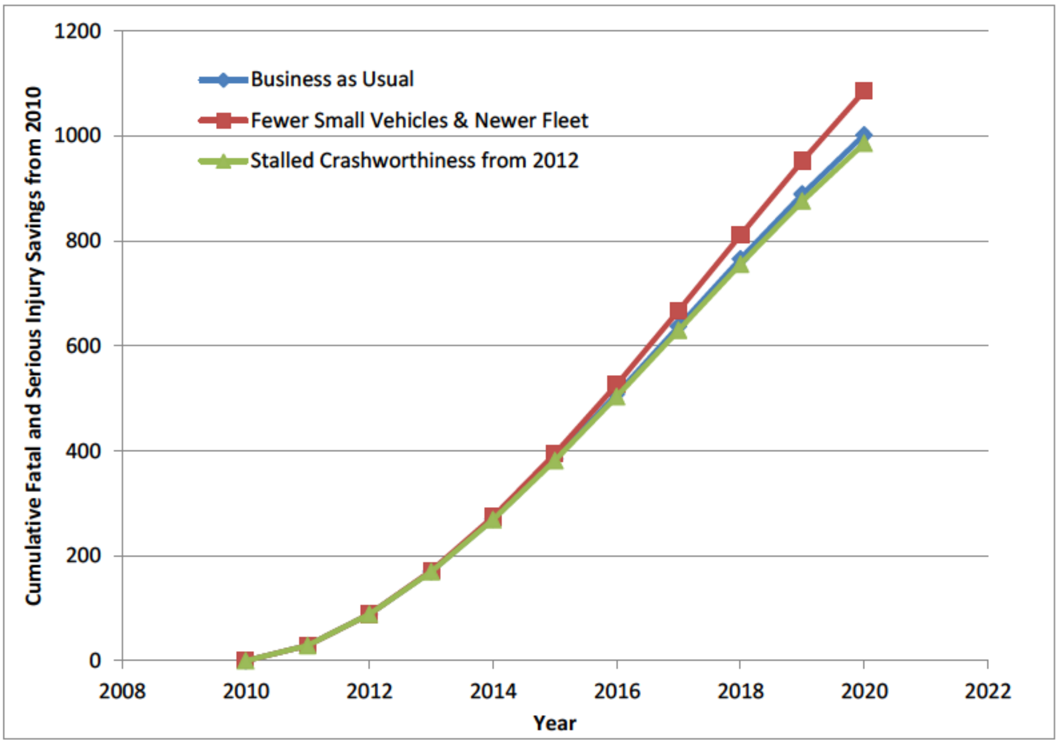


Figure E7: ***New Zealand estimated actual and projected serious and fatal injury savings due to changes in fleet crashworthiness from either a year 2000 baseline or projected from a 2010 baseline under a "business as usual" crashworthiness trend.***

INJURY AND COST SAVINGS ASSOCIATED WITH VARIOUS SAFETY TECHONOLOGIES

Further savings to fatal and serious injury counts are possible through fitment of emerging crash avoidance technologies to vehicles. The fatal and serious injuries prevented by these technologies were estimated for each year from 2010 to 2020 as newly manufactured vehicles with these technologies fitted penetrate the market. The penetration of safety technology was estimated by examining fitment rates in vehicles new to the fleet, at each vehicle year of manufacture for each crash year. The savings to fatal and serious injuries from these vehicles entering the fleet associated with technology fitment was estimated for AEBS (operating at all speeds as well as only speeds of 80km/hr and above), ESC (for all vehicles in New Zealand and for light commercial vehicles in Australia), and FWS, LDWS and LCWS/BSWS. The savings associated with fitment of the selected safety technologies were on top of those expected purely through projected improvements to vehicle secondary safety.

The projected benefits of each crash avoidance technology were estimated under the two scenarios of future crashworthiness performance described in the previous section as well as for two scenarios of penetration the technology:

T1 - All vehicles mandated to have the technology from 2014

T2 - Gradual penetration of the technology into the new vehicle fleet based on market forces

These two penetration scenarios for new vehicles are illustrated in Figure E8. The only exception to these scenarios was for ESC fitment to light commercial vehicles in Australia where this technology is mandated from 2016 as illustrated in Figure E8.

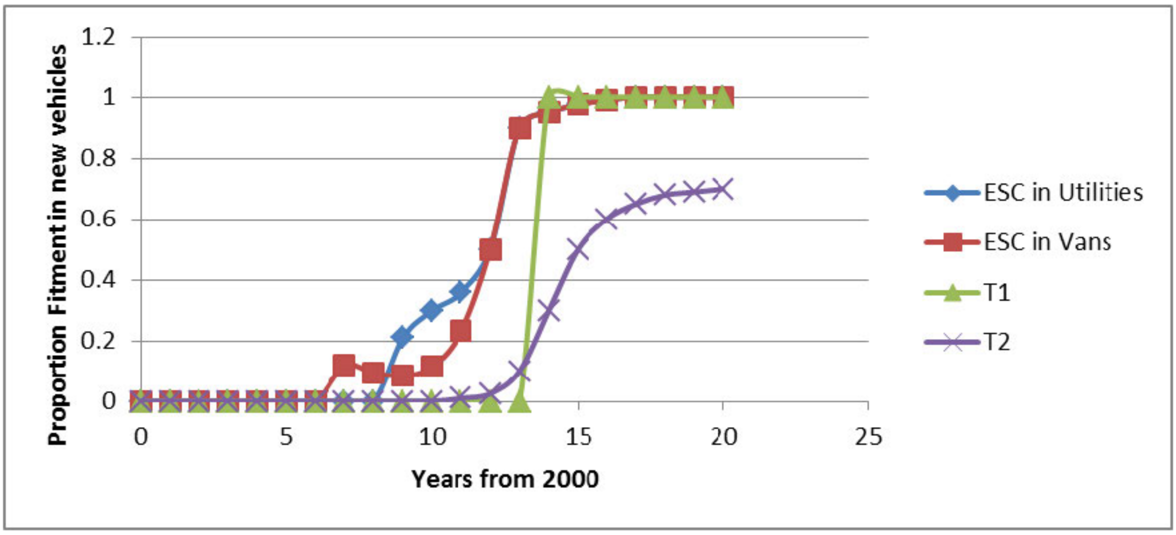


Figure E8: ***Australian fitment models for ESC and emerging safety technologies (T1 and T2).***

Table E3 summarises the estimated reductions in fatal and serious injuries in Australia expected by 2020 (relative to 2010) associated with each of the technologies considered above and the savings estimated through secondary safety improvements. Economic savings to the community are also shown each with a range reflecting the variation due to the scenarios considered.

Table E3: ***Summary of average estimated savings in fatal and serious injuries (%) and injury cost (million 2010 AU$) for each safety technology over the period 2010-2020 and savings extremes by jurisdiction and vehicle type.***

	Australia	
Safety System	% F&SI Saving and Range	Cost Saving
Autonomous Emergency Braking- All Speeds	5-10 %	$108-297M
Autonomous Emergency Braking - Speeds >=80km/hr	1.5-3.1%	$35-96M
Lane Departure Warning	0.2-0.5%	$6-16M
Fatigue Warning	1.5-3.2	$36-98M
Lane Change (Blind Spot) Warning	0.6-1.2%	$14-37M
ESC Light Commercial Vehicles	4.5-5.7%	$142-143M

Figures E9 and E10 show the percentage savings in fatal and serious injuries relative to 2010 in Australia for each year from 2011-2020 estimated for each technology considered under the mandate from 2014 (T1) and gradual penetration scenario (T2) respectively.

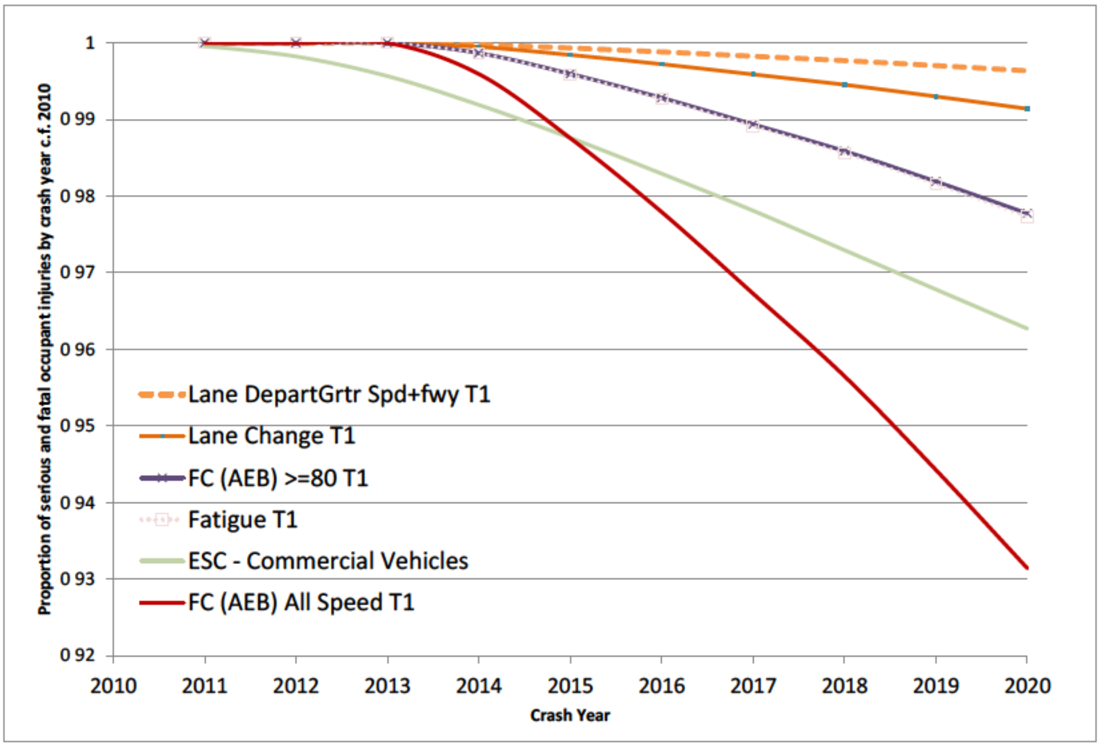


Figure E9: ***Proportion of 2010 vehicle occupant fatal and serious injuries estimated each crash year from 2011-2020 from safety technology fitment mandated in 2014, Australia.***

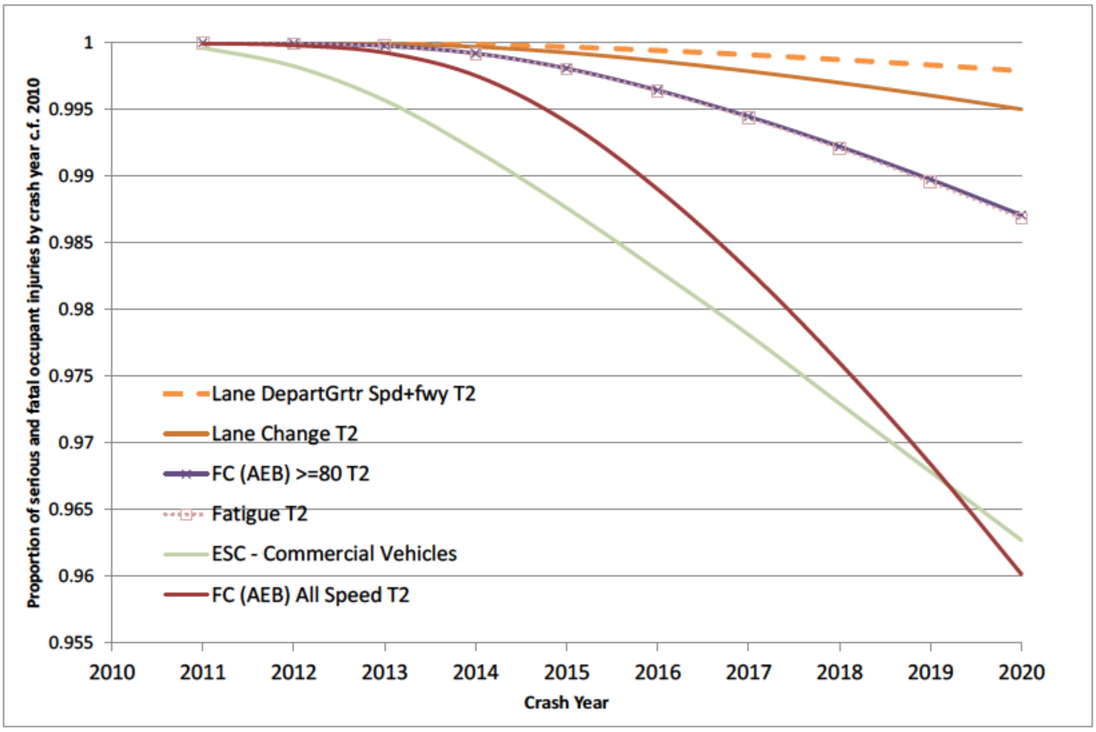


Figure E10: ***Proportion of 2010 vehicle occupant fatal and serious injuries estimated each crash year from 2011-2020 from safety technology fitment with gradual fleet penetration, Australia.***

In Australia, AEB operational at all speeds was the technology estimated to result in the largest savings in fatalities and serious injuries from light vehicle crashes with savings of between 5% and 10% possible in 2020 relative to 2010 depending on whether the technology is mandated or allowed to penetrate gradually due to market forces. Limiting AEB effectiveness to only high speed crashes (80km/hr or more) showed reductions of only 1.5%-3.1%. ESC for commercial vehicles was also estimated to have large potential benefits with reduction in fatal and serious injuries of between 4.5% and 5.7%. ESC will be mandated in light commercial vehicles in Australia from 2016. Potential fatal and serious injury savings from the remaining technologies were much smaller with estimated savings of 1.5% and 3.2% for Fatigue Warning Systems (FWS), 0.6% and 1.2% for LCWS/BSWS and 0.2%-0.5% for LDWSs over a ten year period.

Projected absolute and relative effectiveness of these technologies in the New Zealand fleet were similar to that estimated for Australia and are shown in Figures E11 and E12 for the mandated and gradual penetration scenarios respectively. The only exception was for ESC which had estimated benefits similar to AEB in New Zealand reflecting that there is currently no mandate for ESC in any light vehicles in New Zealand.

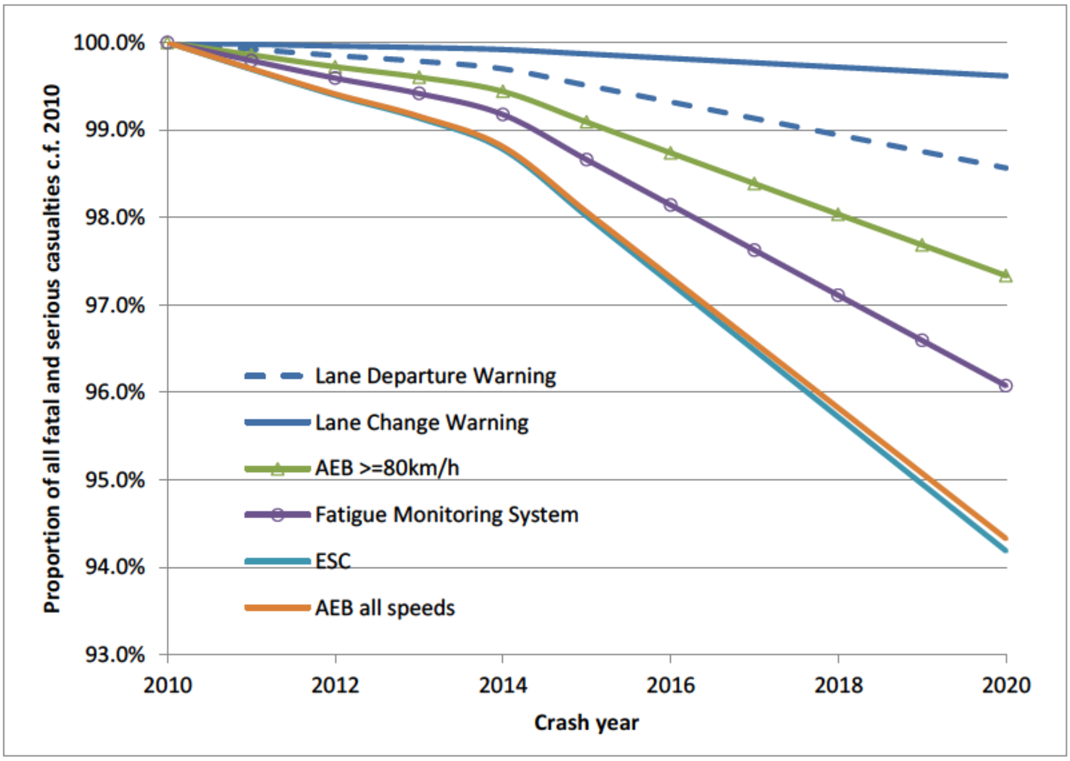


Figure E11: ***New Zealand projected fatal and serious injuries in light vehicle crashes relative to 2010 expected from the fitment of each crash avoidance technology under technology penetration scenario 1 (technology mandated for all vehicles from 2014).***

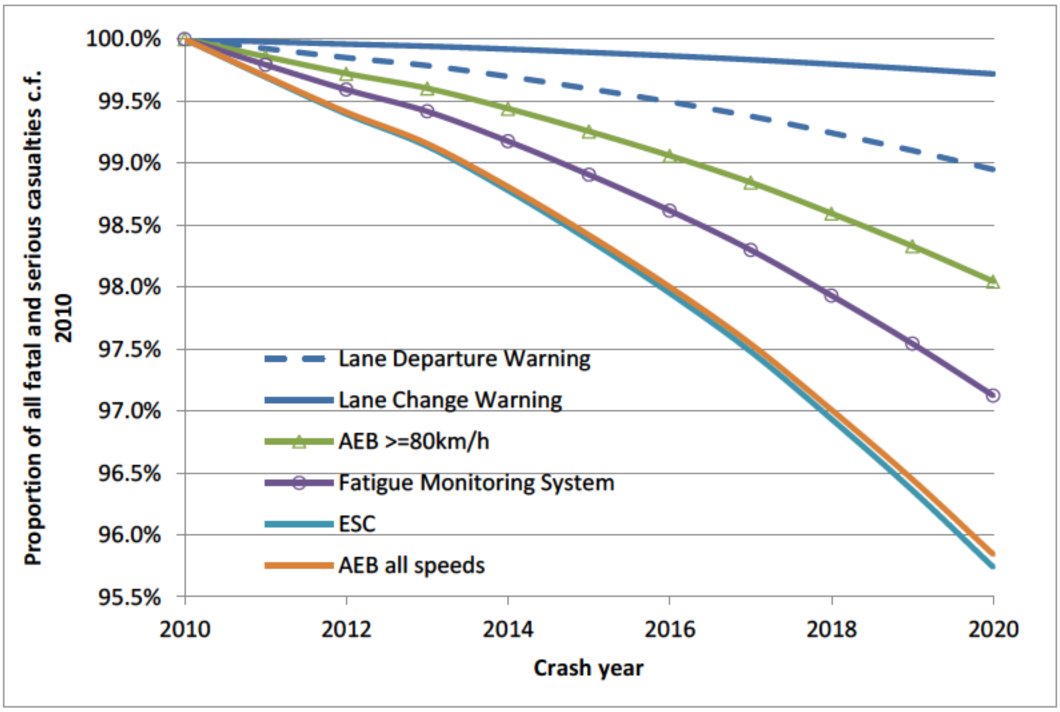


Figure E12: ***New Zealand projected fatal and serious injuries in light vehicle crashes relative to 2010 expected from the fitment of each crash avoidance technology under technology penetration scenario 2 (technology mandated for all vehicles from 2014).***

Estimated possible injury savings for each technology were converted to community cost savings and related to the number of vehicles in the fleet required to be fitted with the technology. From this, a break-even cost was estimated to determine the expenditure per vehicle possible before the cost of trauma savings made equalled the cost of fitment. This estimate also represents the average trauma savings per fitted vehicle. The resulting break-even estimates are summarised in Table E4. Break-even costs estimated were different for Australia and New Zealand largely reflecting the different basis on which community costs from road crashes are calculated between the two countries.

Table E4: ***Summary of estimated break-even costs (present value 2010 $AUS and 2011 $NZ), for monetised benefits in terms of injuries prevented over a 20-year period.***

	Australia ($AU)	New Zealand ($NZ)
Safety System	Range	Range (6%-4% discount)
Autonomous Emergency Braking- All Speeds	60-130	620-740
Autonomous Emergency Braking >=80km/hr	20-43	320-380
Lane Departure	3-7	130-160
Fatigue	20-40	370-440
Lane Change	7-16	50-60
ESC	250	620-740

ESC for commercial vehicles in Australia and all vehicles in New Zealand had the highest break-even value: AU$250 in Australia and NZ$620-$740 in New Zealand. AEBS at all speeds had the next highest break-even value, equivalent to ESC in New Zealand and between AU$60 and AU$130 in Australia depending on the fleet penetration rate. The break-even value for high speed AEB (>=80km/hr) and FWS was similar at AU$20-AU$40 in Australia and NZ$370-NZ$440 in New Zealand. The break-even point for the remaining technologies, LDWS and LCWS/BSWS were AU$16 or less in Australia and less then NZ$160 in New Zealand.

The savings estimated for individual safety technologies are not summative because crashes may be sensitive to more than one technology. The largest overlap in crash effects is likely to be between *FWS, LDWS* and *ESC*. Future studies need to focus on the interaction of these three technologies in crash prevention, and to specifically measure their effectiveness in combination as more vehicles enter the fleet with combinations of these technologies.

One limitation of the current study is the estimates of the crash effects of a number of the emerging technologies considered have not been derived from post-hoc evaluation of the technology in real world application. Instead they have been estimated prospectively through the analysis of crash causation factors to identify crashes that are likely to be prevented by the technology given its documented operation. ESC and low speed AEB have been evaluated retrospectively using real world crash data: however the remaining technologies have not. Estimates of the projected effects of these technologies on overall road trauma as presented in this report need to be revisited as post-hoc evaluation of the real world effectiveness of these technologies becomes available. Undertaking these evaluations as early as possible is recommended.

1 INTRODUCTION

Vehicle safety is a cornerstone of the Safe Systems framework for road safety management and planning, with vehicle safety improvement a key element of all government road safety strategies, both state and national. Improvement in vehicle safety is vital for achieving road trauma reduction targets set out in state and national road safety strategies in Australia and New Zealand. Vehicle safety also continues to be an area of focus by the media, motoring clubs, vehicle manufacturers and consumers alike. Consumers continue to place increasing priority on safety issues when purchasing a vehicle, with vehicle manufacturers leveraging this priority in marketing. In response to market demand, vehicle manufacturers offer an ever-increasing range of safety features in their vehicles.

The age profile of the vehicle fleet has a fundamental influence on road safety, both in terms of crash avoidance technologies (primary safety) and levels of protection provided once a crash occurs (secondary safety). This is because there have been considerable advances in the safety of vehicles over the past 40 years. There are also differences in the safety performance of different vehicle market groups, whose mix in the Australasian vehicle fleets has changed substantially over this period. Larger vehicles often provide good protection for their own occupants but impose greater risk on other road users. The converse is often true for smaller vehicles. It is of interest to establish how changes in the age profile, market group composition and secondary safety performance of the light vehicle fleet have influenced historical road trauma trends. It is also of interest to project how expected changes in these parameters will likely influence future road trauma trends. There is also a raft of crash avoidance (primary safety) technologies likely to enter the light vehicle fleet in the short to medium term. Understanding how these technologies are likely to influence future road trauma trends is also important for setting road safety targets as well as for prioritising which of these technologies should be prioritised.

In this study, primary (crash risk) and secondary (injury risk in a crash) safety trends, both retrospective and projected, in the Australian and New Zealand light passenger and light commercial vehicle fleets were modelled separately. Secondary safety improvements were projected to the year 2020 under two main scenarios: *business as usual*, representing a continuation of current trends in fleet composition and historical crashworthiness improvements; and a scenario of *'stalled' safety improvements*, in which no further secondary safety gains are made. It compared estimates of the fatal and serious injuries for the baseline year of 2010 with those projected to 2020. Projections were derived from trends in vehicle age and secondary safety performance by market group within each market group and jurisdiction. The light vehicle fleet of 2000-2010 involved in injury crashes served as the basis for the projections which estimated expected deaths and serious injuries from crashes in each year of the projection. Based on the projected fatal and serious injuries to the years 2011 to 2020, savings to the community associated directly with projected future vehicle safety improvements and fleet trends were estimated.

For examining potential primary safety improvements, crash types sensitive to the emerging technologies were identified as described in existing local studies (Anderson et al, 2011 and Scully et al, 2010). The technologies considered include Electronic Stability Control (ESC), Autonomous Emergency Braking Systems (AEBS), Fatigue Warning Systems (FWS), Lane Departure Warning Systems (LDWS) and Lane Change (Blind Spot) Warning Systems (LCWS/BSWS). For these safety technologies, crash and injury reductions have not been evaluated using real-life data, with the notable exception of ESC (e.g. Scully et al, 2010). The effectiveness of the other four safety systems was approximated using estimates provided by Anderson et al (2011). Although these were based on empirical data in the sense of estimating likely benefits from crash studies, they do provide a basis for prioritising one technology over another by defining the likely range of crashes prevented. Projection of future incremental fleet safety benefits due to crash avoidance technologies considered reflected current fitment rates.

1.1 SCOPE

Australian and New Zealand injury crash data were obtained from the Police reported crash data used in the database established for the MUARC Used Car Safety Ratings (UCSR) research program. The Australian[1] data were aggregated across five states that together account for more than 90% of all Australian injury crashes (BITRE, 2009)[2]: New South Wales, Victoria, Queensland, Western Australia and South Australia. Ten year total Australian fleet projections, and ten year market group and jurisdictional proportions, were quantified using crash history from the years 2000 to 2010 in the five available jurisdictions. All New Zealand data on reported injury crashes was made available for this project from the Ministry of Transport's Crash Analysis System (CAS).

For this project a light vehicle was defined as a motor vehicle with a tare weight up to 3.5 tonnes and includes both regular passenger vehicles and light commercial vehicles. Market groups of passenger vehicles were categorised to match those used in the UCSR (Newstead, Watson et al. 2012). This categorisation allowed for subsequent matching of crashworthiness and aggressivity estimates by market group to quantify secondary safety performance. These market groups are based on those used by the Federal Chamber of Automotive Industries (FCAI, www.fcai.com.au) and are displayed in Appendix M. The following abbreviations for the market groups are used throughout the report:

SL - Light	SUVC- Compact
S - Small	SUVM- Medium
M - Medium	SUVL- Large
L - Large	CU - Commercial Utility
PM - People Mover	CV - Commercial Van

[1] Unless otherwise defined, and in the context of analysed data of this project, '*Australian*' refers to the aggregation of these five states only.
[2] Table A2.2 of Appendix A2 presents the 2006 injury crash costs, and Table A2.3 presents the injury counts for Australia by jurisdiction.

In addition, light vehicles appearing in the crash data analysed were limited to those without missing year of manufacture data due to the requirements for vehicle age profiling, and to those of an age where crashworthiness ratings could be applied to enable examination of prospective changes. Crashworthiness ratings estimates were only available for vehicles with a year of manufacture of 1964 and beyond so prospective age profiling was limited for each crash year to vehicles aged 46 years and below. This encompassed the majority of the light vehicle fleet which has an average lifetime of around 22 years.

Fatal and serious injury reductions were estimated for the years 2011-2020 using trends in vehicle secondary safety, crashed fleet size and market group composition over ten years (2000-2010). In addition to general secondary safety improvements, projections were made showing the additional benefits of fitment of each of five safety technologies to new vehicles. The five safety technologies are described in Section 1.2; and evidence or assumptions about their effectiveness made in developing models of injury reductions is discussed in Section 3.

The Australian fitment of four emerging safety technologies (excluding ESC) was modelled in two ways: the first assumed zero fitment prior to 2014 and 100% fitment from 2014 (T1 in Figure 1), the second assumed a classic gradual uptake fitment model passing from 0% in 2010, to 70% in 2020 (T2). In Australia, injury reductions associated with fitment of the fifth emerging technology, ESC, were only estimated for new commercial vehicles and fitment was modelled from existing data available for Victorian new car purchases. Actual Victorian fitment rates in new vehicles were used for vehicles up to a 2011 year of manufacture, after that a sigmoidal uptake is modelled to ensure that 100% fitment is achieved by the end of 2016 when the technology becomes mandated. The fitment rate in new vehicles was assumed to be the same for crashed vehicles of the same year of manufacture. These three fitment models are depicted in Figure 1.

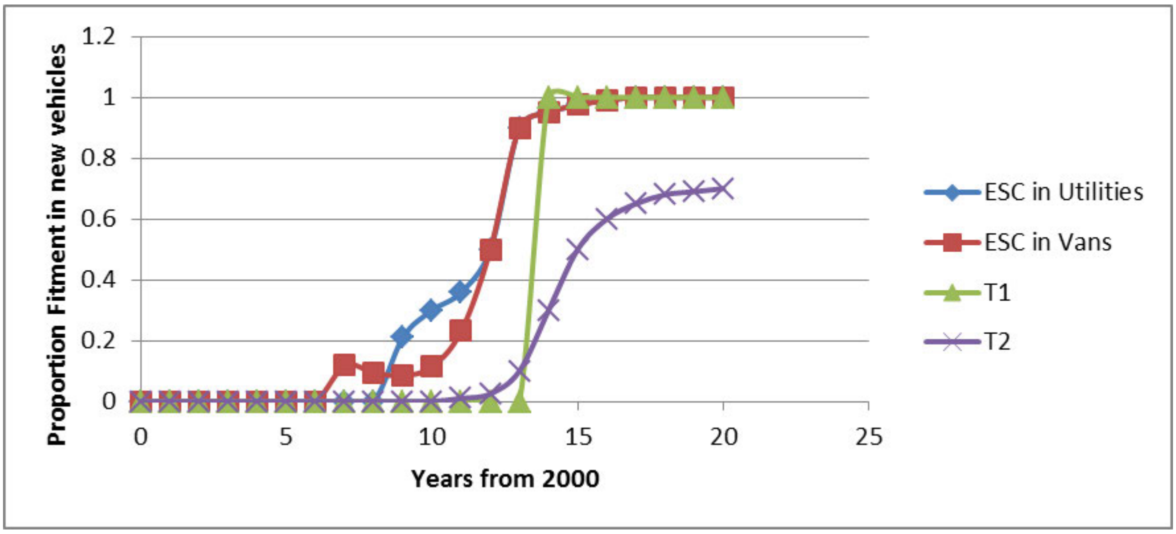


Figure 1: ***Australian fitment models for ESC and emerging safety technologies (T1 and T2).***

For the New Zealand analysis, scenarios were modelled in which the technologies considered were assumed to be mandated for all vehicles entering the fleet in 2014. Under this scenario two thirds of the fleet would have the technology fitted by 2020 reflecting the fleet age profile for New Zealand in 2011. As New Zealand currently does not mandate fitment of ESC in new vehicles, safety benefits were estimated for the entire light passenger vehicle fleet, not just for light commercial vehicles as in the Australian analysis. Despite lack of mandated fitment, the prevalence of ESC in New Zealand new vehicles was very high in the latest available data.

Analysis used the secondary safety ratings reported in the UCSR described in Newstead, Watson and Cameron (2012), to estimate expected relative fatal and serious injuries associated with each crashed passenger vehicle crashes in 2010 and for vehicles projected to be crashed the next ten years. The data set of light vehicle crashes used for this project was limited to only those involved in an injury crash to provide consistency across each jurisdiction. An injury crash was defined as a vehicle crash where at least one person involved in the crash is injured. It is possible that passenger vehicles involved in an injury crash may have had no injured occupants. It is also possible that passenger vehicles involved in an injury crash had no occupants at all.

Investigating the potential interaction of safety effects and crash avoidance technologies considered was generally out of the scope of this study. For example, a certain crash type may be prevented by more than one type of technology, and a vehicle may contain a number of these technologies that prevent the same crash type. However, the degree of overlap of the crash types addressed by various technology combinations was estimated from the New Zealand crash data for some technology combinations to provide some guidance on how estimated benefits might be biased. Further discussion of effectiveness overlap is presented in Section 8.

Estimates of economic benefits in this report are costed as present value 2010 $AUS for the Australian analysis and 2011 $NZ for the New Zealand analysis which reflect the slightly more recent New Zealand data available for the analysis.

1.2 AN OVERVIEW OF SAFETY FEATURES/TECHNOLOGIES CONSIDERED

There are two ways in which safety features can reduce the burden of injury associated with vehicles. Firstly, primary safety features reduce the risk of a vehicle becoming involved in a crash. Examples of primary safety features include ESC and Anti-lock Braking Systems (ABS). The other way that safety features can reduce the burden of injury is by preventing injuries or reducing the severity of injuries when a crash occurs. These safety features are called secondary safety features and airbags, safety belt pre-tensioners and child restrains are common examples. Primary safety features reduce crash risk, while secondary safety features reduce the severity of injuries, or reduce the risk of injury, when a crash occurs.

The emerging technologies examined in this report are primary safety features. Analysis in this report is based on the premise that, when present in a vehicle, primary safety features will prevent a percentage of serious and fatal injury crashes. Consideration of secondary safety in this study is incorporated in the *stalled safety improvements* and *business as usual* modelling.

There are four factors that must be known in order to model the effectiveness of the chosen emerging technology at reducing crashes or injuries within this study:

(i) the types of crashes where the technology is effective;
(ii) the expected or measured crash or injury reduction for the type of crash;
(iii) the fitment rate of the technology within the population of crashed vehicles; and
(iv) the projected level of injury in the crash types considered in the absence of the safety feature being assessed.

In this study:

(i) crash types sensitive to the emerging technologies have been selected following techniques described in literature (Anderson et al, 2011 and Scully et al, 2010);
(ii) there is good scientific evidence of the effectiveness of ESC, (Scully, 2010), however the effectiveness of the other four safety features were determined using the estimates of Anderson (2011);
(iii) current and past fitment rates for ESC were available, however fitment rates for the remaining technologies, in the years up to a 2010 year of manufacture, were considered so low as to be zero; and
(iv) real crash data were used to determine the 2010 base year level of injury.

The remainder of Section 1.2 describes the five safety technologies considered in the study. Section 3 outlines details of how crashes sensitive to the technologies were identified and how fitment rates were modelled.

1.2.1 Electronic stability control (ESC)

Scully et al (2010) described ESC as an in-vehicle safety technology designed to prevent a driver from losing control by applying wheel brakes or reducing engine power when it has identified that the direction of travel is not as intended. It does this by using sensors that measure a vehicle’s steering wheel angle, lateral and rotational acceleration and the speed at which individual wheels are rotating, to continuously monitor the direction of travel. It is now standard on most regular passenger vehicles and four wheel drive wagons in Australia through a mandate which has recently been extended to apply to light commercial utilities from 2016 onwards. As yet there is no mandate for ESC fitment to any vehicle in New Zealand.

1.2.2 Emerging vehicle safety technologies

Anderson (2011) evaluated the likely relative benefits of emerging vehicle safety technology using New South Wales (NSW) Police reported crash data from 1999-2008. The report also described the technology. This section summarises Anderson’s description of four of these technologies considered to have the most potential for passenger vehicle injury crash reduction. Costs from Anderson’s 2011 report are included in the summary below. It should be noted that the technologies listed here are also featured in the future road map of the Australasian New Car Assessment Program (ANCAP) further endorsing their relevance for consideration in this study.

Forward Collision Warning/Avoidance (FCWS)

Forward Collision Warning uses laser/radar sometimes in combination with cameras to monitor the distance to and the speed of objects in a vehicle's path and alerts the driver of danger. It is left to the driver to respond appropriately to the warning with the car not intervening in any other way. Anderson (2011) documented that it was standard fitment to the Mercedes S Class and the Audi A8 although this technology is now filtering down to a wider range of more affordable new vehicles.

Forward Collision Detection and Intervention (also known as AEB) targets rear-end crashes by taking the forward collision warning a step further with the inclusion of an autonomous braking intervention by the vehicle ***(AEBS)***. The system can also warn the driver and prime the braking system. Some systems only work at lower speeds (up to 30km/hr or 50km/hr) whilst others work at higher speeds using a combination of short and long range radar technologies. Whilst originally developed to avoid collisions with other vehicles or fixed objects, these systems are now being adapted to prevent pedestrian crashes. A related feature is Adaptive Cruise Control (ACC) which actively controls acceleration and braking of the vehicle to maintain set distance headway to a preceding vehicle. ACC generally works at vehicle speeds between 60km/hr and 180km/hr.

Emergency Brake Assist is an enhancement to the braking system which senses emergency braking or rapid lift off from accelerator pedal, and works with ABS and ESC to apply the maximum braking force. It is common amongst popular new cars and is often combined with electronic brake force distribution which distributes braking force automatically amongst each wheel according to the available grip.

FCWS specifically reduce or prevent rear-end collisions, collisions with stationary objects on-path, and run-off road crashes at the end of a road or T-intersection. Because they detect objects in the path of a vehicle or generally reduce braking distance, they are expected to reduce the frequency or injury severity of some other crash types which may (or may not) involve a vehicle or object passing in front of the vehicle with the forward collision avoidance system. For example: collisions with unprotected road users on the carriage way, intersection collisions, collisions with vehicles travelling in the opposite direction, collisions with objects falling from other vehicles.

In 2010 the cost of collision detection, ACC and ABS was estimated at approximately $2,700 (Anderson, 2011), although as seen with other safety technologies this is expected to decrease rapidly as the technology becomes more common.

Side Blind Spot/Lane Change Warning (LCWS/BSWS)

This technology targets crashes that occur during intentional lane changes. When a road user attempts a lane change without noticing a potential hazard, typically in the driver blind spots of the vehicle, the system alerts the driver.

This technology uses sonar, radar or cameras to detect the presence of other road users alongside of the vehicle and uses a number of sensors to determine whether or not a lane change or merger is intentional and alerts the driver of danger. It is left to the driver to respond appropriately to the warning. It was first seen standard or optional in Mercedes and Audi passenger vehicle models and optional for $1,275-$1,550 in Volvo passenger vehicle models but is now becoming more widely available in cheaper new vehicles.

Lane Departure Warning (LDWS)

This technology targets unintentional departure from a lane. It uses forward and side viewing cameras to identify reflective lane markings to establish a vehicle's position within a lane. It then takes information on steering angle, measures of the intention of the driver and applies these to complex algorithms to alert the driver if the computer deems the lane departure as unintentional. Some systems go as far as taking corrective action usually in the form of applying braking to a single wheel to correct the path of the vehicle back into the intended lane. The feature started as standard on some Audi and Mercedes models and optional in BMW, Volvo and other Audi and Mercedes models with costs varying from $1,400 to $2,075. The feature is becoming more widely available and is expected to get much cheaper.

Fatigue Warning System (FWS)

This technology targets crashes resulting from driver fatigue such as those that occur when the driver is not in control. Fatigue may be detected by using infrared cameras to detect changes in eyelid movements of the driver, by using sensors to detect erratic steering wheel movements or a combination of these. Once fatigue is detected the driver may be alerted with an audible signal. Fatigue warning systems commenced as standard to the Mercedes S Class and were available from 2010 on Volvo trucks for $1,500. They are also becoming cheaper and more widely available.

2 CRASH DATA SOURCES AND MANAGEMENT

Analysis on this project was based on crash data from MUARC's *UCSR* research program covering Police reported crash data from New Zealand and five Australian jurisdictions. Crash cost data was taken from figures published by BITRE (2009).

2.1 CRASHWORTHINESS DATA

As defined by Newstead et al. (2012), the crashworthiness rating of a vehicle is a measure of the risk of death or serious injury to the driver of that vehicle when it is involved in a crash where a vehicle is towed away or someone is injured. Each rating is expressed as a percentage, representing the number of drivers killed or admitted to hospital per 100 drivers involved in a tow-away crash. This risk is estimated from large numbers of records of injury to drivers of that vehicle type that were involved in real world crashes reported to Police. Crashworthiness ratings are calculated by multiplying injury risk (probability that a driver involved in an injury or tow-away crash was injured) by injury severity (probability that a driver injured in a crash was killed or severely injured). The latest update of the crashworthiness ratings available for this study can be found in Newstead et al. (2012) and are reproduced by market group and year of manufacture in Table B1 (Appendix B) of this report.

Newstead et al (2012), defines aggressivity ratings as a measure of the serious injury rate for drivers of other vehicles and unprotected road users involved in collisions with vehicles from the given market group. It is calculated using similar methodology to the crashworthiness ratings with the key difference being the injury outcome focus is on the other road user colliding with the rated vehicle and not the vehicle occupants. The total safety rating is a measure of the combined crashworthiness and aggressivity of the vehicle with each component weighted by its relative influence on injury outcomes across the observed distribution of real world crash types.

Crashworthiness, aggressivity and total safety ratings were attached to crashed vehicles in the crash data so that fleet averages could be estimated.

Australian forecasts of crashworthiness ratings (by market group) by years of manufacture up to 2020 were made from the available data so that injury savings could be forecast. Forecasts are differentiated from crash data by the use of italic and red font in Table B1 (Appendix B). Aggregate market group forecasts were made by linear regression of data from 1973 to 2010. Forecasts for SUV, utility and people mover market groups were made using all available years of manufacture and an exponential line of best fit. Forecasts for all other market groups were made using all available years of manufacture and a logarithmic line of best fit. Forecast curves may be found in the Appendix B.

2.2 AUSTRALIAN CRASH DATA

Police reported crash data used in this project were that used for the *UCSR* and included data from New Zealand and five Australian states: New South Wales (NSW), Victoria (Vic), Queensland (Qld), Western Australia (WA) and South Australia (SA). This data covered the complete years, 2000-2010, except for Queensland where no 2010 data and only partial data for 2000 and 2005 were supplied. Further details as well as counts of cases for each jurisdiction and crash year are tabled in Appendix A.

The cases were reduced to passenger vehicles involved in injury crashes to make the data from each jurisdiction consistent (only injury crashes are reported in Victoria). This was also consistent with measuring the effects of primary and secondary safety effects on injury outcomes. Market group information and vehicle safety ratings from the *UCSR* research program was merged onto the data. Vehicles with no valid year of manufacture (YOM) were excluded. Counts of crashed passenger vehicles (with a valid YOM) involved in injury crashes are tabled by jurisdiction and crash year in Table 1. The proportion of these counts disaggregated by market group is shown in Table A1.5 of Appendix A1.

Table 1 : ***Police reported crashed passenger vehicles involved in injury crashes by crash year and jurisdiction (2000-2010)*.***

	NSW	Qld	SA	Vic	WA
2000	32,152	15,636	12,165	27,031	14,911
2001	34,213	19,156	12,010	24,916	15,103
2002	32,655	18,943	11,663	25,120	16,989
2003	31,563	19,140	11,024	24,736	15,910
2004	30,282	18,841	10,251	23,774	15,956
2005	28,985	7,610	9,281	23,040	13,499
2006	28,974	18,287	9,201	18,111	17,838
2007	29,649	20,018	9,730	18,053	17,615
2008	27,343	19,976	10,155	17,914	17,745
2009	27,360	19,115	9,469	18,653	15,379
2010	28,362	-	9,987	18,405	15,307

*Where year of manufacture data are not missing.

Data Management is described in more detail in Appendix A1. The following are dot points presenting some issues primarily with consistency between states that needed to be accounted for in formulating the analysis.

Crashes

- 2005 Queensland Crash Data were incomplete and Queensland 2010 data were missing, so projections were used to estimate injury crashes for these years. These projections were used in Australian aggregated data.
- Crash location as rural, remote or metropolitan was not available for Queensland.

Injuries

- New South Wales only provided two injury severity categories for injured people: injured and fatal. When calculating injury reductions expected from crashes sensitive to the safety technologies serious injuries were estimated for New South Wales using data from other jurisdictions.
- Crash Injuries include injuries from riders/occupants on/in the other vehicles and also injuries from pedestrians.

Crashed Vehicles

- The total number of occupants in a crashed vehicle is not known reliably for Victoria. Australian occupancy rates were averaged over four states. The Australian average was assumed for Victoria.
- Crashes with parked vehicles listed as cases in the crash data were considered to be multi-vehicle crashes.

Issues with identification of crashes sensitive to emerging vehicle technologies

- South Australia does not have a crash type code variable similar to the ‘DCA’ or ‘RUM’ code used in other states.
- Illegal speeding was able to be identified only for New South Wales, South Australia and Western Australia and is determined from Police judgement on crash causation.
- Exceeded driver blood alcohol concentration (BAC) limits were identifiable only for New Zealand, Queensland, South Australia, Victoria and Western Australia, and there may be some under-reporting in these states.
- Fatigue as a factor was only present in the New Zealand and Western Australia data as judged by Police as a contributing factor.
- Identification of crashes at roads with edge line marking could be estimated with the use of various variables in all jurisdictions.
    - Highways and expressways could be identified:
        - for New South Wales and South Australia as divided roads and dual freeways;
        - for Victoria and Queensland as divided roads; and
        - for Western Australia as highways from the highway coding or highway road name.
    - For New Zealand highways and expressways could not be identified, however sealed and bitumen roads could.

Issues with merging of safety ratings onto crash data

- Safety ratings for specific vehicle models were available only for vehicle models with a year of manufacture >1982.
- Safety ratings were not available for all models with a year of manufacture >1982 and pre 1982 vehicles.
    - For 1982 vehicles and beyond with a known market group, average safety ratings by market group and year of manufacture were assigned.
    - For all other vehicles, average safety ratings by year of manufacture were assigned.
- Vehicles manufactured prior to 1964 were not considered but represented a very small proportion of the light vehicle fleet.

2.3 AUSTRALIAN CRASH DATA PROFILE

In order to provide the background against which estimates of effects of changing secondary safety and the effectiveness of emerging vehicle technologies were made, analysis of the profile of crashes observed in Australia is presented in the following sections. The analysis focuses particularly on vehicle type as well as those crash types which are likely to be saved by the emerging technologies considered.

2.3.1 Vehicles per crash

Multi-traffic unit crashes were the predominant crash type involving light vehicles in the analysis data with an average of 1.8 vehicles per crash. In Western Australia, vehicles per crash averaged 2.0 in 2010 (Table A1.6). Multi-unit crashes usually involved other passenger vehicles; there were 1.6 to 1.7 passenger vehicles (with a valid year of manufacture) per injury crash (Table A1.7). Vehicles per crash disaggregated by crash year and jurisdiction are presented in Tables A1.6 and A1.7 of Appendix A1.

2.3.2 Vehicle occupancy

Over each of the 11 years of crash data, the average recorded occupancy for Australian passenger vehicles was 1.5. From 2006, occupancy by jurisdiction was also measured at 1.5 persons per vehicle. Average occupancy in 2010, (and in 2009 for Queensland) by jurisdiction and market group is displayed in Table A1.8 of Appendix A1. The 2010 weighted average occupancy over the four states used 2009 data for Queensland. Victoria has been excluded because vehicle occupancy data are not reliable. Crashed commercial utilities and vans possessed the lowest 2010 average occupancy rate of 1.3. Light to medium cars had a slightly higher occupancy rate of 1.4 persons per vehicle. The highest occupancy rate was within the people mover market group as expected.

2.3.3 Crash types

The proportions of each crash type examined in this report varied little from 2000 to 2010, over all of Australia and within each jurisdiction or market group; so only data for 2010 have been presented. Queensland data for 2009 was included only for the Australian aggregates.

Figure 3 displays the 2010 proportions of passenger vehicle injury crashes for: multi-vehicle, intersection rear-end, unprotected vehicle, pedestrian, heavy vehicle, head on and roll-over crashes. These categories are not mutually exclusive and the figure shows that 60%-80% of all passenger vehicle injury crashes involved more than one vehicle. This proportion was highest in Western Australia where the proportions of intersection and rear-end crashes were also higher than for other states. These two features demonstrated the high proportion of Western Australian injury crashes occurring in urban areas, where 84% of all passenger vehicle injury crashes occurred in metropolitan locations (Figure 2). Multi-vehicle, intersection and rear-end crashes represented the greatest proportion of crashes in the small, light and compact SUV market groups, likely a reflection of largely urban exposure.

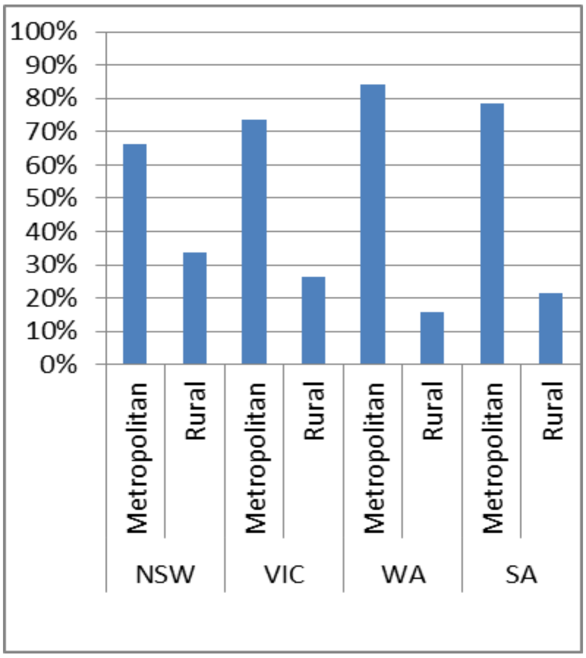


Figure 2: ***2010 Proportions of passenger vehicle injury crashes for Metropolitan and Rural (including remote) locations, for Australia, by jurisdiction.***

The proportions of unprotected road user (motorcycle, bicycle and pedestrian – noted as unprotected vehicles in the charts) crashes were greatest in Victoria. These crash types were most prevalent in the people-mover, van, and medium and large SUV market groups. Greater proportions of medium than large SUVs were involved in pedestrian crashes, again likely reflecting their higher urban exposure.

The highest proportion of heavy vehicle and head-on crashes were observed for large SUVs, vans and utilities. The proportion of roll-over crashes was highest with large-SUVs and utilities. Both these traits represent higher proportion of rural exposure for these vehicle types.

The greatest proportions by crash type, regardless of jurisdiction or market group, were for the types: multi-vehicle, rear-end, single vehicle and intersection. Proportionally 20%-40% of crashes were single vehicle crashes. Amongst the less frequent crash types utilities and vans featured strongly.

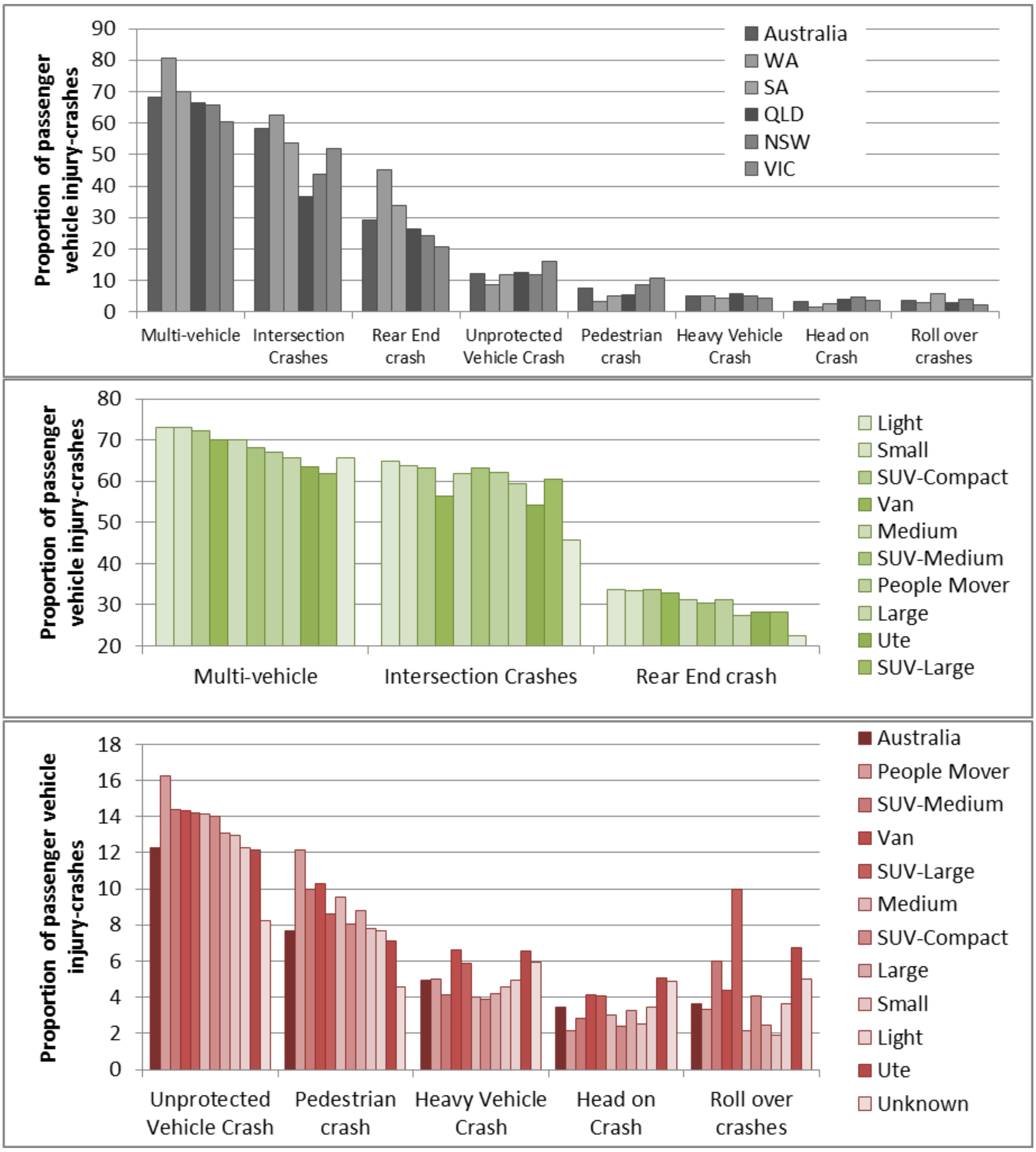


Figure 3: ***2010 Proportions of passenger vehicle injury crashes for various crash types, for Australia, and by jurisdiction or market group.***

2.3.4 Driver age profile

The influence of Australia's ageing population was observed as a small increase in the proportion of older drivers of injury-crash involved passenger vehicles (Figure 4).

The driver age distribution was similar over each jurisdiction. People movers and SUVs were more likely to be piloted by 35-54 year old drivers and light, small and medium vehicles were more popular for both younger and older drivers. Further details, including graphs by driver age and market groups can be found in Appendix A1.

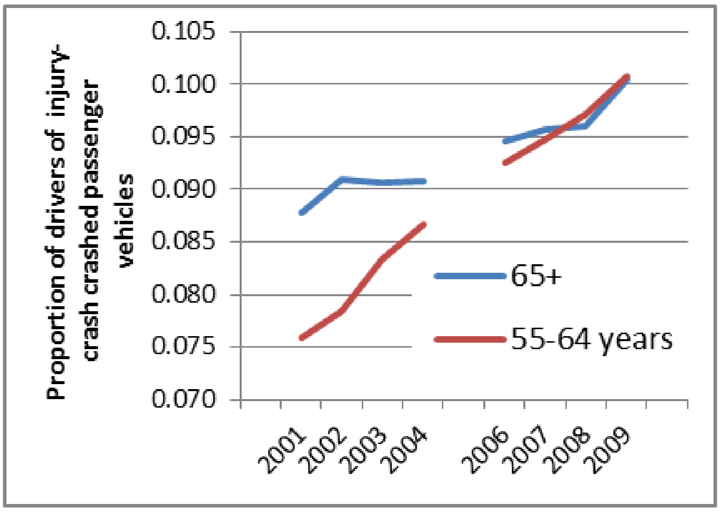


Figure 4: ***2001-2009 Proportions of older drivers of injury-crash passenger vehicles, for Australia (2005 is not included because of incomplete Queensland data).***

2.3.5 Vehicle age profile

The proportions of vehicles of each age (crash year - YOM) and each age group were determined for each year of crash for all of Australia, by jurisdiction and by market group. Figure 5 displays the proportions for the combined 2000 to 2010 data by jurisdiction. It may be seen that the with the exception of South Australia, which is noticeably older, the fleets in each state had a similar age distribution.

Other age profiles including those by market group may be found in Appendix J.

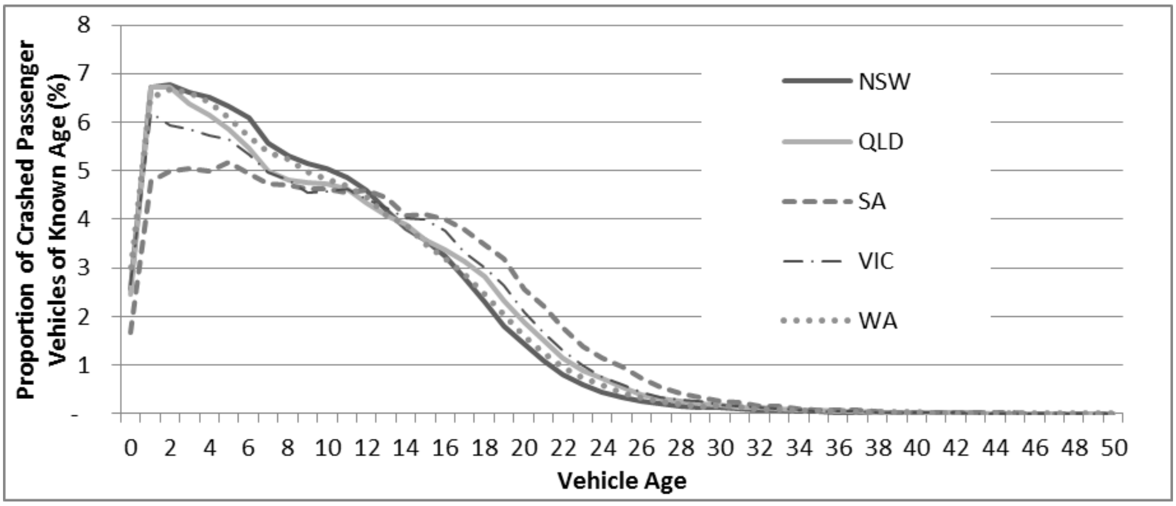


Figure 5*:* ***Vehicle Age distribution by jurisdiction for crash data from 2000 to 2010.***

2.3.6 Vehicle safety profile

Summaries of crashed vehicle safety rating averages over the crash years, 2000-2010 are presented in Figures 6 to 8. A range of 2.2% units was used in each vertical scale, except for the plot of small and light vehicle crashworthiness, where the range had to be extended due to a greater change over the time period. The average estimates are obtained by averaging over all the injury crash involved passenger vehicles within a crash year according to the vehicle age profile.

It may be observed from Figures 6 to 8 that over 2000-2010, crashworthiness, and total safety ratings have declined, nationally, and for each jurisdiction and market group. Aggressivity ratings have remained fairly constant with evidence of a small increase of about only 0.1% units nationally over the 11 year period. South Australia, Queensland and Western Australia performed worse than the national average on the measures of crashworthiness ratings, total safety ratings and aggressivity although the long term trends in each jurisdiction were similar.

The small and light vehicle market group fleets had the poorest crashworthiness while large and medium SUVs had the best. The commercial van and utility and medium and large SUV fleets consistently had the poorest aggressivity, with increases of up to 0.7% units seen for commercial vehicles over the period (i.e. the aggressivity of the commercial fleet has become worse over time). Conversely, small and light vehicles displayed the best aggressivity, however, light vehicle aggressivity has increased (by 0.1% unit) over the period. The medium SUV fleet has shown the largest decrease in aggressivity over the period, dropping from 4.8% to 4.4% over the period. The next best improvement was seen in people movers where a 0.3% unit drop in aggressivity was observed over the period. People movers also saw a 1.4% drop in the total safety ratings, which was the greatest drop in total safety ratings observed for all market groups over the period. Large drops of about 1.0% in average total safety ratings were seen for light vehicles, compact SUVs and medium SUVs.

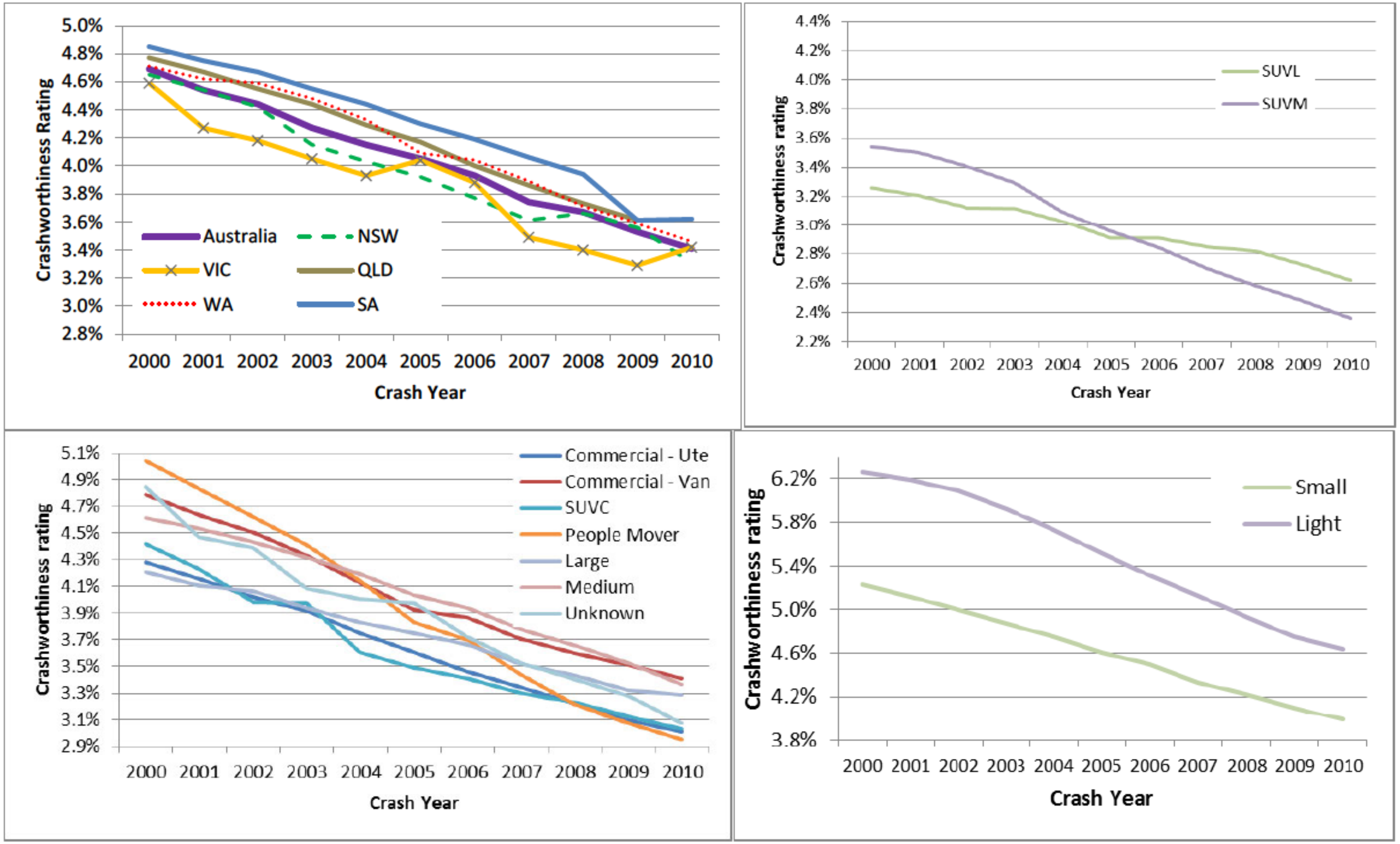


Figure 6: ***2010 Crashworthiness ratings of injury crash passenger vehicles, for Australia, and by jurisdiction or market group.***

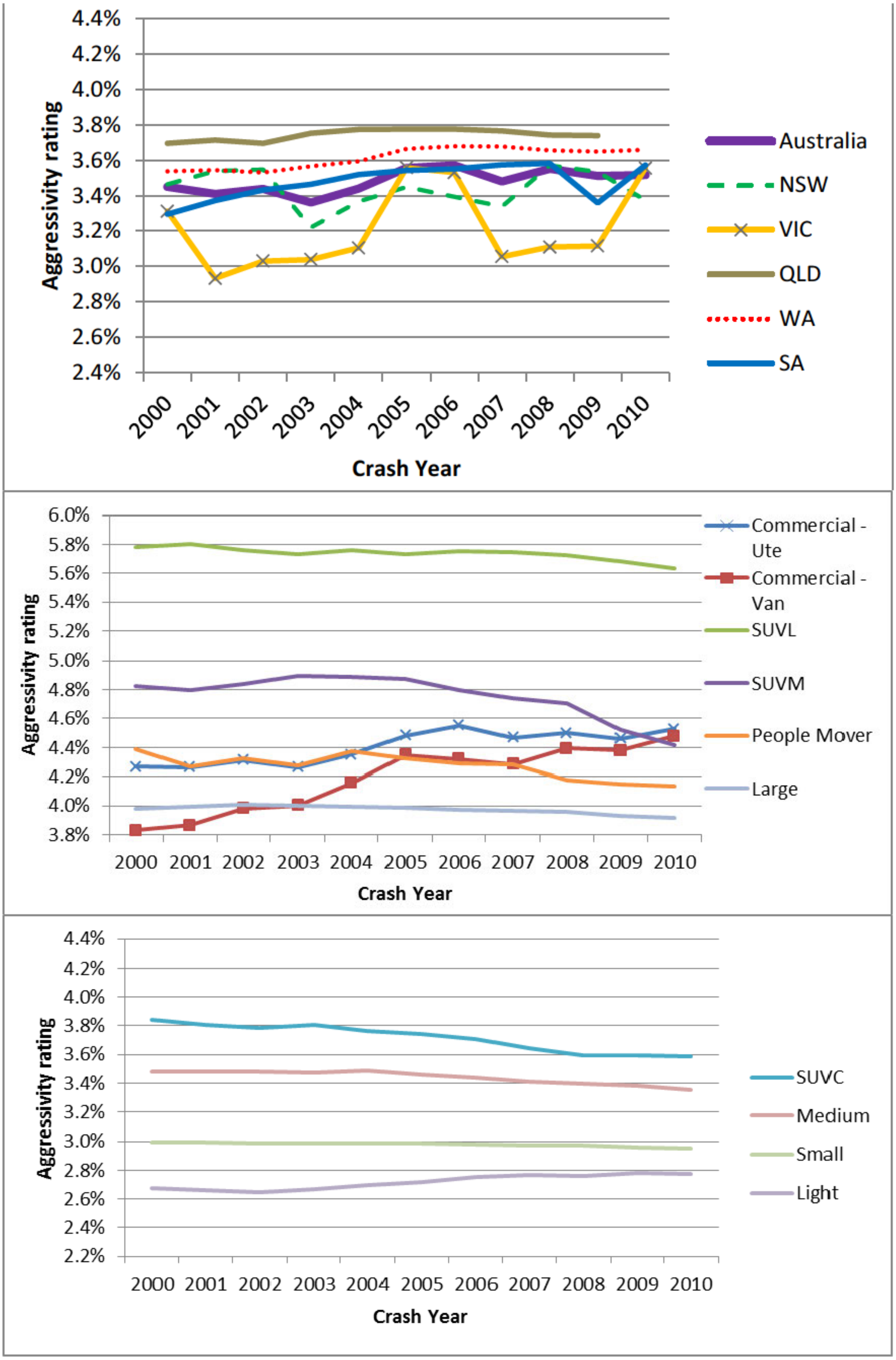


Figure 7: ***2010 aggressivity ratings of injury crash passenger vehicles, for Australia, and by jurisdiction or market group.***

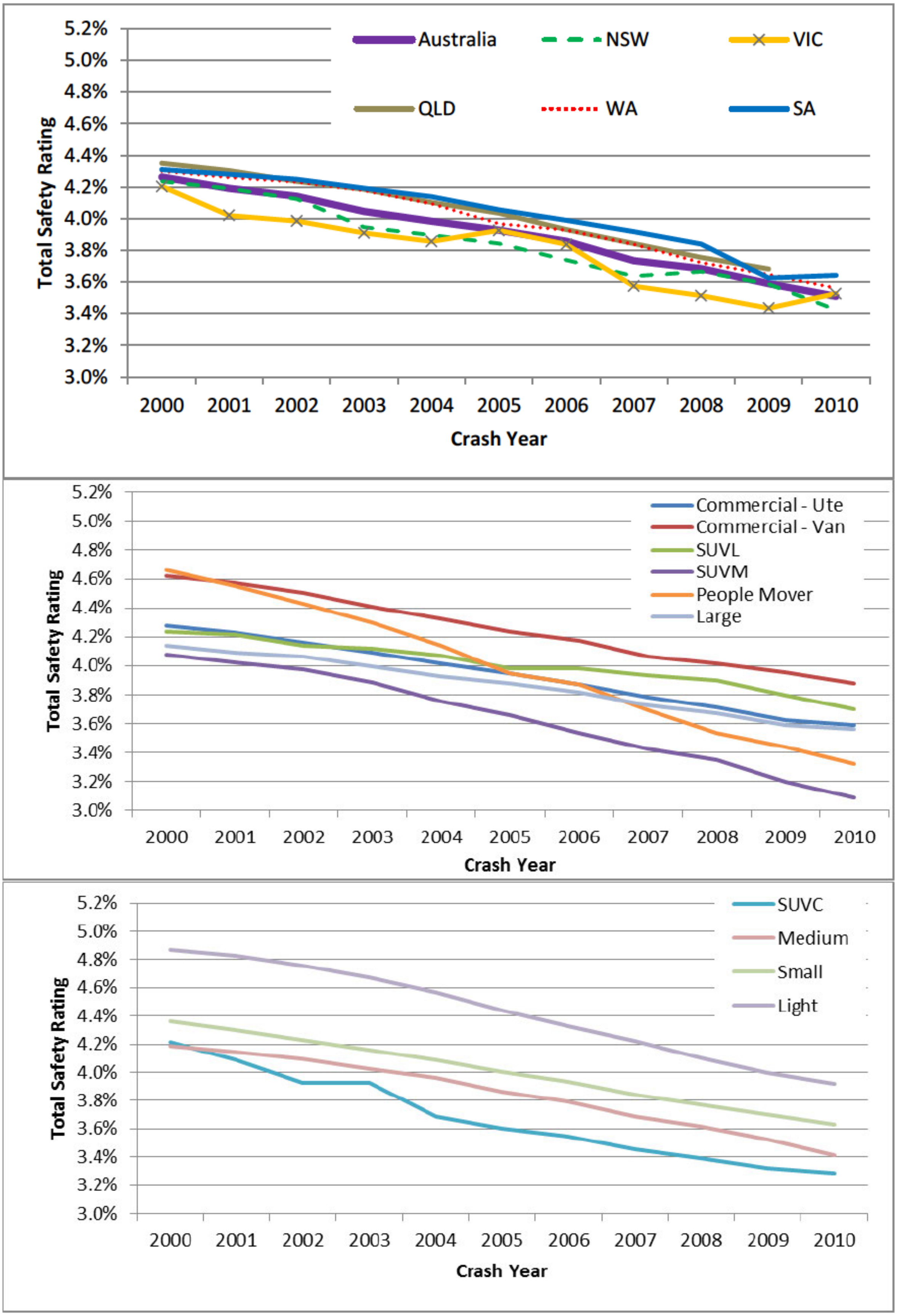


Figure 8: ***2010 total safety ratings of injury crash passenger vehicles, for Australia, and by jurisdiction or market group.***

2.4 NEW ZEALAND CRASH DATA

Table 2 shows the New Zealand data analysed, also spanning a decade, but from 2003 to 2012. The New Zealand data include both crashed vehicles, as for the Australian jurisdictions, as well as regular snapshots of all licensed (registered) light vehicles in New Zealand. The latter were analysed to show how the licensed vehicle fleet was changing.

Table 2 : ***New Zealand light passenger vehicle fleet data analysed: vehicles involved in reported injury crashes and total light vehicles licensed.***

Year of Crash	Crashed vehicles	Licensed vehicles
2003	15,036	2,443,276
2004	14,576	2,549,278
2005	14,083	4,818,274*
2006	14,048	
2007	14,953	2,757,638
2008	14,058	2,773,940
2009	13,671	-
2010	12,843	-
2011	11,286	2,820,587
2012	11,024	2,843,625
Total	135,578	21,006,618

* 2005 and 2006 combined

Figure 9 shows the cross sectional average crashworthiness of the licensed New Zealand light vehicle fleet. Like the Australian analysis, there were general trends towards improved average crashworthiness of the fleet over time. However, the New Zealand fleet generally had poorer crashworthiness, likely to be associated with a different age and size profile of vehicles compared to Australia, specifically with fewer new vehicles and generally smaller vehicles in the New Zealand fleet. The abrupt apparent deterioration in crashworthiness in 2011 and 2012 for commercial utility vehicles is most likely an artefact of better specific coding of makes and models for those years rather than to any underlying change in crashworthiness.

2.4.1 Vehicle safety profile

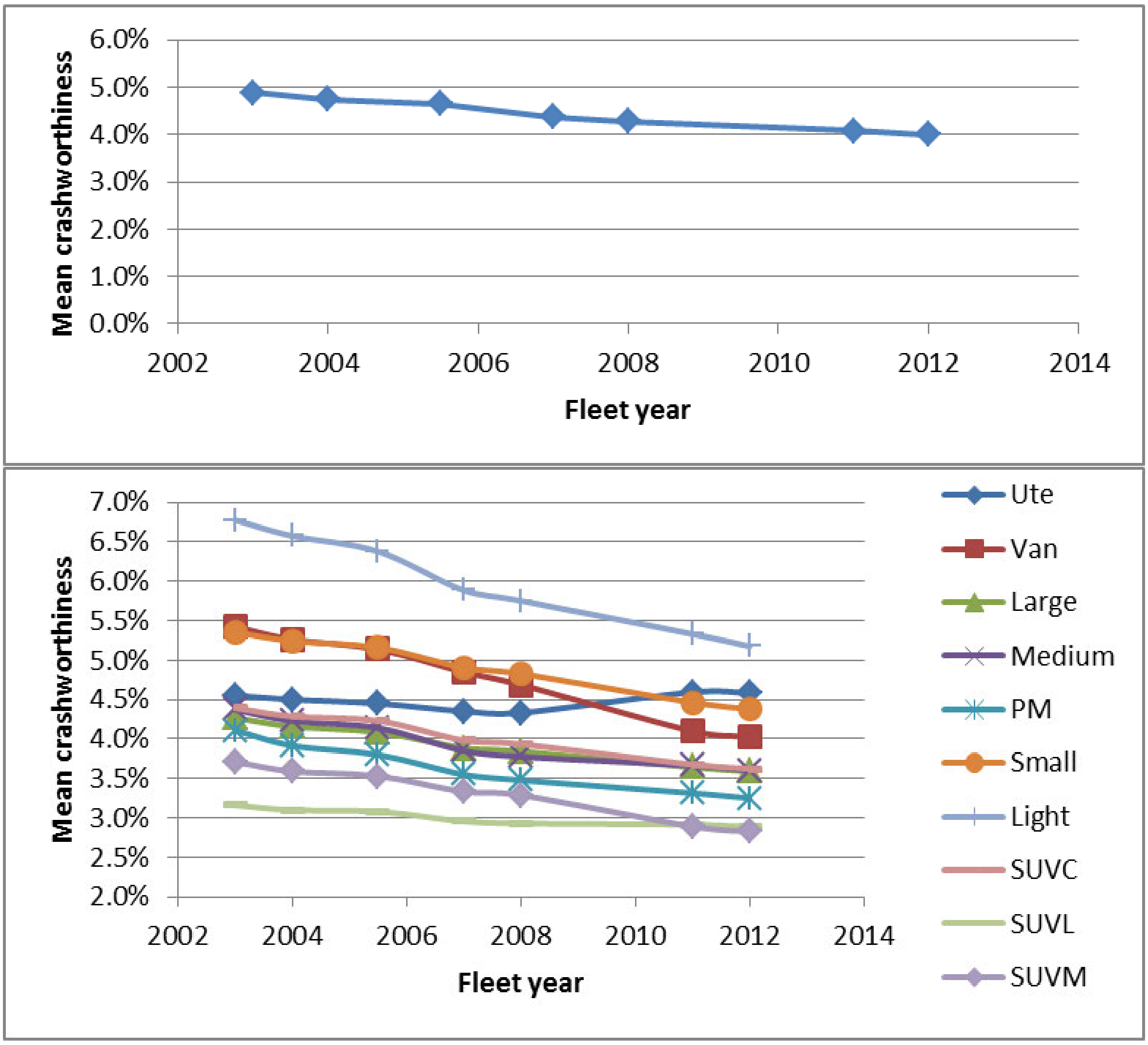
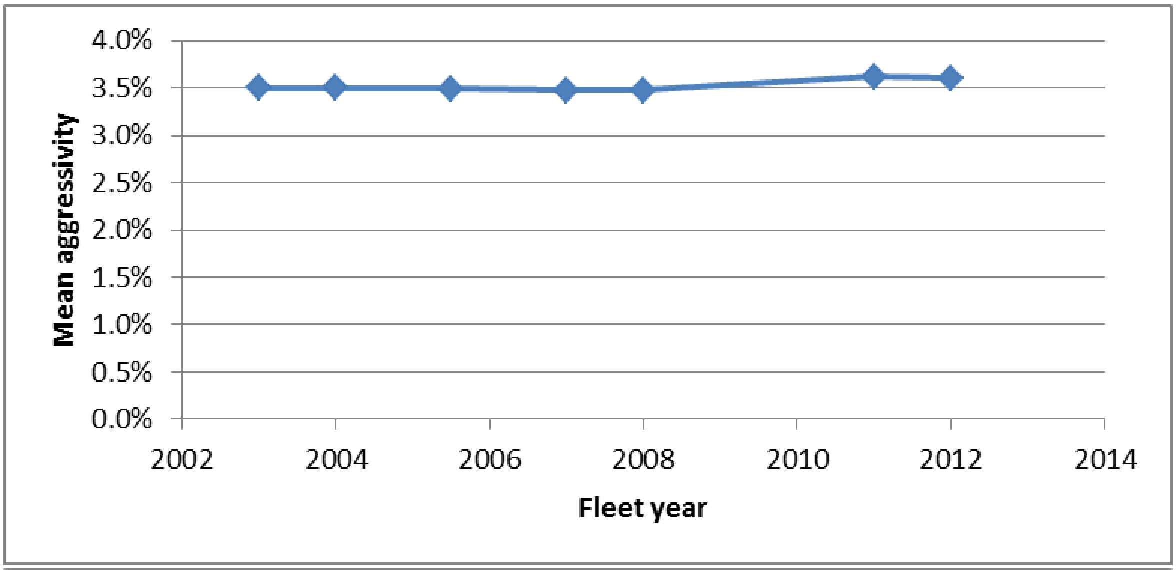


Figure 9: ***New Zealand crashworthiness ratings for licensed vehicle fleet by fleet year overall and by market group.***

Figure 10 shows the New Zealand estimates of average fleet aggressivity by year. These also generally show a similar ordering of market groups to the Australian estimates shown in Figure 7. The Australian fleet has on average a similar aggressivity to the New Zealand fleet.



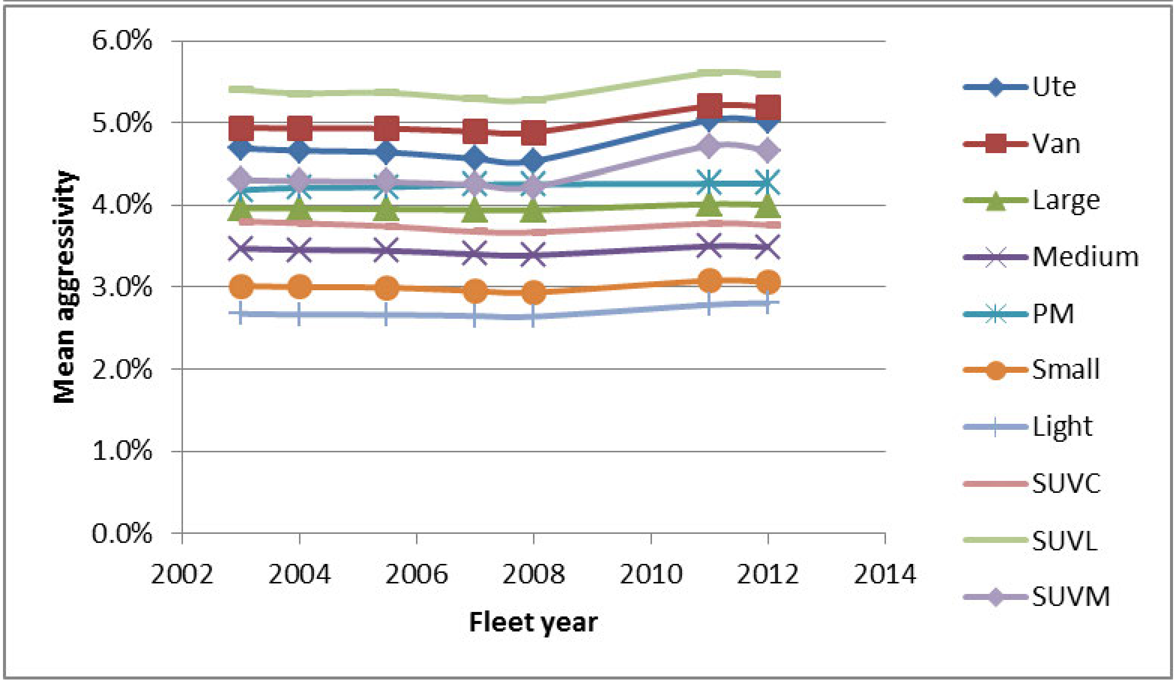


Figure 10: ***New Zealand aggressivity ratings for licensed vehicle fleet by fleet year overall and by market group.***

Figure 11 shows the New Zealand estimates of average total secondary safety by fleet year, which measures combined crashworthiness and aggressivity, but with a greater weight given to the crashworthiness ratings as these are the more influential on overall injury outcomes. Comparison with the Australian estimates shows the Australian fleet has on average superior (lower average) total safety than the New Zealand fleet reflecting the superior crashworthiness of the Australian fleet.

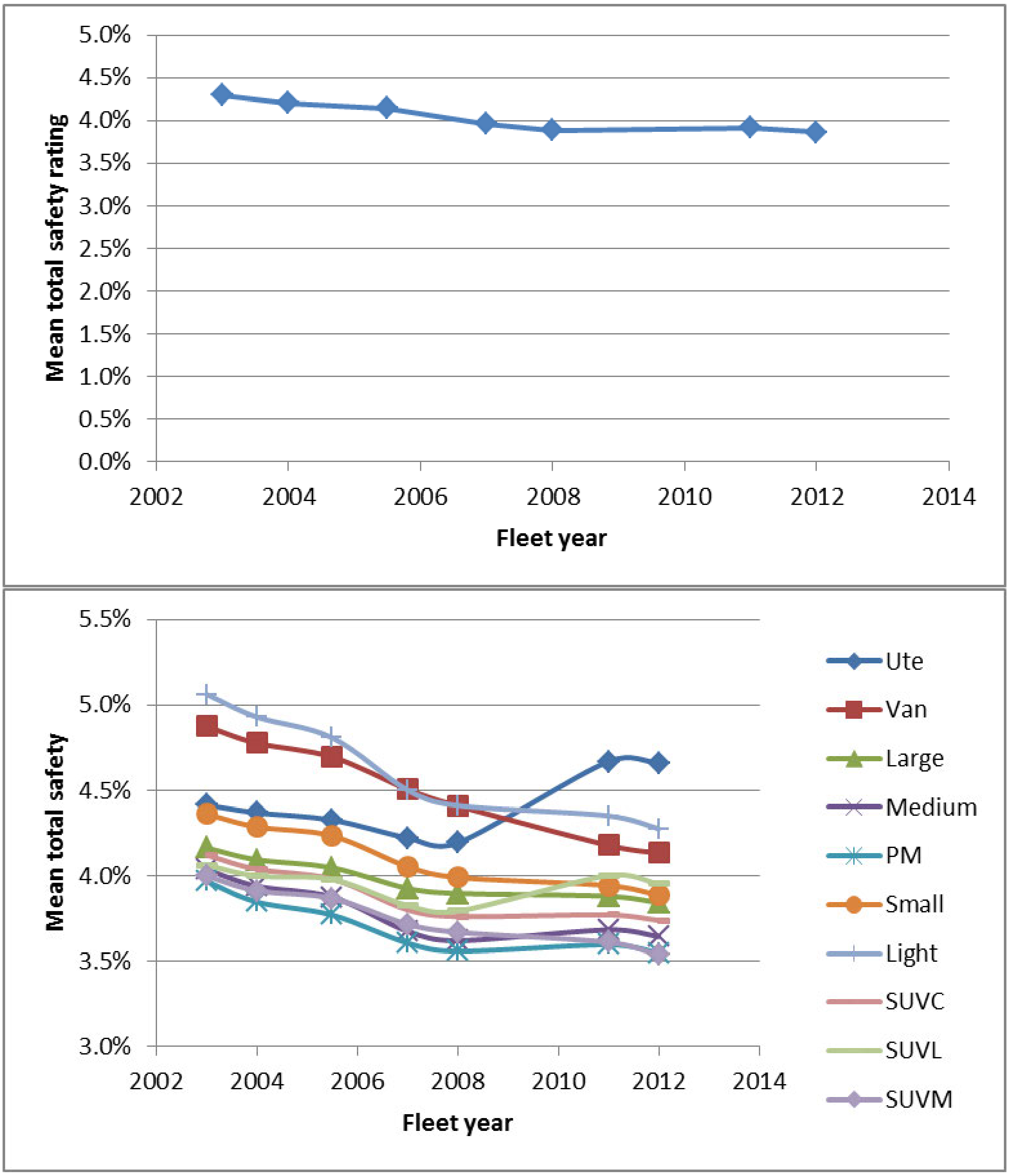


Figure 11: ***New Zealand total secondary safety ratings for licensed vehicle fleet by fleet year overall and by market group.***

2.4.2 Relationship between crash and on-road fleets

The data from New Zealand enabled a comparison to be made between the on-road fleet secondary safety ratings and the crash fleet secondary safety ratings. This was important as the crash fleet does not constitute a random sample from which the nature of the on-road fleet can be directly inferred. For example, vehicles that are commonly used by high-risk driver groups (particularly young drivers) will be overrepresented in the crash fleet relative to the on-road fleet. Similarly, vehicles that have a high degree of usage in congested urban settings will have a high rate of crashes (but not necessarily the more severe crashes). The following two figures show a comparison of mean crashworthiness and aggressivity for the crash fleets and the on-road fleets in New Zealand over the course of a decade from 2003 to 2012.

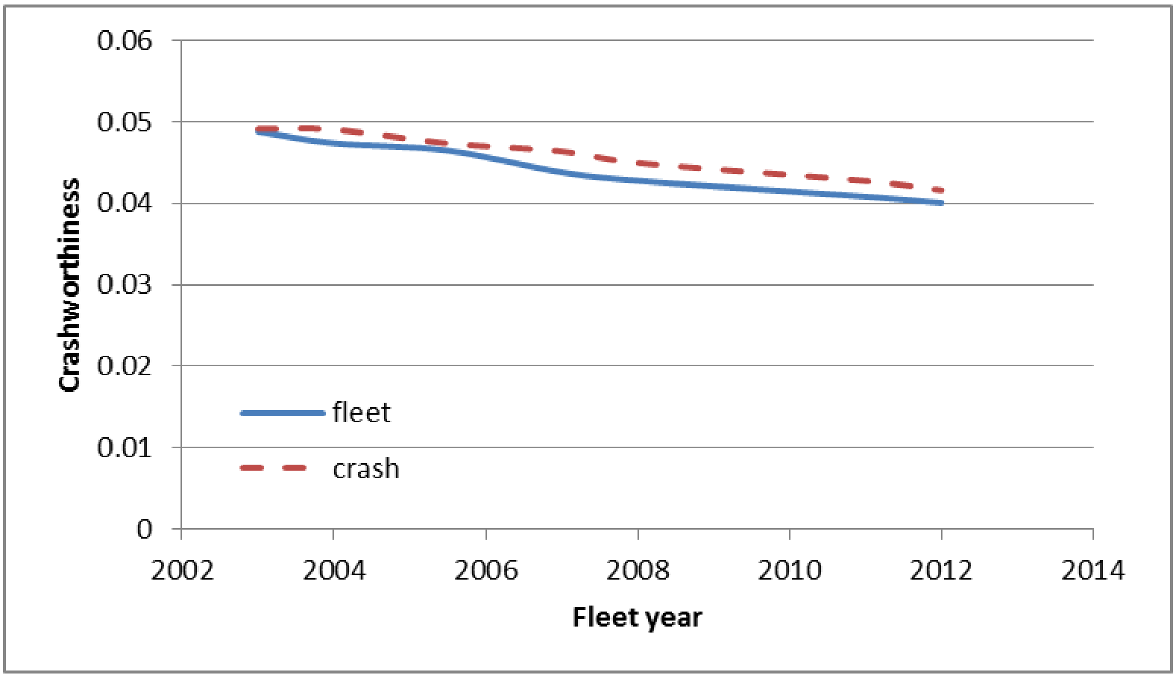


Figure 12: ***Comparison of average crashworthiness for the crash fleets and the on-road fleets in New Zealand.***

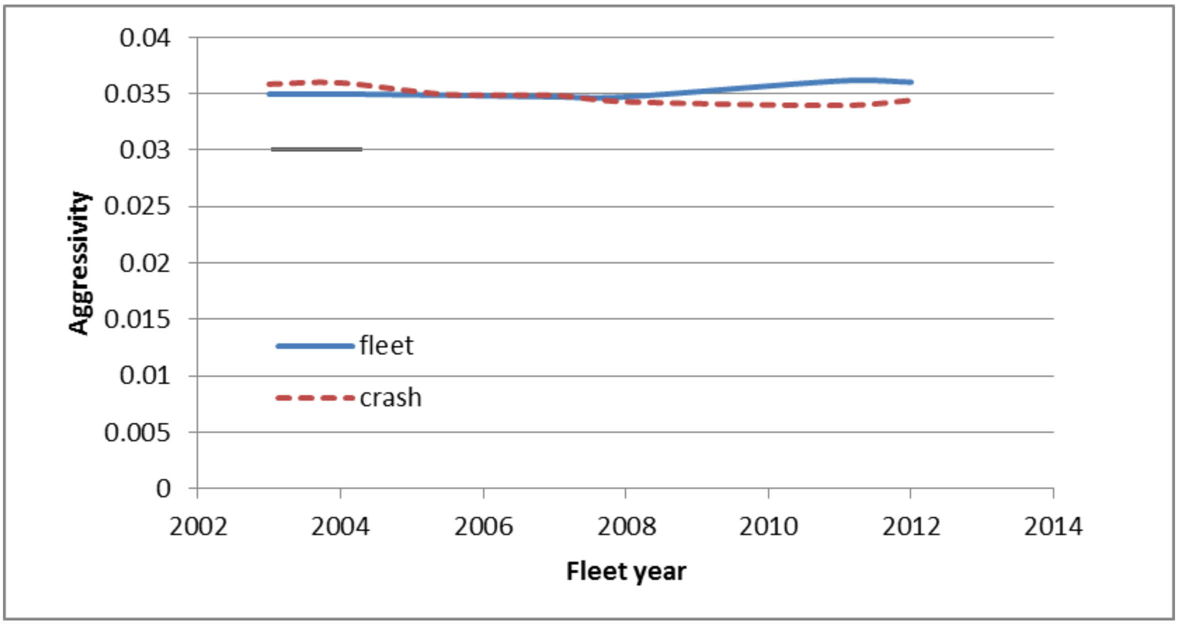


Figure 13: ***Comparison of average aggressivity for the crash fleets and the on-road fleets in New Zealand.***

These figures show that the crashworthiness of the crash fleet is generally slightly poorer than the crashworthiness of the licensed vehicle fleet (which can be considered to approximate the on-road fleet), but the overall trend in improving safety is similar (Figure 12). In terms of aggressivity (Figure 13), there is little discernible trend in either series, although the on-road fleet was assessed to have higher levels of aggressivity at the latter end of the period than the licensed vehicle fleet.

The implications of these analyses are that general trends and levels are likely to be similar for crashworthiness, and that general levels are likely to be similar for aggressivity when modelling changes in the crash fleet as a surrogate for the licensed vehicle fleet.

2.5 CRASH COST DATA

For the Australian analysis, the unit injury costs for fatal and serious crashes and their associated vehicle related costs have been taken from the Bureau of Transport Economics' report that described a methodology to estimate the costs due to road crashes in Australia (BITRE, 2009). This report took a hybrid human capital approach to estimating the magnitude of different components of the costs of injury from road crashes. The alternative to the human capital approach is to include the cost of pain and suffering and reduced quality of life. This willingness to pay method involves estimating the maximum amount of money a person is willing to pay to reduce risks to his or her safety. The New Zealand analysis used a valuation of crashes and injuries used in the economic evaluation of transport projects and policies, which are based on the willingness to pay approach (Ministry of Transport, 2008).

Both the willingness to pay and the human capital approaches have their deficiencies. The reader is referred to BITRE (2009) for a detailed description of the disadvantages and advantages of both approaches. BITRE (2009) recognised that as willingness to pay includes elements that the human capital approach does not include in its estimates of cost, the former approach usually gives higher values of the cost of injury than the human capital approach. The hybrid approach used by BITRE (2009) includes: a notational age dependant value for the quality of life that would be lost by the unknown individual in the event of their premature death; an allowance for pain, grief and suffering that the family and relatives of the deceased suffer; costs to employers for the disruption caused; the cost of a premature funeral and the costs of prosecuting culpable drivers. Despite all the quality of life inclusions in the hybrid approach BITRE (2009) estimates the full 'willingness to pay' costs at 52% higher than their hybrid approach.

The Australian analysis uses the 2006 values estimated by BITRE (2009), further updated to year 2010 prices. The methods used in estimating crash costs in this report are detailed in Appendix A. The estimates themselves are displayed in Table 3 .

Table 3 : ***Estimated social cost of road crash injuries by jurisdiction, dollars, 2010.***

	fatal injury	Serious injury	Minor injury	non-fatal injury*	Fatal and Serious Injury*
NSW	3,243,408	290,022	2,876	39,130	427,029
Victoria	3,295,723	290,958	2,906	39,508	409,225
Queensland	3,334,993	288,915	2,843	38,741	450,479
South A	3,185,437	290,162	2,875	39,142	424,907
Western A	3,177,728	286,836	2,760	37,677	504,108
5 states	3,262,357	289,799	2,867	39,030	433,478
Australia	3,245,910	289,688	2,865	38,997	434,048

*weighted averages

The amount of money required today to pay for a future event is generally assumed to be less than the amount of money that would be required to pay for that event when it occurs in the future. This is because an equivalent sum of money can alternatively be invested in a zero-risk investment (such as government bonds) from now up until the time when the event occurs. In this time the alternative investment increases by a net percentage termed the discount rate. The estimated costs in this report are therefore based on present value estimates using 4%[3] and 6% discount rates. Table 4 displays the Australian 2010-2020 estimated injury costs for fatal and serious injuries with a 4% discount rate.

Table 4 : ***Estimated average present value cost of road crash fatal and serious injuries by jurisdiction and crash year, $2010, 4% discount.***

	NSW	Victoria	Queensland	South A	Western A	5 states	Australia
2010	427,029	409,225	450,479	424,907	504,108	433,478	434,048
2011	410,605	393,486	433,153	408,564	484,719	416,806	417,353
2012	394,812	378,352	416,493	392,850	466,076	400,775	401,301
2013	379,627	363,800	400,474	377,740	448,150	385,360	385,867
2014	365,026	349,808	385,071	363,212	430,913	370,539	371,026
2015	350,987	336,353	370,261	349,242	414,340	356,287	356,755
2016	337,487	323,417	356,020	335,810	398,404	342,584	343,034
2017	324,507	310,978	342,327	322,894	383,080	329,408	329,841
2018	312,026	299,017	329,161	310,475	368,347	316,738	317,154
2019	300,025	287,516	316,501	298,534	354,179	304,556	304,956

[3] BITRE (2009) assumed a discount rate of 4% when estimating the cost of the loss of future income and productive capacity for people injured in road crashes.

2020	288,485	276,458	304,328	287,052	340,557	292,842	293,227

3 SCENARIOS CONSIDERED

This project evaluated future safety levels if current trends in the vehicle fleet continue and the additional savings that would be made if specific primary safety technology fitment were increased or mandated. This section details the specific scenarios considered. In all scenarios applied to the Australian data, the safety technology was assessed in terms of its ability to prevent fatal and serious injuries from occurring. Since crashes that result in only minor injuries and/or property damage constitute a relatively small proportion of safety benefits of the technologies considered, for simplicity the benefits were calculated as thought the crash was prevented completely rather than allowing for cases where serious and fatal injuries were replaced by minor injuries. For the New Zealand data analysis, the costs of minor injuries prevented were also considered, although the cost of each minor injury is very small compared to the costs of fatal and hospitalised injuries using New Zealand willingness to pay estimates.

3.1 SCENARIOS FOR CRASHWORTHINESS IMPROVEMENTS

Projected fatal and serious injuries for 2011 to 2020 were estimated in two ways:

A. using projected crashworthiness ratings based on previous trends from 2000-2010 and (*business as usual*); and

B. using 2010 crashworthiness ratings assuming no improvement since that year (*stalled crashworthiness*).

3.2 SCENARIOS WITH MANDATORY FITMENT OF FORWARD COLLISION WARNING SYSTEM WITH AUTONOMOUS EMERGENCY BRAKING SYSTEMS (AEBS)

The Australian crash data profiling of Section 2.3 found that 60%-80% of 2010 injury crashes involving passenger vehicles were multi-vehicle crashes and 20%-45% were rear-end crashes, although the injuries in the rear-end crashes were generally less severe. Due to the prevalence of these types of crashes and existing evidence that AEBS is the most relevant technology for preventing rear-end crashes (Anderson, 2011), scenarios of AEBS were considered.

FCWS directly target forward on-path collisions. FCWS with automatic braking are considered capable of preventing some forward collisions when the travelling speeds are greater than 60km/hr (Anderson, 2011), however, mitigation of collisions with stationary objects is more successful at lower speeds. Given that AEBS have been developed to work at a range of speeds, the scenario has been considered both in all speed zones and in speed zones limited to ≥80km/hr. Both scenarios are applicable if future advances make this technology effective at all speeds. Anderson (2011) found that removal of crashes where speeding was involved only reduced crash benefits slightly so for this scenario, crashes where speeding was a factor were included.

As summarised in Table 5, the 'narrow' sensitivity crashes were defined (Anderson, 2011) as crashes with vehicles travelling in the same direction which were hit in the rear, crashes whilst reversing in traffic and crashes with objects or vehicles parked/stopped on path.

'Broadly' sensitive crashes were crashes which involved a collision with something in the path which was either not a vehicle or not travelling in the same direction. This set potentially included: crashes with trains, pedestrians, animals and objects falling in their path, crashes at intersections, crashes with vehicles heading in the opposite direction, crashes whilst manoeuvring when entering/leaving parking or footways or U-turning into a fixed object, and crashes whilst overtaking including only head on, pulling out, cutting in or turning.

3.3 SCENARIO WITH MANDATORY FITMENT OF FATIGUE WARNING SYSTEMS (FWS) AND LANE DEPARTURE WARNING SYSTEMS (LDWS)

Australian single vehicle crashes also were shown to have reasonably high (20%-40%) prevalence (Section 2.3.3) in 2010. Single vehicle and particularly roll-over single vehicle crashes (which contributed to less than 5% of injury crashes) usually have serious outcomes. These serious injury crashes, as well as heavy vehicle and head-on crashes, often occur when a vehicle is out of control potentially through driver fatigue and thus lend themselves to prevention via FWS and LDWS.

Diamantopolou (2003) defined fatigue related crashes as either those where the vehicle's controller was described by Police as being sleepy, drowsy or fatigued and/or the vehicle was involved in a "loss of control" type crash where no other relevant factor such as overtaking or speeding could be identified as a factor for the manoeuvre.

As fatigue was either not recorded or not reliably recorded as a factor in the Police reported crashes for all states, only "loss of control" crashes where speeding and alcohol were not recorded as outside the respective limits were identified as broadly sensitive to FWS. Even then, speeding as a factor could not be identified in Queensland and Victorian data and drivers exceeding BAC limits could not be identified in New South Wales. Exceeding the speed limit was added to the exclusion criteria of Anderson because Diamantopolou (2003) identified it as a separate contributing factor to the crash and as such if a choice was made to speed, driver risk-taking would be more likely than fatigue to be the main cause of the crash. However, it is acknowledged that speeding could be a result of fatigue rather than conscious choice.

For FWS, Anderson (2011) defined narrowly applicable crashes as "loss of control" where alcohol was not considered a factor (driver BAC was below the 0.05% limit). Broadly applicable crashes were those where the FWS would not be as effective due to the effects of alcohol (BAC>0.05%). In this study, a conservative approach was taken where all selected crashes were considered *broadly* applicable due to uncertainty around driver BAC levels in the available data.

A narrower set of crashes were also defined as a variation to this scenario for the LDWS only, focusing just on crashes with no alcohol or speeding that were on higher speed (>=80km/hr) highways or expressways. The alcohol and speeding limitations remove crashes that may not be benefited by the technology. The 'highway/expressway' limitation was imposed because LDWS need to identify reflective lane markings which may not be present on other road classifications. The '>=80km/hr' limitation was imposed because it is the speed zone in which lane departure crashes are most common.

Difficulties with the identification of speed zones and speeding and alcohol as a factor within each crash data jurisdiction is discussed in the data management section of the methodology. Highways and expressways were identified in different manners for each of the different jurisdictions. In the New Zealand analysis, such roads were identified as being either State Highways or multi-lane non-State Highways.

Table 5 : ***Technologies considered with the range of crash types affected either narrowly applicable or broadly applicable (as described in Anderson, 2011).***

	Ranges used in scenarios	Narrow (75% effectiveness)	Broad (25% effectiveness)
Forward Collision (FCWS with AEB)	• Speeds >=80km/hr • All speed zones	Rear ends; reversing in traffic; struck object in path; off end of road or T intersection	Pedestrians; intersection; opposing direction; overtaking (except out of control); struck animal
Lane Departure (LDWS)	• All speed zones • >=80km/hr, no illegal alcohol or speeding and major highway or expressway		Head on (not overtaking); off path (excluding out of control on carriageway; turning)
Fatigue (FWS)			"Loss of control" with no illegal alcohol and no speeding
Lane Change (LCWS)	• All speeds	Lane changing; pulling out	Leave or enter parking
ESC	• Single vehicle injury crashes: 32% effectiveness found by Scully and Newstead (2010)		

Lane departure warnings are designed to prevent unintentional movement from lanes; so unlike FWS sensitive crashes, LDWS sensitive crashes did not include "loss of control" on the carriageway crashes (and thus no lane departure for the out of control vehicle) nor "loss of control" crashes resulting from a deliberate turn. All LDWS sensitive crashes were considered *broadly* sensitive.

3.4 SCENARIO WITH MANDATORY FITMENT OF LANE CHANGE WARNING SYSTEMS (LCWS) AND BLIND SPOT WARNING SYSTEMS (BSWS)

The LCWS and BSWS scenario models the reduction to injuries from side-swipe crashes due to lane change and blind spot warning technology that enhance the safety of lane changing. Narrowly sensitive crashes affected by lane change warnings were crashes that occurred with vehicles travelling in the same direction and crashed during a lane change manoeuvre. Lane change warning broadly sensitive crash types consisted of crashes occurring whilst manoeuvring in or out of a parking space.

3.5 SCENARIO WITH MANDATORY FITMENT OF ELECTRONIC STABILITY CONTROL TO LIGHT COMMERCIAL VEHICLES (AUSTRALIA) AND ALL LIGHT PASSENGER VEHICLES (NEW ZEALAND)

The Australian car industry is aware of the importance of ESC in reducing road trauma. In a 2007 press release by the ANCAP, both ESC and side curtain airbags were singled out as being two important features that the organisation would like to see as standard features on all new cars in the future. Since then, significant effort has been made in many jurisdictions to promote these two key safety features with ESC becoming mandatory for all new light passenger vehicles and four wheel drives (ADR certification class MA and MC vehicles) across Australia from January 1, 2012 although not for light commercial (ADR certification class NA) vehicles until November, 2015.

ESC had already substantially penetrated the Australian light passenger vehicle market as indicated by the 2011 Victorian data shown in Table 3 (from Polk). This shows that 100% of new large and medium vehicles and more than 95% of compact and medium SUVs were sold with ESC as standard, even prior to the 2012 regulation. In contrast, ESC penetration in commercial vehicles was much lower so the benefits of compulsory fitment for these vehicles are higher.

Table 6 : ***Victorian passenger vehicles sold with Electronic stability control as standard by market group (2011, Polk).***

Market group	ESC	Market group	ESC
All vehicles Victoria	81%		
		SUV Large	58%
Large Vehicles	100%	**SUV medium**	99%
Medium Vehicles	100%	**SUV-compact**	97%
Small Vehicles	85%		
Light Vehicles	74%	**All Commercials**	27%
		Pick-Up 4*2	38%
People Movers	94%	Pick-Up 4*4	20%
		Vans	23%

The Australian scenario of mandatory fitment of ESC to new commercial utilities and vans was applied where ESC was not standard to the make and model. The fitment and availability estimates for ESC used in the present report were derived from Polk and provided by the Western Australia Department of Transport. Actual Victorian fitment rates in new vehicles were used for vehicles up to a 2011 year of manufacture, after that a sigmoidal uptake was modelled to achieve 100% fitment by the end of 2016.

In New Zealand, although ESC fitment is not mandated in new vehicles, about 90% of cars and commercial vehicles sold new from 2009 have had ESC fitted[4]. Scenarios of mandated fitment were tested on the whole fleet, where only a little over 10% additional savings could be expected from policy that lifted fitment rates to 100%.

This scenario took the same approach as Newstead (2007) in that it was assumed that ESC prevented 32% of single vehicle injury crashes (and all consequent serious and fatal injuries) entirely. This means that the evaluated crash reduction used in this scenario is from the most recent and largest study.

[4] From web site fuelsaver.govt.nz/safety, accessed 8 September 2013.

4 METHODOLOGY

The methodology of the Australian analysis component of this report is an adaption of the methodology used by Keall, Newstead and Scully in 2006 in the MUARC report "Projecting effects of Improvements in Passive Safety of the New Zealand Light Vehicle Fleet to 2010". This approach estimated the composition of the future fleet by market group and age range in conjunction with a projection of future crashworthiness ratings. The projected estimates were made for the whole of Australia and disaggregated by jurisdiction or market group. Australian crash data from the years 2000 to 2010 was used to make the projections.

The New Zealand analysis modelled trends in injury and injury severity for the crash types considered in an integrated analysis. Using social cost estimates (which form a weighted count of injuries suffered) for each crash type over the ten year period 2003-2012, projections were made using negative exponential statistical models to the year 2020. This approach accounts for the influence of several factors, including fleet composition, changes in driving patterns and behaviours, as well as gradual environmental changes (due to road improvements, for example). Exponential models are appropriate for representing changes over time that may arise from approximately constant proportional changes in rates (such as incremental improvements in fleet safety or road network safety).

The modelled scenarios examined the effect of adding vehicles to the fleet carrying the chosen safety technologies. Vehicles added with a year of manufacture beyond 2010 have an effect on improving the safety of the fleet. An assumption was made that improved crashworthiness, which by definition improves the injury outcome for the driver, also improved the injury outcomes for other occupants.

Section 4.1 details the process of determining the crash reduction factors which were applied to the projected fatal and serious injuries, to estimate the potential benefits of the emerging technologies.

4.1 CRASHES SENSITIVE TO ESC AND SAFETY TECHNOLOGIES AND THE EXPECTED INJURY REDUCTIONS

For each scenario, crashes sensitive to the emerging safety technology were identified using a modification of the methodology of Anderson (2011) presented in Section 3. The methodology of Anderson (2011) was used to identify crashes broadly and narrowly affected by forward collision detection, lane change, lane departure and driver fatigue in the 2000-2010 crash data. Crashes sensitive to ESC were identified as single vehicle driver injury crashes in commercial vehicles.

Anderson (2011) estimated the fitment of emerging technologies to prevent 75% of narrowly sensitive crashes and 25% of broadly sensitive crashes. Anderson (2011) further assumed that injury and fatal crashes were equally reduced, an assumption also used here. The expected injury or crash reduction has been calculated based on the sum of the product of 0.75 and the proportion of crashes narrowly sensitive to the technology and the product of 0.25 and the proportion of crashes broadly sensitive to the technology.

Crashes broadly sensitive to LDWS were identified using the methodology of Anderson (2011) although the percent effectiveness used in the calculations was considered high when compared with the recent literature values listed in the study on LDWS by Visvikikis et al (2008). Anderson (2011) used an effectiveness of 75% whereas literature values for the same target crashes were summarized by Visvikikis (2008) to range from 16%-48% reduction for fatal injuries and 12%-36% for serious injuries. It was therefore considered that in using the approach of Anderson (2011), 25% effectiveness would be applied in this study to the identified LDWS broadly sensitive crashes. This matched the 25% applied by Anderson to the broadly sensitive crashes for all other emerging technologies.

Anderson (2011) examined ten years of New South Wales crash data (1998 to 2008) and calculated fatal crash and injury crash reductions. Anderson's reduction rates are presented in Table 7 , for comparison with the crash reductions calculated in this study for the period (2000-2010) for New South Wales and for the combined jurisdictions of New South Wales, Victoria, Western Australia and Queensland. In this table 'Injury' crashes refers only to non-fatal injury crashes. Compared with Anderson (2011), higher potential crash reductions were estimated here for Forward Collision Avoidance. Differences in the manner Anderson identified highways, and in the sensitivity reduction applied (75% rather than 25%) explain differences seen in LDWS reductions. Also, exceeded BAC limits could not be identified in the New South Wales data for this study, whereas Anderson was able to identify exceeded BAC for this jurisdiction. As fatigue as a factor could not be identified in all states, this variable, when present was not used to identify fatigue crashes in this study and would explain the higher crash reductions seen in Table 7 .

Table 7 displays the crash reductions for fatal and non-fatal injury crashes estimated for the emerging technologies other than ESC. Estimated crash reductions for FWS and LDWS are small and likely to be under-estimated because of the uncertainties in determining speed zones, road classifications and exceeded alcohol and speed. Estimated crash reductions for LCWS were small because the counts of crashes sensitive to this technology were relatively small.

The process for estimating crash reductions due to ESC fitment in light commercials was similar. For each of the two market groups, the proportion of single vehicle driver injury crashes (or injuries from single vehicle driver injury crashes) of all crashes (or of injuries from all crashes), was multiplied by the 32% reduction in crash risk found by Scully (2010).

Table 7 : ***Estimated crash reductions for Fatal and Injury crashes for Australia and NSW (2000-2010) compared with those estimated previously (1998-2008).***

		Fatal		
		% crash reduction		
		ALL*	NSW	Anderson†
AEBS	All speeds	16	16	12
	Speeds >=80km/hr	12	9	7
Lane Change warnings		1	1	1
Lane Departure	All speeds	14	15	
	≥80km/hr roads +no illegal alcohol/speeding	9	9	11
	major highway expressway only	2	1	6
Fatigue	"Loss of control" with no illegal alcohol or speeding	10	9	8
		Injury		
AEBS	All speeds	33	30	25
	Speeds >=80km/hr	7	4	4
Lane Change warnings		4	3	2
Lane Departure	All speeds	6	7	
	≥80km/hr roads +no illegal alcohol/speeding	3	3	4
	major highway expressway only	0.7	0.5	2
Fatigue	"Loss of control" with no illegal alcohol or speeding	5	6	4

*excluding SA, †(2011)

Table 8 displays estimated fatal and serious injury reductions expected from ESC fitment as well as the other emerging technologies considered in preventing a proportion of crashes sensitive to the devices. The South Australia data are not included in the 'ALL' injury reductions for emerging technologies but are included for ESC reductions. Instead of disaggregating by jurisdiction, Table 10 disaggregates by market group.

Table 8 : ***Australian estimated fatal and serious injury reductions by jurisdiction*** *(% maximum possible reduction from existing or zero fitment rates to 100% fitment).*

		Fatal and Serious Injury					
		% injury reduction					
		ALL	NSW	VIC	QLD	WA	SA
AEBS	All speeds	23	22	24	24	23	
	Speeds >=80km/hr	7	5	8	6	5	
Lane Change warnings		3	3	3	3	2	
Lane Departure	All speeds	9	11	9	8	8	
	≥80km/hr roads +no illegal alcohol/speeding	5	5	4	4	3	
	major highway expressway only	1	1	2	1	2	
Fatigue	"Loss of control" with no illegal alcohol	8	9	7	7	8	
ESC commercial Ute		10	10	9	10	11	14

ESC Commercial Van	7	7	6	7	8	11

The New Zealand estimates shown in Table 9 are not directly comparable with the Australian estimates in Table 8 as the former are expressed in terms of social cost, which places a much greater weight on fatal injuries. Also, the coding of the New Zealand data is somewhat different, meaning that some crashes are classified differently between the two countries. Nevertheless, generally similar ordering of potential safety benefits is represented in the two tables. ESC fitment has been around 90% in new cars since around 2009, so only a little over 10% of the 13% shown in the table (viz. approximately 1.4% of total social cost) is achievable by lifting fitment rates from 90% to 100%.

Table 9 : ***New Zealand estimated reductions in social cost predicted from specified technologies in fleet*** *(% maximum possible reduction in social cost due to 100% fitment compared to zero fitment rates)*.

		% Reduction in social cost
Forward Collision	All speeds	13
	Speeds >=80km/hr	7
Lane Change warnings		1
Lane Departure	All speeds	5
	≥80km/hr roads +no illegal alcohol/speeding	
	major highway expressway only	3
Fatigue	“Loss of control” with no illegal alcohol and no speeding	9
ESC		13

The summaries for crashes sensitive to the five safety technologies, for Australia, may be found in Appendices C through F. The summaries include counts of crashes, and the counts of injuries from crashes, by injury type and sensitivity (narrow and broad) to the five technologies and ESC. Crashes sensitive to LDWS were not classified into broad and narrow categories, but appear in one of these column categories in the tables. To avoid double counting of injured persons, injury counts were made per crash rather than per crashed vehicle.

New South Wales data did not distinguish serious from minor injuries. Serious and minor injuries, and serious and minor injury crashes sensitive to technologies were estimated for New South Wales using a ratio of ‘serious to non-fatal’ calculated from the combined states of Western Australia, South Australia (ESC only), Queensland and Victoria for each set of crashes identified as sensitive to a particular technology. These ratios may be found in the safety technology tables of the appendices.

Crashes sensitive to emerging technologies could not be counted using the methods of Anderson (2011) from South Australian data because crash data did not contain a road user movement or 'DCA' coding for crash types. Western Australian percentage reductions were applied to South Australian projections.

Table 10 : ***Estimated Fatal and Serious injury reductions from Injury crashes for Australia (excluding SA) by market group (%).***

		Fatal and Serious Injury											
		% injury reduction											
		ALL	CU	CV	SUVL	SUVM	SUVC	PM	L	M	S	SL	Un-Known
AEBS	All speeds	23	23	25	22	22	23	23	23	24	25	25	21
	Speeds >=80km/hr	7	10	8	10	7	6	5	8	6	7	7	8
Lane Change warnings		3	3	3	3	3	3	3	3	3	3	3	3
Lane Departure	All speeds	9	10	7	9	9	8	8	9	8	7	7	12
	≥80km/hr roads +no illegal alcohol/speeding	5	6	4	6	6	5	4	4	3	3	3	6
	major highway expressway only	1	1	1	1	1	1	1	1	1	1	1	2
Fatigue	"Loss of control" with no illegal alcohol	8	8	6	9	8	7	7	8	6	6	6	10

4.1.1 Overlap of Crash Types

The Australian methodology evaluates each safety technology independently. However, crash and injury savings attributed to each safety technology cannot actually be summed to produce the total savings possible if all the technologies were fitted within the vehicles. This is because crashes may be sensitive to more than one safety technology.

Police reported crashes identified as sensitive to ESC, LDWS and FWS overlap considerably. All three system sensitivities include off path, “loss of control” crashes, on a straight or curved piece of road, which don’t involve the making of turns, running off the end of a road, being out of control on the carriageway or mounting traffic islands. Essentially these three safety technologies prevent a lot of the same broadly defined kinds of crashes. However, the method employed in crash prevention by ESC is quite different from LDWS and FWS and this would mean that they could act to prevent different sub-sets of the overlapping crash types. FWS will help prevent any kind of fatigue related crash, whereas LDWS and ESC respond only in specific circumstances, however when these are met, their targeted approach is likely to be more effective. ESC will help a driver retain control from an over- or under- steer event, which is often related to road curvature or low friction road surfaces (e.g. wet or gravel), whereas both LDWS and FWS usually act solely as warning devices, although LDWS may also include automated steering correction. In contrast, LDWS are less able to function in wet weather, due to the obstruction of the optical system, and do not work at all on unsealed roads or roads without edge lines, so by definition are the least functional on the surfaces on which ESC is the most functional. In addition LDWS are most efficient at higher speeds, whereas both ESC and FWS will function well at lower speeds.

The following are minor overlaps in infrequent crash types which would contribute insignificantly to double counting if safety benefits were summed. In addition, they are, mostly overlaps in crashes broadly sensitive to the technology, so it is possible that, by being only a ‘broad’ sensitivity, there is no overlap at all.

Lane Departure and Forward Collision type broadly sensitive crashes overlap for:

- not overtaking head-on crashes.

Forward collision and Lane Change type broadly sensitive crashes overlap for:

- pulling out, same direction crashes (which are narrowly sensitive for LCWS).
- leaving and entering parking manoeuvring.

Table 11 shows some New Zealand examples of the extent of overlap of the estimated benefits when more than one technology is being assessed. For example, if the combined benefits of LDWS and FWS are being assessed, the benefits of each technology separately are added, but then discounted by 23% (the right-hand column) to remove double-counted crashes. If different technologies address different causal factors in crashes (as seems likely) then this approach will be conservative.

Table 11 : ***New Zealand estimated reductions in social cost predicted from specified technologies in fleet*** *(% maximum possible reduction in social cost due to 100% fitment compared to zero fitment rates)***.**

Combinations of technologies	% social cost overlap
Forward Collision, Lane Departure, Lane Change, Fatigue, ESC	39%
Forward Collision (Speeds >=80km/hr), Lane Departure (80km/hr or greater zones +no illegal alcohol/speeding, major highway), Lane Change, Fatigue, ESC	30%
Lane Departure, Fatigue	23%
Lane Departure, Fatigue, ESC	22%

4.2 PROJECTED CRASHED VEHICLES - AUSTRALIA

In projecting the crashed vehicle fleet, ten year total Australian fleet projections, and ten year market group and jurisdictional proportions, were made using the (five jurisdiction) history of crash years 2000 to 2010. Trends in market group proportions were applied so that safety improvements also reflected the underlying vehicle choices of Australian drivers. Sensitivity to the use of Australian projected crash fleet totals was measured by undertaking an additional analysis using the 2010 Australian crashed passenger fleet total for all projected years.

4.2.1 Crashed vehicle fleet projections

Total crashed passenger vehicle counts (involved in injury crashes) with a year of manufacture were plotted and projected to 2020 with a logarithmic line of best fit (Figure 14). This relationship was used to project total vehicles in 2011 through to 2020. Figure 14 shows that the number of projected crashed passenger vehicles was falling. Scenarios were considered both using these projections as well as in a sensitivity analysis using the 2010 crashed vehicle counts through to 2020.

Because of the issues with Queensland data in 2000, 2005 and 2010, the 2000, 2005 and 2010 Australian crash totals were corrected with interpolations from Queensland trends over 2001-2004 and 2006-2009.

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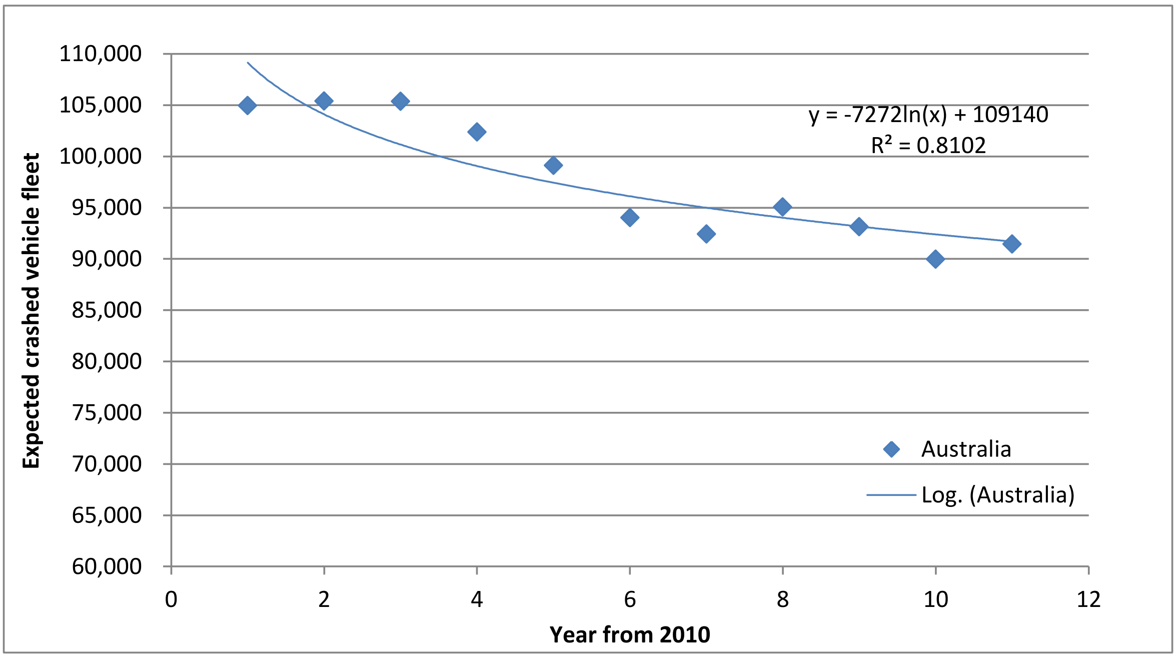

Figure 14: ***Australian Crashed passenger vehicles involved in injury crashes, with a year of manufacture.***

Crashed vehicles involved in injury crashes (with a year of manufacture) were also projected, disaggregated by market group or jurisdiction. Plots of these may be found in Appendix G.

4.2.2 Crashed vehicle jurisdictional and market group proportion projections

Proportions of the total crashed passenger vehicles (with year of manufacture and involvement in injury crashes) for market groups and jurisdictions were also plotted and projected to 2020 using logarithmic relationships. Medium and compact SUV trends were a better fit with a linear relationship. Queensland trends were quantified without the 2000 and 2005 data and there was no 2010 data for Queensland.

It was seen that by jurisdiction, from 2000-2010, the proportion of Australian crashes that were from New South Wales, Victoria and South Australia decreased, as the other states increased proportionally. In 2010, 31% of crashes from these five states were from New South Wales, 21% from Queensland and 20% from Victoria. South Australia contributed 11% and Western Australia 17%.

Utilities, vans and small cars also proportionally increased over the years 2000-2010. Medium and compact SUVs increased rapidly in proportion; so much so that a logarithmic line of best fit was not appropriate, and a linear trend line had to be applied. Figure 15 shows the trends in SUV market group proportions: the logarithmic relationship as a broken line and the linear relationship as a solid line.

Plots of crashed vehicle proportional projections disaggregated by market group or jurisdiction may be found in Appendix H. These projected proportions were used with the total fleet projection for each crash year to estimate the projected fleet by jurisdiction or market type for each of the years 2011 to 2020 (Appendix I).

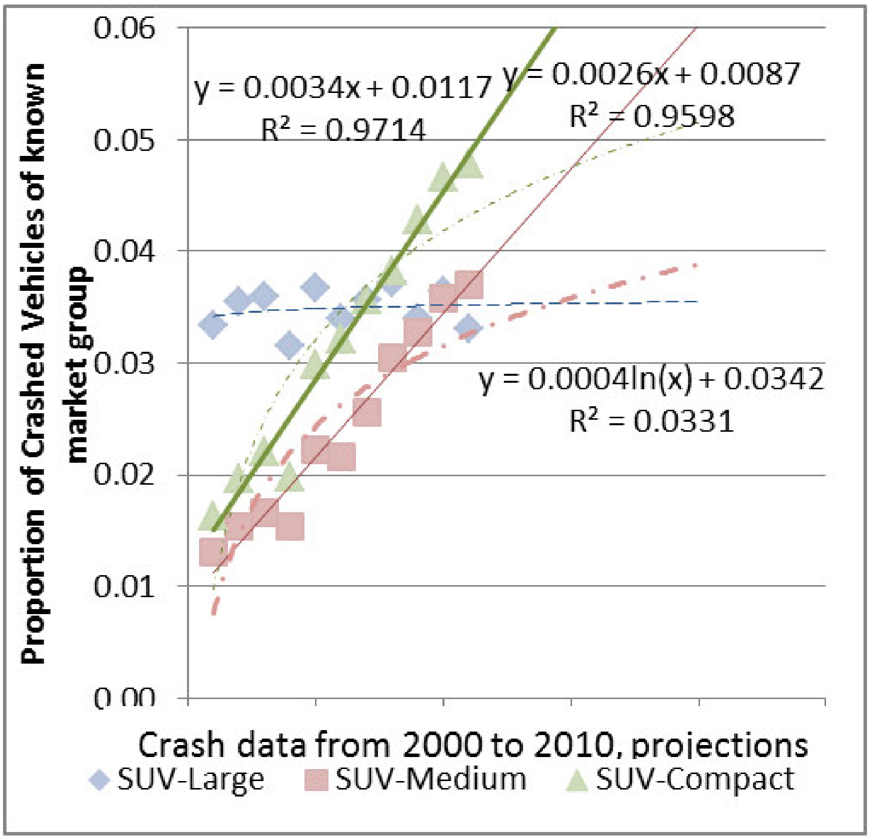

Figure 15: ***SUV proportions of Australian Crashed passenger vehicles involved in injury crashes, with a year of manufacture.***

Projected market group proportions were further applied to the jurisdictional fleet count estimations to estimate utility and van fleet sizes within each state. Utility and van fleets by jurisdiction needed to be estimated to project injury reductions from mandated ESC fitment. Crashed vehicle fleet projections including commercial vehicle projections by jurisdiction may be found in Appendix I.

4.2.3 Vehicle age profiles

Age group proportions were linearly regressed against crash year for Australia (Figure 16), each jurisdiction and each market group and for commercial vehicles by jurisdiction. The trends were used to predict the age group proportions in 2011 to 2020. These predictions were then applied proportionally to predict the vehicle age distribution in crash years 2011 to 2020, which was then used with the fleet projections (Appendix I) to predict crashed vehicle counts for each vehicle age within each future crash year. The results are shown for two actual and two projected crash years for Australia in Figure 17.

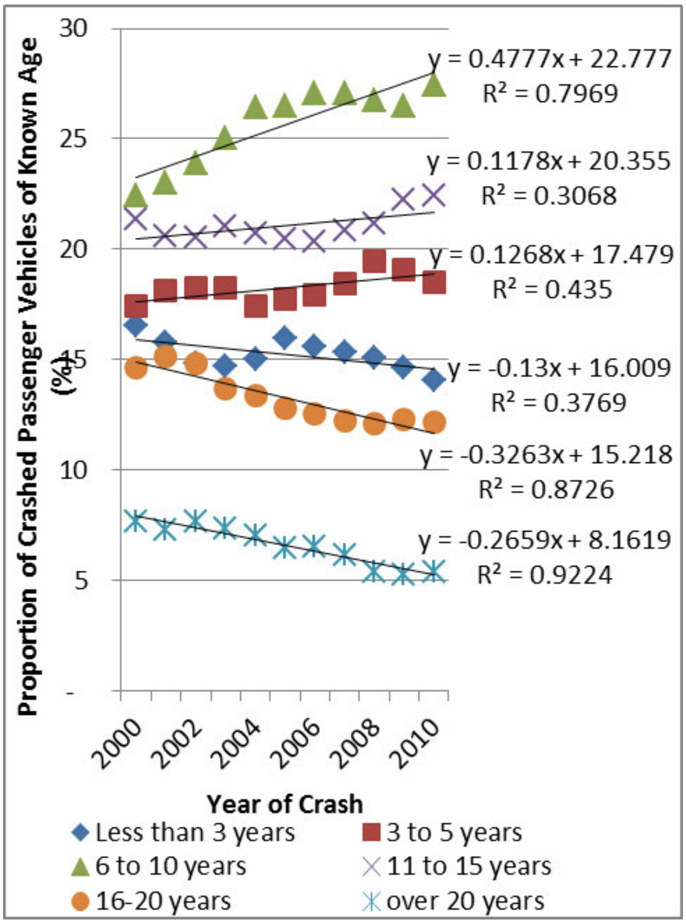

Figure 16: Vehicle Age group distribution by crash year crash data from 2000 to 2010, Australia.

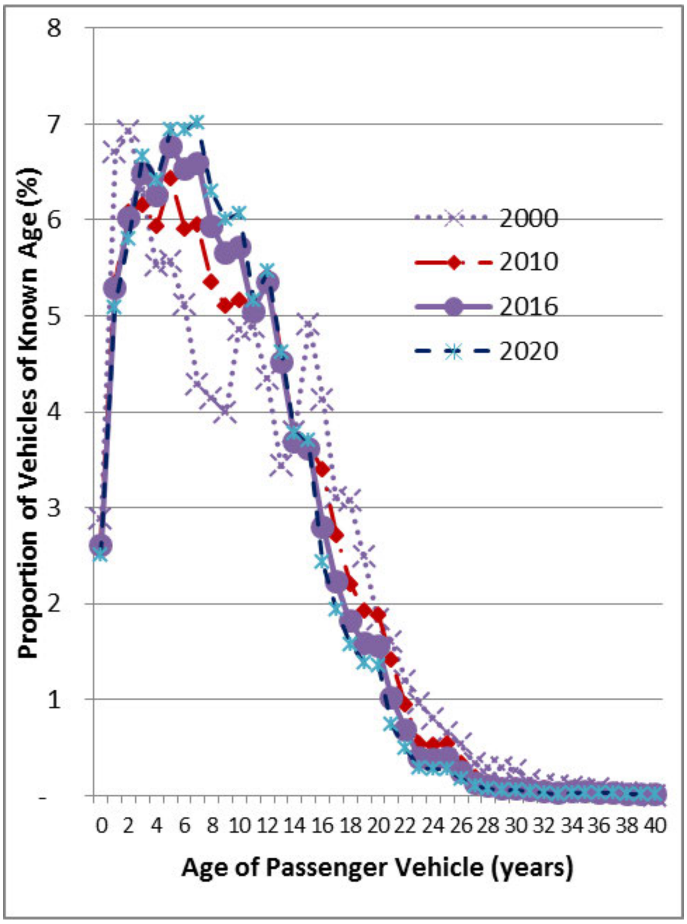

Figure 17: ***Vehicle Age distribution and projected distribution for four crash years: two actual and two projected, Australia.***

A particular pattern that was observed for large SUVs impacts on the evaluation of scenarios later in the report. It was seen in Figure 15 that proportionally the large SUV market share is declining. And from Figure 14, the conclusion that they are also declining in number may be made. If one examines Figures **J59** and **J43** in Appendix J, it is clear that the proportion and count of large SUVs aged 0–6 years are declining. Given that fitment of technology is the greatest in new vehicles, the impact of technology fitment in large SUVs will be poor. Low injury savings associated with safety technology fitment in large SUVs are clearly illustrated in Tables 16 to 19 of Section 6.

4.3 NET GAIN IN SAFER VEHICLES FROM 2010

The crashed vehicle fleet gain from 2010 by vehicle year of manufacture was estimated, for each projected crash year. For example, the gain in crashed vehicles with a 2009 year of manufacture in the crash year of 2012 was the difference between the crashed vehicles aged three in 2012 and the vehicles aged one in 2010. If there were more of these vehicles crashed in 2012 than in 2010, there was a net gain; if there were fewer, there was a net loss.

Net gains were a primary interest in this analysis as, without the entry of large numbers of used imported vehicles into Australia, they represent the vehicles added to the fleet (and subsequently crashed) beyond 2010 with new safety features. The modelled scenarios examined the penetration effects over time from the annual addition of vehicles carrying the chosen safety technologies. Although removing vehicles of poorer crashworthiness or vehicles without ESC does have an effect on injury savings, these effects are of limited influence in the future scenarios considered. Furthermore, the effects of this decision are further mitigated by assessing the fleet profile against a projected crash population in future years which will reflect the estimated fleet size.

It is also of significance to point out that the sum of the net gains from the 2010 base year by crash year (2011 to 2020) for data disaggregated by jurisdiction or market group does not total to the same value as the sum of the net gains by crash year for the aggregated states. This was due to artefacts of the modelling process which had to compensate for missing data as well as project fleet mix which is subject to some error. The errors in the state based sums were relatively small compared to the Australian total used hence the overall error is expected to be small.

An example of how the net gain was calculated is presented in Appendix K. The net gain calculation was made for each age profile: aggregated data, jurisdictional data and data by market group. An example of the way this was calculated is presented in Appendix K.

4.4 PROJECTED INJURIES

Driver injuries were estimated by multiplying crash vehicle counts by crashworthiness ratings (applied by market group and year of manufacture). Crashworthiness ratings produced by two methods were used: a) crashworthiness ratings projected into 2020 for vehicles manufactured in the years 2011 to 2020; and b) crashworthiness ratings maintained at 2010 vehicle year of manufacture levels for vehicles manufactured in the years 2011 to 2020 (termed *stalled crashworthiness*).

Although vehicle projections (Section 4.2.1), and net vehicle gains for each crash year, were made using the vehicle age distribution, crashworthiness ratings were applied by year of manufacture (and market group for data disaggregated by market group), and by not vehicle age, to crashed vehicle counts. This did not prevent the summation of net gains by vehicle age and crash year.

The crashed vehicles used for injury estimations were projected over ten years, with an age profile of vehicles from 0 to 46 years. This age range was chosen because a 46 year old vehicle in 2010 had a year of manufacture of 1964 and 1964 is the earliest year to have a crashworthiness rating estimated. Estimated driver injuries could not be derived from crash counts when a vehicle was older than 46 years using the methodology presented in this report. In this study, crashed vehicles aged 47 to 74 years amounted to less than 1% of the crashed passenger vehicles in the crash year 2010, over the aggregated and disaggregated data groups.

Occupant injuries were estimated by multiplying driver fatal and serious injury counts by the average 2010 (and 2009 for Queensland) vehicle occupancy by jurisdiction and market group (Refer to Section 2.3.2 and Table A1.8 of Appendix A1). Occupancy rates were unavailable for Victoria, so the four state averages were used for this jurisdiction. Market group occupancy rates were also calculated as a weighted average over the four available jurisdictions: Western Australia, South Australia, Queensland and New South Wales. The total of estimated occupant injuries from crashed vehicles aged 0 to 46, for the crash years

2010 and 2020, and for the net gain from 2010, over the crash years 2011 to 2020 are presented in Table 13 of Section 5 (Baseline).

4.5 SCENARIO INJURY SAVINGS

The total fatal and serious injuries in 2010 were compared with those projected for 2020 using the two models of projected crashworthiness: crashworthiness ratings assumed to stay at 2010 levels, and crashworthiness ratings projected for vehicles manufactured beyond 2010. In addition, the fatal and serious injuries from only net gain vehicles of 2010 and 2020 were also compared. The 2010 to 2020 comparisons were made with projected changes to market group distribution and with two variants of modelling the future fleet size: one with the fleet size projected to 2020 and one with the fleet size maintained at 2010 levels. The results of the latter model are considered in the sensitivity analysis of Section **Error! Reference source not found.**.

The remaining scenarios considered the effects of additional injuries prevented by the use of vehicle safety technologies. The injury savings for these scenarios were also modelled with two variants of projected fleet size and the two variants of projected crashworthiness ratings. The percentages of fatal and serious injuries estimated to be prevented by each technology were applied only to the net gain vehicle occupant injuries for each crash year and year of manufacture.

Fatal and serious injury reductions associated with each technology were calculated by applying the expected reductions (from Section 4.1) and proportion fitment (Figure 1) to the net gain in fatal and serious injuries. For each set of injuries associated with a vehicle of year of manufacture from 2010 to 2020, the appropriate fitment proportion was multiplied by the appropriate injury reduction rate to get the number of injuries reduced by the fitment of the technology.

The projected effect of ESC was more complicated than that of the other safety technologies examined, mainly because ESC had a presence in the fleet prior to 2011. The 2010 and projected 2011-2020 crashworthiness ratings have the effects of ESC on vehicles manufactured prior to 2011 factored into them. The ESC fitment scenario therefore made the assumption that because the market penetration of ESC was low in 2010 for commercial vehicles, the portion of the crash risk change attributable to ESC was insignificant, and thus the proportion projected into 2020 was also insignificant. However, even considering this assumption, to apply a crash risk and associated injury reduction factor for ESC on vehicles with a year of manufacture less than 2011 would amount to ‘double dipping’, since the effect, although deemed insignificant, has already been factored into the analysis. In this study a conservative approach to calculate injury savings has been adopted with respect to ESC savings; this means that estimated reductions in injuries through reduced crash risk attributable to ESC fitment was not applied to vehicles with a year of manufacture less than 2011.

Calculating the savings from ESC in vans and utilities was carried out in the market group disaggregated data only. The evaluated injury and cost reductions associated with ESC for the net gain crashed vehicles in all of Australia and in each state were summed for vans and utilities. These summations were then subtracted from the baseline net gain injuries and associated costs for Australia and for each state, to provide the savings associated with ESC for Australia and for each state. As previously discussed (Section 4.3), summing the disaggregated net gain effects will possibly overestimate the group net gain effect. The overestimation will be counteracted by underestimations from the conservative approach to ESC fitment and in not considering the effect of removal of less safe vehicles.

When savings were calculated in each of the scenarios, comparisons were only made between estimates using the same future crashworthiness model (A – *business as usual* or B – *stalled crashworthiness*) and the same fleet projection model.

4.6 COST OF SAVINGS

The cost per fatal and serious injury saved, discounted for each crash year (as described in Section 2.5), was calculated through multiplication of the net gain vehicle occupant injury savings, by vehicle age and crash year, to determine the cost of the savings in overall injuries. Because present value costs apply to a particular crash year, the costs were calculated for each injury count by crash year.

4.7 BREAK-EVEN COSTS

Australia

The cost savings and fitted net gain vehicles were totalled for each scenario by crash year for the aggregated states and by jurisdiction or market group. For each crash year the savings cost was divided by the estimated number of registered vehicles fitted with the technology in that crash year. A scaling factor was used to scale up the fitted net gain crashed vehicles to estimate the registered vehicles fitted with each technology. The sum over each of the crash years 2011 to 2020 produced the '*Break-even'* cost or cost benefit per vehicle. This gave a *rough* indicator of how much additional expenditure per vehicle is possible before the additional cost outweighs the injury savings benefit estimated for the technology.

The net gain vehicles with technology fitment were determined by the product of fitment rates and projected net gain crashed vehicle totals by year of manufacture. The scaling factor used to estimate the fitted registered vehicles was the proportion of 2010 new vehicles, from vehicle sales record, involved in injury crashes. 2010 crashed vehicles and 2010 year of manufacture was the most recent crash cohort available. This was best estimator of future vehicle crash rates and the fitted net gain vehicles consisted entirely of vehicles manufactured in 2011 or beyond.

The 2010 injury crash involved vehicles were identified as the sum of those where the year of manufacture equalled the crash year and half of those vehicles where the year of manufacture was one year less than the crash year. The latter were included to reflect that the year of manufacture is rounded; meaning that a vehicle manufactured in July 2010 only has half a year of exposure in 2010.

New vehicle sales, as reported by the Australian Bureau of Statistics (2013), were scaled into jurisdictions and market groups using 2012 jurisdictional data and using 2010 market group data reported by the Federal Chamber of Automotive Industries (2013). The 2010 estimated new passenger vehicle sales, excluding the contributions of Tasmania, Northern

Territory and the Australia Capital Territory and heavy vehicles, were used to approximate registered new vehicles in 2010. The proportions of crashed new passenger vehicles, overall, by jurisdiction or by market group, were used to estimate the registered vehicles fitted with a technology. The scaling proportions used, along with 2009 and 2010 injury crashed vehicles (to accommodate volatility in the data and vehicle year of manufacture errors) and 2010 new vehicle sales disaggregated by jurisdiction and market group are tabled below. It is interesting to see that crash rates for new vans are many times 2.5 to 9 times higher than any other market group other than "large" most likely reflecting the high travel exposure of vans.

Table 12 : ***Scaling proportion used to estimate net gain registered vehicles.***

	2010 Crashed vehicles		2010	Proportion
AGE	**2009 YOM**	**2010 YOM**	**New Sales**	
ALL	2,406	4,879	960,957	0.005
NSW	742	1,566	307,583	0.005
QLD	292	1,232	211,862	0.004
SA	156	434	61,297	0.006
VIC	472	1,026	264,825	0.004
WA	518	818	115,389	0.008
Light	129	472	127,881	0.003
Small	329	944	234,104	0.003
Medium	67	199	82,504	0.002
Large	128	576	59,815	0.007
People Mover	12	36	8,935	0.003
SUV Large	30	99	122,105	0.001
SUV Medium	89	236	98,280	0.002
SUV Compact	98	271	54,600	0.004
Utility	186	532	154,865	0.003
Van	69	188	17,869	0.009

New Zealand

New Zealand savings were calculated to be present value estimates over 20-year savings with the mean injury rate estimated to be the 2020 projection, which is approximately the mid-point of a 20-year period starting from the endpoint of the period of data studied.

5 RESULTS: RETROSPECTIVE EFFECTS OF VEHICLE SAFETY IMPROVEMENTS IN THE AUSTRALIAN AND NEW ZEALAND VEHICLE FLEETS

In constructing a model of future vehicle safety benefits upon which to apply estimates of emerging vehicle technologies, the first task was to examine the retrospective cross-sectional safety of the vehicle fleet. There is a lack of any current objective measure of primary safety (crash avoidance) associated with various vehicle types and noting that even with the advent of ESC, primary safety is largely driven by driver and not vehicle characteristics. Consequently, assessment of the retrospective safety effects of the vehicle fleet has focused on secondary safety improvements which can be derived by the measures of secondary safety from the UCSRs program by make and model of vehicle, market group and year of manufacture.

Changes in the average cross sectional secondary safety of the fleet related to changes in vehicle mix have been estimated for both Australia and New Zealand separately based on the profile of crashes vehicles. For each crashed vehicle in each year, the UCSR crashworthiness and aggressivity ratings were assigned to each vehicle either directly by make and model of vehicle if available, by market group and year of manufacture if a make and model based rating was not available or only the market group and year of manufacture was known or by year of manufacture if market group was unknown. All the vehicles in the crash data could be assigned a rating on this basis. The average crashworthiness and aggressivity was then calculated within each year across all vehicles crashed in that year to show the improvement in secondary safety. The improvement in secondary safety can be considered a measure of the reduction in total vehicle related road trauma related to secondary safety improvements in vehicles.

Analysis showed that the average aggressivity of the vehicle fleet has not changed over the period of study. Hence all secondary safety improvements in the vehicle fleet will be driven by improvements in vehicle crashworthiness so only the analysis of cross sectional fleet crashworthiness trends over time are detailed here.

Figure 18 shows the cross sectional improvement in crashworthiness of the Australian vehicle fleet from 2000 to 2010. Over that period, the average crashworthiness of the fleet has improved by just over 27%. In other words, improvement is vehicle crashworthiness have led to a 27% reduction in the expected number of deaths and serious injuries to vehicle occupants over the period 2000 to 2010. To illustrate the effects on observed fatalities of vehicle occupants in Australia of the measured improvements in crashworthiness, Figure 19 plots the observed annual vehicle occupant fatalities in Australia along with the number that would have been expected without any improvements in the crashworthiness of the vehicle fleet since 2000. The cumulative saving in fatalities over this time was 1999 or an average of nearly 200 per year. It was not possible to plot a similar chart for serious injuries since there is no national Australian data on serious injuries to vehicle occupants from road crashes.

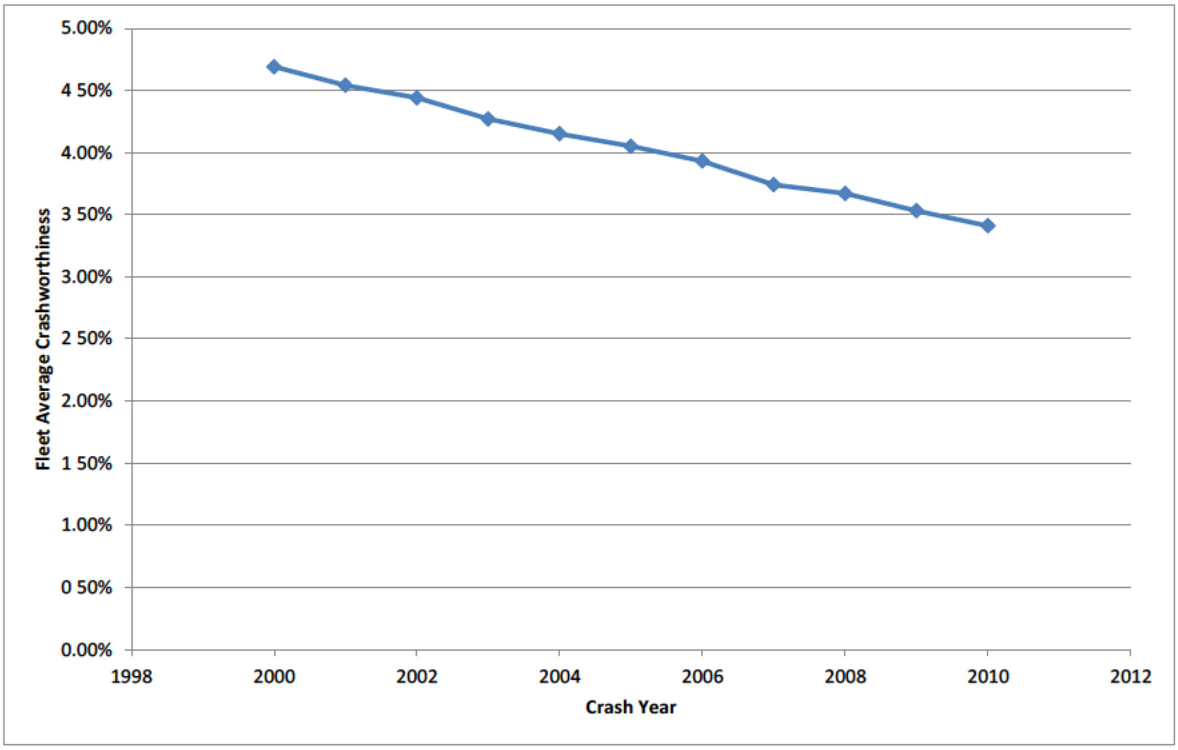

Figure 18: ***Change in average crashworthiness of the Australian vehicle fleet by calendar year.***

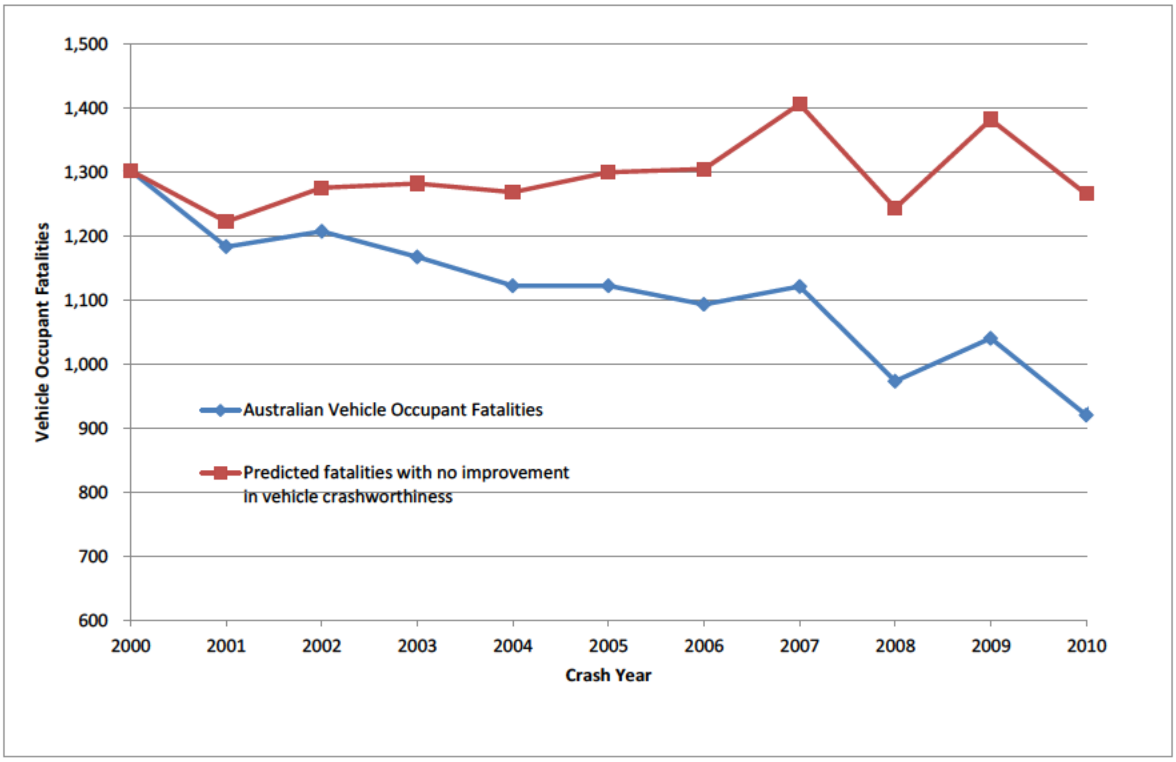

Figure 19: ***Estimated effects on vehicle occupant fatalities of vehicle fleet crashworthiness improvements in Australia.***

Figure 20 shows the corresponding improvement in the average crashworthiness of the New Zealand vehicle fleet over the period 2003-2012 for which data was available. It shows an improvement over this time period of 18%. The effect on vehicle occupant fatalities is shown in Figure 21 equating to a cumulative saving of 313 over the time period or an average of 35 vehicle occupant lives saved per year.

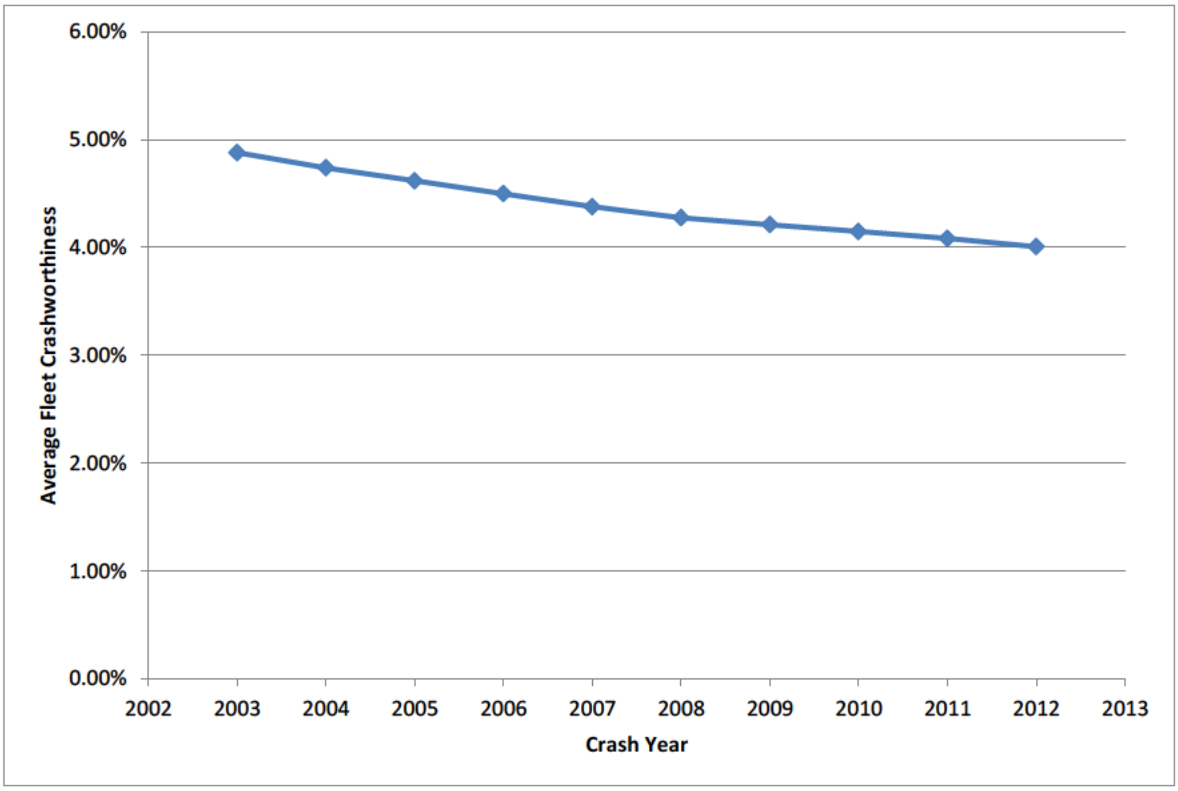

Figure 20: ***Change in average crashworthiness of the New Zealand vehicle fleet by calendar year.***

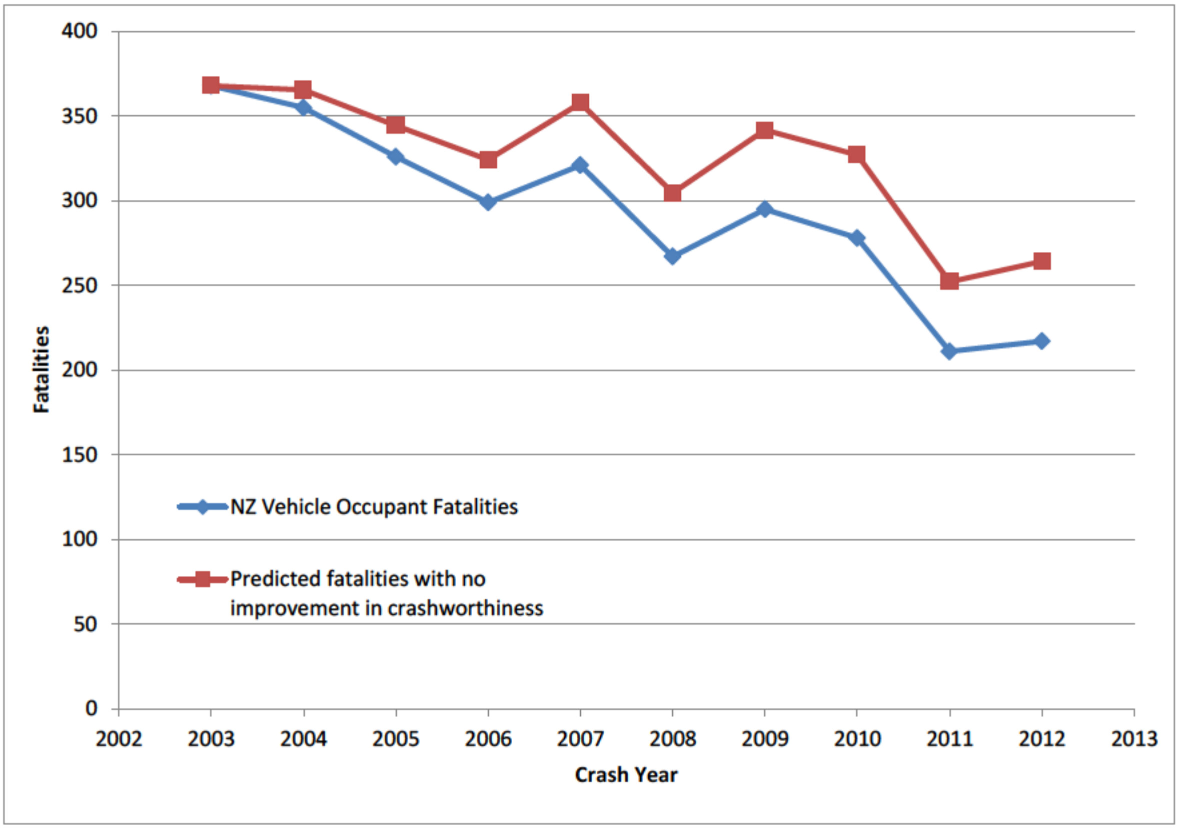

Figure 21: ***Estimated effects on vehicle occupant fatalities of vehicle fleet crashworthiness improvements in New Zealand.***

6 RESULTS: PROJECTED FUTURE ROAD TRAUMA SAVINGS DUE TO SECONDARY SAFETY IMPROVEMENTS

6.1 AUSTRALIA

6.1.1 Australian Baseline Future Projections Model

Projected injury involved crashes for the Australian vehicle fleet from 2011-2020, the number of fatal and serious injuries resulting from these crashes, and present value costs assigned to occupant injuries from crashes were used as a baseline against which to evaluative crash and injury savings. This was completed for each vehicle safety technology fitment scenario considered later. Projected crashes, fatal and serious injuries and costs were derived using projections of the vehicle fleet size, market group mix and average crashworthiness under two different scenarios as described in the methods.

Table 13 uses two methods of projecting future crashworthiness:

A crashworthiness ratings for vehicles manufactured from 2011 to 2020 were obtained from projections using regression estimates of trends (*business as usual*).

B. crashworthiness ratings of 2010 were used for vehicles with a year of manufacture from 2011 to 2020 (*stalled crashworthiness*).

Table 13 shows the number of crashed vehicles, fatal and serious injuries and costs in the 2010 vehicle fleet along with that projected in 2020 under the two crashworthiness projection scenarios. It shows these both in aggregate as well as broken down by each state considered in the Australian analysis as well as by vehicle market group.

Table 13 : ***Baseline 2010 and 2020 year vehicle fleet crashed passenger vehicles, occupant fatal and serious injuries and cost of injuries in 2010 AU$.***

		2010	2020	
			A (Business as usual)	B (Stalled crashworthiness)
ALL	vehicles	91,422	86,981	
	F&S injuries	3,821	2,350	2,870
	Cost	$1,656,121,346	$688,264,103	$840,563,686
NSW	vehicles	28,352	26,484	
	injuries	1,161	726	867
	Cost	$495,662,528	$209,566,495	$250,194,299
QLD	vehicles	19,396	19,293	
	injuries	809	506	638
	Cost	$364,618,010	$154,128,563	$194,293,056
SA	vehicles	9,981	8,632	
	injuries	444	248	294
	Cost	$188,533,691	$71,278,233	$84,515,696
VIC	vehicles	18,396	16,076	
	injuries	775	439	533
	Cost	$317,164,641	$121,489,076	$147,245,122
WA	vehicles	15,294	16,498	
	injuries	633	430	546
	Cost	$318,960,802	$146,377,640	$185,880,271
Light	vehicles	6,160	5,735	
	injuries	1,695	1,461	1,548
	Cost	$734,822,850	$427,866,326	$453,268,811
Small	vehicles	19,733	18,334	
	injuries	5,163	4,457	4,678
	Cost	$2,238,103,750	$1,305,151,701	$1,370,019,029
Medium	vehicles	7,403	5,945	
	injuries	1,674	1,192	1,211
	Cost	$725,689,760	$349,062,119	$354,615,749
Large	vehicles	21,068	18,529	
	injuries	5,109	4,121	4,174
	Cost	$2,214,602,447	$1,206,771,809	$1,222,460,313
People Mover	vehicles	948	874	
	injuries	296	198	219
	Cost	$128,273,077	$57,840,622	$64,088,850
SUV-Large	vehicles	2,481	2,421	
	injuries	467	390	395
	Cost	$202,269,993	$114,238,931	$115,732,166
SUV-Medium	vehicles	2,771	4,330	
	injuries	569	663	753
	Cost	$246,765,868	$194,241,646	$220,525,111
SUV-Compact	vehicles	3,589	5,686	
	injuries	802	922	1,026
	Cost	$347,738,602	$270,120,267	$300,520,277
Utility	vehicles	8,180	8,014	
	injuries	1,479	1,194	1,205
	Cost	$641,201,771	$349,554,601	$352,927,249
Van	vehicles	2,567	2,265	
	injuries	538	416	433
	Cost	$233,085,235	$121,880,785	$126,809,827
Unknown	vehicles	16,523	14,861	
	injuries	709	356	479
	Cost	$307,500,579	$104,239,620	$140,226,295

The comparison of 2020 and 2010 crash year injuries gives the estimated savings in annual fatal and serious injuries expected from safety improvements in the vehicle fleet over ten years for the two crashworthiness projection scenarios considered and reflecting predicted vehicle age and market group distributional changes. These savings result from safer vehicles entering the fleet over time and the retirement of less safe, older vehicles from the fleet. The savings also reflect the safety implications of trends in vehicle purchase and retention of specific vehicle types. These savings are summarised in Table 14.

Table 14 : ***Estimated savings in vehicles involved in injury crashes, fatalities and serious injuries and injury costs in 2020 compared to 2010.***

		Absolute Savings (2010-2020)		Percentage Savings (2010-2020)	
		A (Business as usual)	B (Stalled crashworthiness)	A (Business as usual)	B (Stalled crashworthiness)
ALL	vehicles	4,441		5%	
	F&S Injuries	1,470	950	38%	25%
	Cost	$967,857,243	$815,557,660	58%	49%
NSW	vehicles	1,868		7%	
	F&S Injuries	434	293	37%	25%
	Cost	$286,096,033	$245,468,229	58%	50%
QLD	vehicles	103		1%	
	F&S Injuries	303	171	37%	21%
	Cost	$210,489,446	$170,324,954	58%	47%
SA	vehicles	1,349		14%	
	F&S Injuries	195	149	44%	34%
	Cost	$117,255,458	$104,017,995	62%	55%
VIC	vehicles	2,320		13%	
	F&S Injuries	336	242	43%	31%
	Cost	$195,675,564	$169,919,519	62%	54%
WA	vehicles	-1,204		-8%	
	F&S Injuries	203	87	32%	14%
	Cost	$172,583,162	$133,080,531	54%	42%
Light	vehicles	425		7%	
	F&S Injuries	234	147	14%	9%
	Cost	$306,956,524	$281,554,039	42%	38%
Small	vehicles	1,399		7%	
	F&S Injuries	706	485	14%	9%
	Cost	$932,952,049	$868,084,721	42%	39%
Medium	vehicles	1,459		20%	
	F&S Injuries	482	463	29%	28%
	Cost	$76,627,641	$371,074,012	11%	51%
Large	vehicles	2,540		12%	
	F&S Injuries	988	934	19%	18%
	Cost	$1,007,830,639	$992,142,134	46%	45%
People Mover	vehicles	74		8%	
	F&S Injuries	98	77	33%	26%
	Cost	$70,432,455	$64,184,227	55%	50%
SUV-Large	vehicles	59		2%	
	F&S Injuries	77	71	16%	15%
	Cost	$88,031,062	$86,537,827	44%	43%
SUV-Medium	vehicles	-1,559		-56%	
	F&S Injuries	-94	-184	-17%	-32%
	Cost	$52,524,223	$26,240,757	21%	11%
SUV-Compact	vehicles	-2,096		-58%	
	F&S Injuries	-120	-224	-15%	-28%
	Cost	$77,618,335	$47,218,325	22%	14%
Utility	vehicles	166		2%	
	F&S Injuries	286	274	19%	19%
	Cost	$291,647,170	$288,274,522	45%	45%
Van	vehicles	301		12%	
	F&S Injuries	122	105	23%	20%
	Cost	$111,204,450	$106,275,408	48%	46%
Unknown	vehicles	1,662		10%	
	F&S Injuries	353	231	50%	33%
	Cost	$203,260,960	$167,274,285	66%	54%

The scenario of *stalled crashworthiness* in Australian vehicles manufactured in 2011 to 2020 produced lower estimated savings in the number and cost of injuries than the *business as usual* scenario because crashworthiness is expected to continue to improve under the *business as usual* scenario. Overall 950-1,470 fewer fatal and serious injuries were estimated in Australia in 2020 compared to in 2010 due to vehicle secondary safety improvements, a saving of between 25% and 38%. This represents a saving in costs to the community of AU$816-$968M or between 49% and 58%.

Of the states, New South Wales displayed the largest absolute reduction in fatal and serious injuries (434) and South Australian the smallest (195) reflecting the relative sizes of the crashes vehicle population. Estimated percentage savings in fatal and serious injury crashes were greatest in South Australia (44%) and lowest in Western Australia (32%) with these jurisdictions also setting the boundaries in percentage cost savings at 62% and 54% respectively.

With respect to vehicle type, the largest absolute injury savings between the two years was seen in large vehicles (988, 19%) and the largest percentage reduction in people movers (98, 33%); the smallest was injury savings seen in large SUVs (77, 16%) and the smallest percentage injury reduction in small and light vehicles (14%).

Gains in injuries (and vehicle fleet) between 2010 and 2020, were seen for medium SUVs (-94, -17%) and compact SUVs (-120, -15%). These figures are partly a function of the projected proportionate change in representation of each vehicle type in the fleet with large cars reducing in representation and small and medium SUVs increasing.

Figure 22 summarises the Australian expected percentage fatality and serious injury savings in the light vehicle fleet expected over the period 2010-2020 due to secondary safety improvements of the fleet. Trends expected under the scenario of *stalled crashworthiness* improvement as well as *business as usual* improvement based on the projection of crashworthiness improvement are seen over the period 2000-2010.

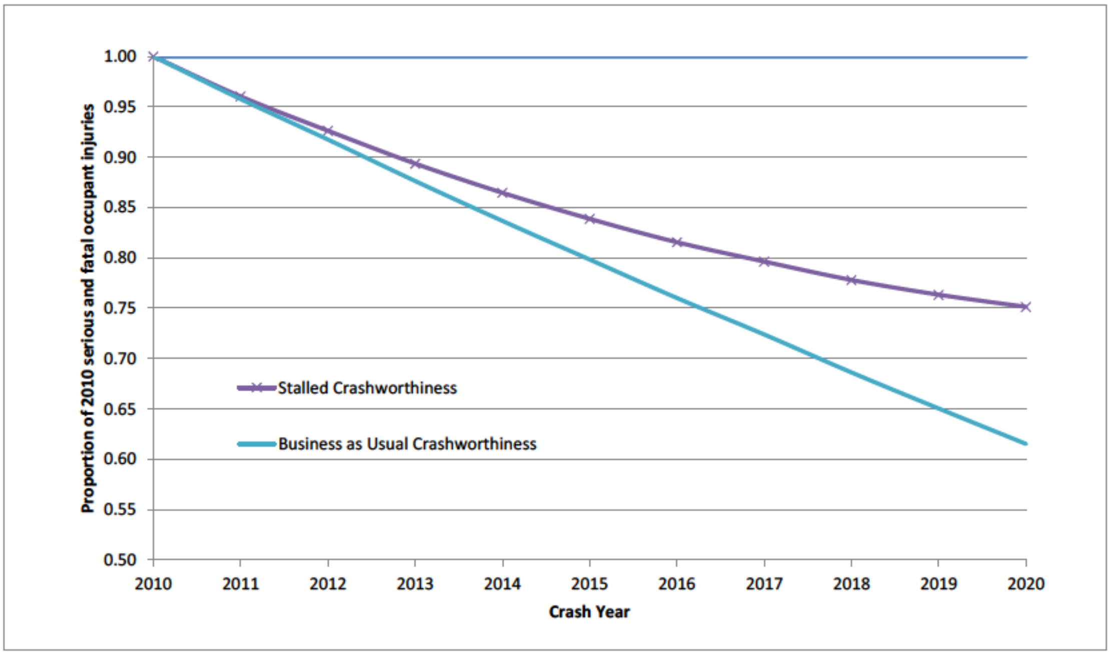

Figure 22: ***Proportion of 2010 fatalities and serious injuries expected in 2011 to 2020 due only to vehicle secondary safety improvements, Australia.***

6.2 NEW ZEALAND

6.2.1 New Zealand Model for future baseline projections

For the New Zealand analysis, vehicle licensing data for seven years: 2003, 2004, 2006, 2007, 2008, 2011 and 2012 for a total of 21,006,618 vehicle-years (so the same vehicle could potentially appear in more than one year) were provided by the New Zealand Transport Agency. Models were fitted to estimate the way that the overall risk of fatal and serious driver injury (given that an injury occurred) changed with time. Estimation of risk ratios using a generalised linear model with a log link function and binomial distribution has been called log-binomial regression by Blizzard and Hosmer (2006). This approach was appropriate for modelling the risks of fatal and serious injury.

As was done in a previous project involving predicting the safety performance of the fleet (Keall, Newstead et al. 2007), no attempt was made to use all available variables in the predictive models, but only use those factors that were of interest in building scenarios of change. These factors included the market group distribution of the fleet (as different market groups have clearly different potential to impose risk on pedestrians), the age of the fleet (as initial analysis showed clear improvements in safety for later model vehicles), and the potential for future further safety improvements beyond those already seen. Once the parameters for the models were estimated from past data, the safety effects of future potential changes in the fleets could then be predicted. Models were fitted using the SAS procedure GENMOD (SAS Institute Inc 2004) with an outcome variable the probability of fatal or serious driver injury (the crashworthiness rating) using covariates vehicle age at the time of the fleet snapshot (<5, 10-14, 5-9, 15-19, 20-24, 25-39 years old), market group, and year of snapshot (as a continuous variable to represent the time trend to be projected into the future).

It was estimated that over the period 2000-2010, a total of 2,381 fatal and serious casualties to New Zealand light passenger vehicle occupants have been saved by fleet improvements in crashworthiness relative to the year 2000. Similarly, it was predicted that if crashworthiness improvements trends continue as expected over the period 2010-2020, there will be an aggregate saving of 1,002 fatal and serious casualties to New Zealand light passenger vehicle occupants due to crashworthiness improvements relative to the year 2010 (Figure 23).

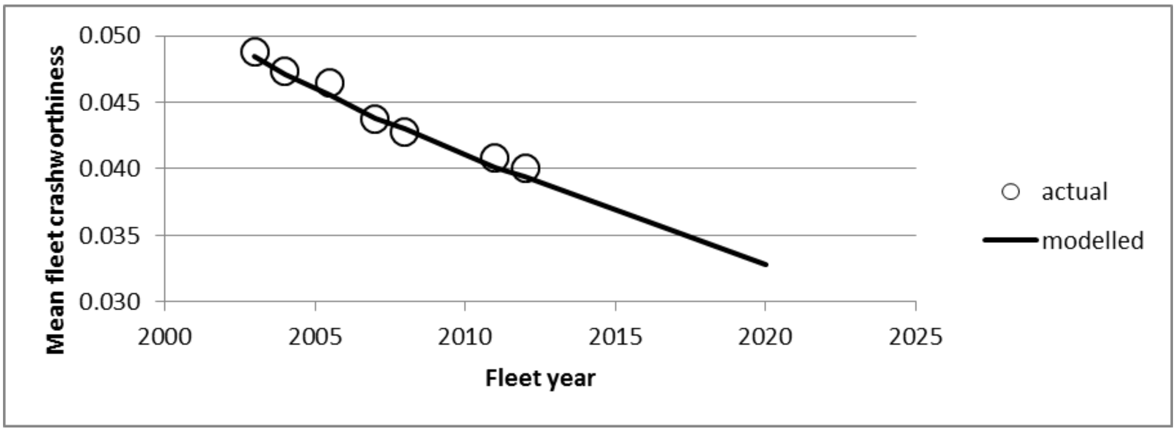

Figure 23: ***New Zealand actual (2000-2010) and projected (2010-2020) fleet crashworthiness under a "business as usual" scenario.***

Figure 23 shows the New Zealand crashworthiness projections for a *business as usual* scenario of continuing improvement in crashworthiness. This represents a 20% improvement in fatal and serious injury rates per tow-away crash (all other things being equal), which equates to about NZ$600M in social cost.

Figure 24 shows the analogous scenario to the Australian scenario B of *stalled crashworthiness* improvements, above. The 2020 fleet crashworthiness was estimated to save 18% of all fatal and serious injuries, which equates to about NZ$500M in social cost. The small difference between this scenario and the preceding one represents the relatively small influence of newer vehicles in the New Zealand fleet compared to the used imported vehicles.

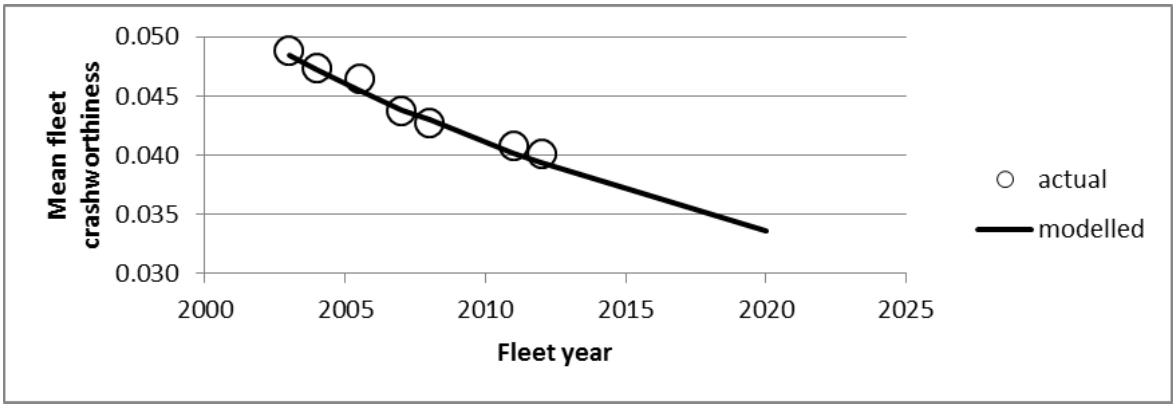

Figure 24: ***New Zealand actual and projected fleet crashworthiness under a "stalled crashworthiness" scenario.***

In the scenarios regarding projected future crashworthiness, a final scenario was proposed for New Zealand in which the market group mix was much more like it was ten years ago (with a higher proportion of larger vehicles) and with an age distribution like the Australian fleet. Figure 25 shows that under this optimistic fleet scenario, approximately 32% of fatal and serious injuries that would have occurred in 2010 would be prevented in 2020, which equates to about NZ$1 billion in social cost.

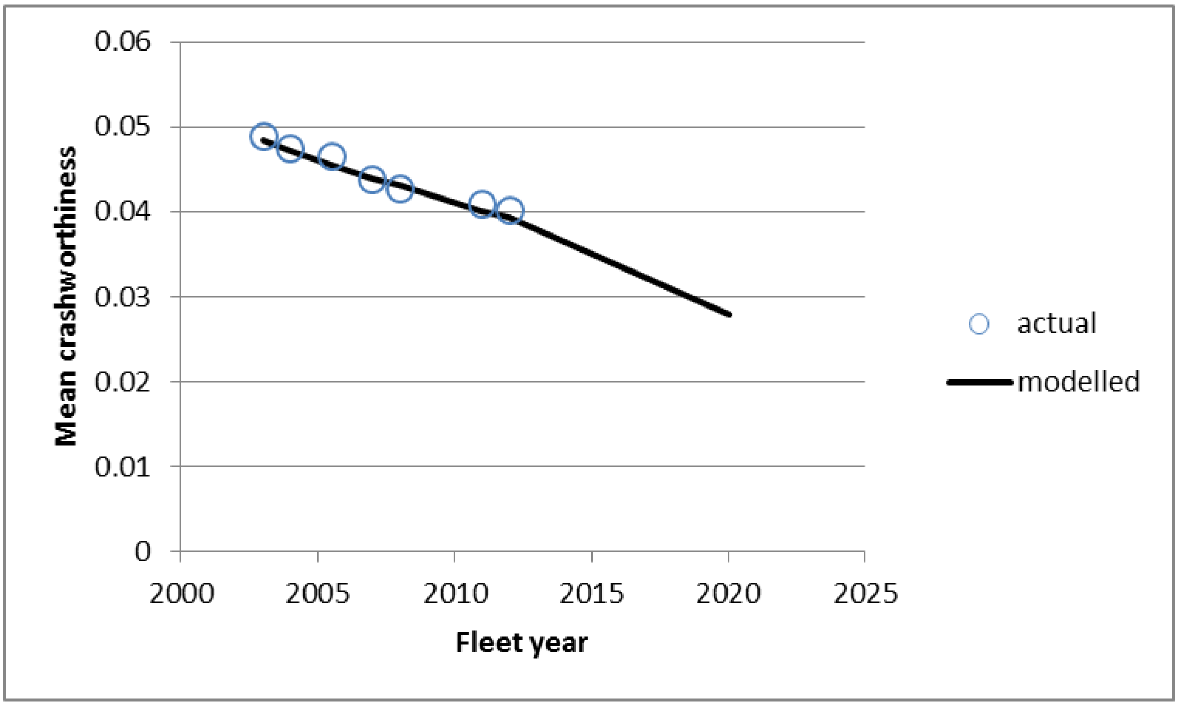

Figure 25: ***New Zealand actual and projected fleet crashworthiness under a "business as usual" scenario but with fewer small vehicles and a newer fleet than expected under current trends.***

Figure 26 summarises the relative savings in fatalities and serious injuries in resulting from the three different future crashworthiness projection scenarios considered over the period 2010-2020.

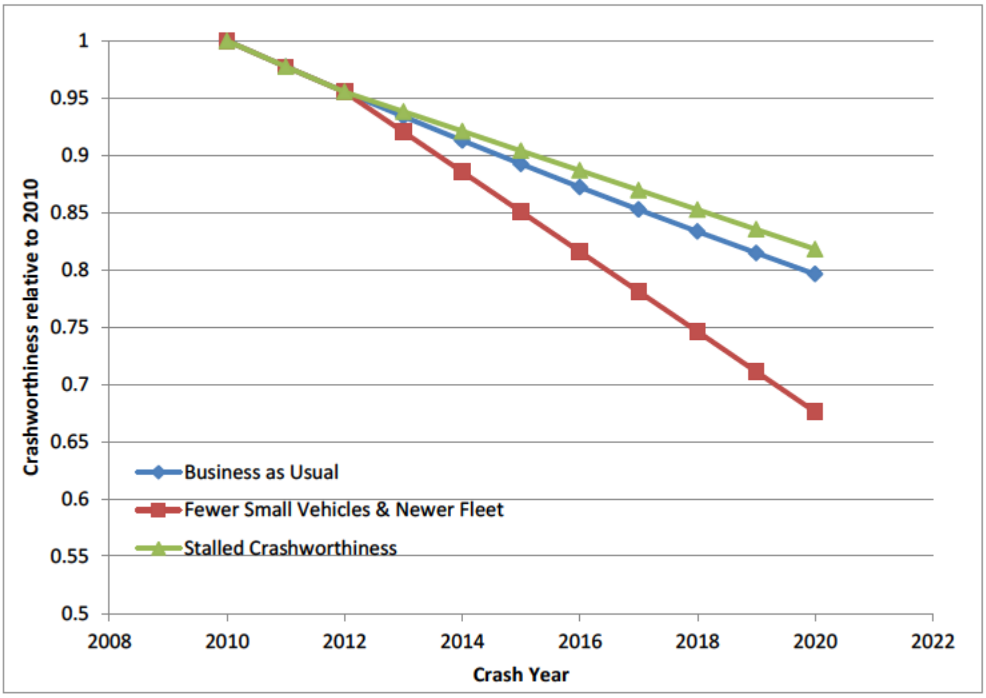

Figure 26: ***Projected proportionate serious and fatal injury savings due to changes in crashworthiness of the New Zealand light vehicle fleet under three different future vehicle crashworthiness scenarios: 2010-2020.***

Figure 27 shows the estimated cumulative total savings in fatal and serious injuries over the period 2010-2020 resulting from the improvements in crashworthiness of the New Zealand vehicle fleet under each scenario summarised in Figure 26.

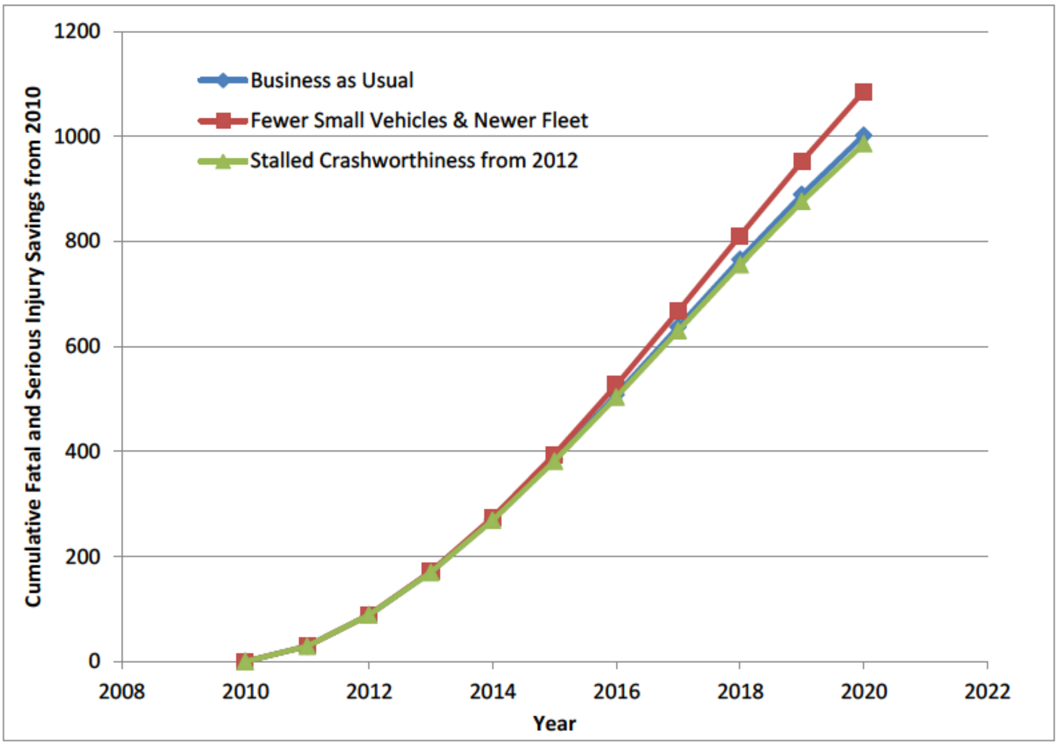

Figure 27: ***New Zealand estimated actual and projected serious and fatal injury savings due to changes in fleet crashworthiness from either a year 2000 baseline or projected from a 2010 baseline under a "business as usual" crashworthiness trend.***

7 RESULTS: INJURY AND COST SAVINGS ASSOCIATED WITH VARIOUS SAFETY TECHONOLOGIES

7.1 AUSTRALIAN ESTIMATES

For each safety technology, reductions in fatal and serious injuries and their associated costs were estimated for the Australian vehicle fleet using the technology effectiveness estimates of Section 4.1 and the methodology of Section 4.5. Comparisons were made against the baseline situation, presented for Australia in Section 6, using the four fitment models presented in Figure 1 of Section 1.1 and the two different crashworthiness projections (A - *business as usual* and B - *stalled crashworthiness*). Savings are presented in terms of absolute reduction and percent reduction of fatal and serious injuries from the baseline projection derived only from crashworthiness improvements. The reduction in present value fatal and serious injury cost is also presented.

The Australian scenarios (excluding ESC) were estimated using four methods, because two fitment models were used (1 - mandating the technology for all new vehicles from 2014 and 2 - gradual penetration of the technology into the fleet) and two methods for projecting future crashworthiness (A - *business as usual* and B - *stalled crashworthiness*). This means that, for these scenarios, a range for each result is presented. The smallest saving produced by any of the four methods was the minimum value of the range and the largest saving produced by any of the four methods was the maximum value of the range. The smallest saving resulted was from fitment model 2 (gradual penetration) and crashworthiness model A (*business as usual*). The maximum was produced by fitment model 1 (mandate from 2014) and crashworthiness model B (*stalled crashworthiness*). Crashworthiness model B projected a greater absolute number of fatal and serious injuries per year than did model B, thus model B had the greater potential for savings form the technologies considered.

The savings for the ESC scenario savings were estimated for Australia in only two ways because fitment was modelled in only one way for vans and utilities. This reflected the mandate for ESC to be fitted to Class NA light commercial vehicles in Australia from 2016 onwards.

Table 15 presents a summary of the average fatal and serious injury savings estimated for the Australian light vehicle fleet over the period 2010-2020 for each crash avoidance technology considered. The greatest AU$ 2010 savings were estimated for *AEB at all speeds*: $108-297M (5-10%) and *ESC for commercial vehicles*: $142-143M (4.5-5.7%). Percentage injury reductions for the other scenarios amounted to 3% or less of the total for the serious and fatal injuries.

Table 15 : ***Summary of average estimated savings in fatal and serious injuries (%) and injury cost (million 2010 AU$) for each safety technology over the period 2010-2020 and savings extremes by jurisdiction and vehicle type.***

	Australia	**Jurisdiction, % reduction in injuries (with Fitment 1, crashworthiness model B)**				**Market Group, % reduction in injuries (with fitment model 1 and crashworthiness model B)**			
Safety System	% F&SI Saving and Cost Saving Range	Worst		Best		Worst		Best	
Autonomous Emergency Braking- All Speeds	5-10 % $108-297M	8.6	NSW SA	10.5	WA	6.1 3.8 1.7	SUV-Compact Large SUV-Large	10.5 11.1 12.6	SUV-Medium Van Light
Autonomous Emergency Braking - Speeds >=80 km/hr	1.5-3.1% $35-96M	1.9	SA	3.1	VIC	1.7 1.3 0.7	SUV-Compact Large SUV-Large	4.2 3.6 3.5	Utility Van SUV-Medium
Lane Departure	0.2-0.5% $6-16M	0.2	NSW QLD	0.8	WA	0.1 0.2	SUV-Large Large	0.6 0.5	SUV-Medium Utility Van
Fatigue	1.5-3.2 $36-98M	2.7	VIC	3.5	WA	1.3 0.7	Large SUV-Large	3.9 3.7	SUV-Medium Utility
Lane Change	0.6-1.2% $14-37M	0.8	SA	1.5	QLD	0.5 0.2	Large, SUV-Large	1.6 1.5	Light Van SUV-Medium
ESC	4.5-5.7% $142-143M	4.2	NSW QLD	4.9	WA	4.8	Vans	6.9	Utilities

The greatest percentage injury reductions (based on fitment model 1 – mandate, and crashworthiness model B – *stalled crashworthiness*) for the *AEBS at speeds >=80km/*hr scenario and the *Lane Departure* scenario were seen in Victoria. The greatest percentage injury reductions (based on the same scenario) for the *AEBS at all speeds*, *LDWS, FWS* and *ESC* scenarios were seen in Western Australia. Queensland saw the greatest percentage savings for the *LCWS* scenario.

Fatal and serious injuries (based on fitment model 1 and crashworthiness model B) from medium SUVs improved with the greatest rate with fitment of all the considered. Over the same scenarios, large passenger vehicles and large SUV vehicles showed the least improvement in percentage reduction (based on fitment model 1 and crashworthiness model B) in fatal and serious injuries.

Figures 28a and b summarise the estimated savings in fatal and serious injury crashes from fitment of each safety technology considered for each year from 2011 to 2020 under fitment scenarios 1 (mandate) and 2 (gradual penetration) respectively. The estimate for each year represents the proportion of the 2010 fatal and serious crash population remaining in that year. It shows that, under a mandate scenario, AEB is estimated to have reduced fatal and serious injuries by nearly 7%. In comparison, commercial vehicle ESC gives a reduction of nearly 4%, high speed only AEB and FWS just over 2% and LDWS and LCWS at under 1%.

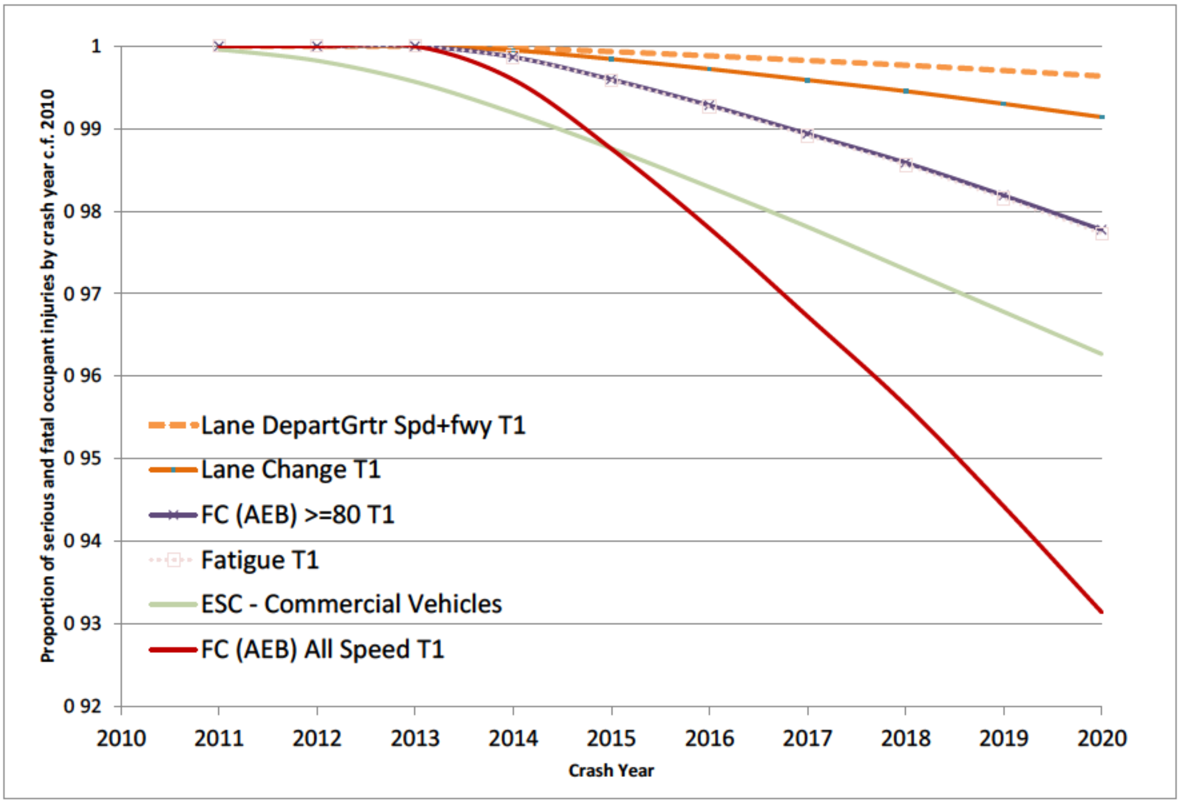

Figure 28a: ***Proportion of 2010 vehicle occupant fatal and serious injuries estimated each crash year from 2011-2020 from safety technology fitment mandated in 2014, Australia.***

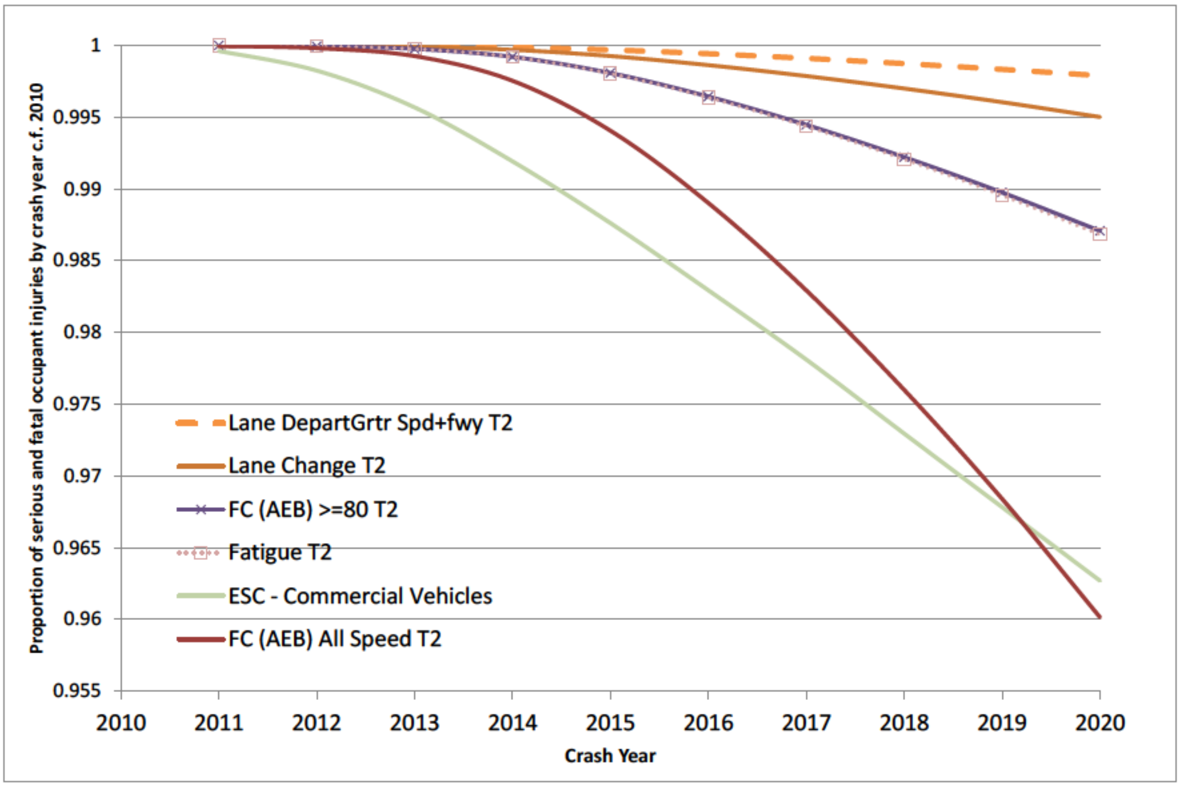

Figure 28b: ***Proportion of 2010 vehicle occupant fatal and serious injuries estimated each crash year from 2011-2020 from safety technology fitment with gradual fleet penetration, Australia.***

The following sections provide the detail of the estimates of effectiveness derived for each technology summarised in Table 15 and Figures 28a and b.

7.1.1 Mandatory Fitment of Forward Collision Warning System with Autonomous Emergency Braking (AEB)

Table 16 presents the estimated average 2011-2020 savings in fatal and serious injuries resulting through the fitment of *Forward Collision Warning Systems with AEB.* With the technology effective across all speed zones, it was possible to prevent between 4.5% and 9.5% of all fatal and serious injuries. This amounted to AU$108-$297M savings in the present value (2010) burden of these injuries on society. When the technology was considered only to be effective over speed zones of 80km/hr or higher, fatal and serious injury reduction rates were estimated to be only 1.5%-3.1 %. This amounted to AU$35-$96M savings in the present value (2010) burden of these injuries on society.

The proportion of injury savings estimated for Victoria, Western Australia and Queensland were similar to those found for the five states aggregated. The proportion of injury savings estimated for New South Wales and South Australia were slightly less than found nationally. Light cars, utilities, vans and medium SUVs benefitted most from this technology.

7.1.2 Mandatory Fitment of Lane Departure Warning Systems (LDWS)

Table 18 presents the estimated average 2011-2020 savings in fatal and serious injuries expected through the fitment of LDWS. With the technology effective in 80km/hr or greater speed zones, where the driver was not declared alcohol impaired or to be speeding, it was possible to prevent between 0.9% and 1.9% of all fatal and serious injuries. This amounted to AU$21-$59M savings in the present value (2010) burden of these injuries on society. When the effectiveness was further restricted to major highways and freeways, fatal and serious injury reduction rates were only 0.2% to 0.5 %. This amounted to AU$6-$16M savings in the present value (2010) burden of these injuries on society.

The proportion of injury savings estimated for each jurisdiction were similar to those found on aggregate, except when crashes were not restricted to freeways in South Australia and Western Australia. In this instance for these two jurisdictions, injury savings were proportionally much less than for the aggregated states.

Utilities, vans and medium SUVs benefitted most from this technology.

7.1.3 Mandatory Fitment of Fatigue Warning Systems (FWS)

Table 17 presents the estimated average 2011-2020 savings in fatal and serious injuries expected through the fitment of FWS. This technology was estimated to prevent between 1.5% and 3.2% of all fatal and serious injuries. This amounted to AU$36-$98M savings in the present value (2010) burden of these injuries on society.

The proportion of injury savings estimated for Western Australia, Queensland and New South Wales were similar to those found in aggregate. The proportion of injury savings estimated for Victoria and South Australia were slightly less than found nationally.

Utilities, light cars and medium SUVs benefitted most from this technology.

7.1.4 Mandatory Fitment of Lane Change and Blind Spot Warning Systems (LCWS/BSWS)

Table 17 presents the estimated average 2011-2020 savings in fatal and serious injuries expected through the fitment of LCWS/BSWS. This technology was estimated to prevent between 0.6% and 1.2% of all fatal and serious injuries amounting to AU$14-$37M savings in the present value (2010) burden of these injuries on society.

The proportion of injury savings estimated for Victoria, New South Wales and Queensland was similar to those found in aggregate. The proportion of injury savings estimated for Western Australia and South Australia were slightly less than found nationally.

Light cars, medium SUVs and vans benefitted most from this technology.

Table 16 : ***Estimated savings in fatal and serious injuries and their associated costs (2010 AU$) over 2011-2020 expected through fitment of FCWS with AEB to the Australian light vehicle fleet.***

		Forward Collision At All Speed				Forward Collision At Speeds ≥80			
		Fitment model 1		Fitment model 2		Fitment model 1		Fitment model 2	
	Ten year Reduction in	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
ALL	Injuries	621	943	345	528	202	307	113	172
	PV Cost of Injuries	$195,629,545	$296,573,009	$108,455,258	$165,628,196	$63,466,877	$96,215,338	$35,185,465	$53,733,726
	% reduction in injuries	8.0	9.5	4.5	5.3	2.6	3.1	1.5	1.7
NSW	Injuries	158	239	88	133	37	55	21	31
	PV Cost of Injuries	$48,921,883	$73,834,971	$27,094,571	$41,130,483	$11,262,668	$16,998,095	$6,237,641	$9,468,952
	% reduction in injuries	7.1	8.5	4.0	4.8	1.7	2.0	0.9	1.1
QLD	Injuries	170	258	95	145	46	69	26	39
	PV Cost of Injuries	$55,105,289	$83,551,932	$30,424,224	$46,513,273	$14,547,597	$22,057,408	$8,031,885	$12,279,336
	% reduction in injuries	8.8	10.4	4.9	5.8	2.4	2.8	1.4	1.6
SA	Injuries	52	79	29	44	12	17	7	10
	PV Cost of Injuries	$15,852,033	$23,897,758	$8,755,222	$13,277,229	$3,394,549	$5,117,458	$1,874,840	$2,843,181
	% reduction in injuries	7.2	8.6	4.0	4.8	1.6	1.9	0.9	1.1
VIC	Injuries	112	169	62	95	37	55	21	31
	PV Cost of Injuries	$33,147,477	$50,116,857	$18,374,864	$27,957,445	$10,774,361	$16,290,143	$5,972,624	$9,087,377
	% reduction in injuries	7.9	9.4	4.4	5.2	2.6	3.1	1.5	1.7
WA	Injuries	147	224	83	127	33	50	20	29
	PV Cost of Injuries	$53,007,663	$81,020,220	$29,500,565	$45,529,152	$11,351,043	$17,349,642	$6,317,241	$9,749,597
	% reduction in injuries	8.9	10.5	5.0	6.0	2.0	2.3	1.2	1.4

Table 16 continued: *FCWS with AEB.*

		Forward Collision At All Speed				Forward Collision At Speeds ≥80			
		Fitment model 1		Fitment model 2		Fitment model 1		Fitment model 2	
	Ten year Reduction in	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
Light	Injuries	816	898	465	512	210	232	120	132
	PV Cost of Injuries	$258,619,106	$284,578,327	$146,736,135	$161,625,880	$66,694,733	$73,389,301	$37,841,471	$41,681,355
	% injury reduction	12.3	12.6	7.0	7.2	3.2	3.2	1.8	1.8
Small	Injuries	1,113	1,233	616	682	289	321	161	178
	PV Cost of Injuries	$349,959,025	$387,618,634	$193,376,913	$214,203,343	$90,729,525	$100,493,064	$50,134,428	$55,533,837
	% injury reduction	7.6	7.8	4.2	4.3	2.0	2.0	1.1	1.1
Medium	Injuries	327	341	183	191	86	89	48	50
	PV Cost of Injuries	$102,480,892	$106,897,654	$56,958,959	$59,459,248	$26,573,033	$27,718,287	$14,769,312	$15,417,630
	% injury reduction	8.8	9.0	4.9	5.0	2.3	2.4	1.3	1.3
Large	Injuries	538	557	287	296	181	188	98	101
	PV Cost of Injuries	$164,767,210	$170,648,283	$87,557,653	$90,595,449	$54,776,894	$56,732,058	$29,108,561	$30,118,476
	% injury reduction	3.7	3.8	2.0	2.0	1.2	1.3	0.7	0.7
People Mover	Injuries	71	85	39	47	16	19	9	10
	PV Cost of Injuries	$22,288,060	$26,628,565	$12,238,318	$14,662,809	$4,918,686	$5,876,579	$2,700,838	$3,235,892
	% injury reduction	7.1	7.9	3.9	4.3	1.6	1.7	0.9	1.0
SUV-Large	Injuries	18	20	10	11	8	9	4	5
	PV Cost of Injuries	$5,612,289	$6,219,807	$3,099,139	$3,408,572	$2,471,923	$2,739,503	$1,365,010	$1,501,300
	% injury reduction	1.5	1.7	0.8	0.9	0.7	0.7	0.4	0.4
SUV-Medium	Injuries	312	369	173	206	104	123	58	69
	PV Cost of Injuries	$98,101,540	$115,863,262	$54,380,849	$64,490,105	$32,757,850	$38,688,805	$18,158,733	$21,534,393
	% injury reduction	9.8	10.5	5.5	5.9	3.3	3.5	1.8	2.0
SUV-Compact	Injuries	251	300	133	159	68	82	36	43
	PV Cost of Injuries	$77,853,010	$93,246,197	$41,389,022	$49,408,771	$21,146,161	$25,327,204	$11,241,941	$13,420,237
	% injury reduction	5.5	6.1	2.9	3.2	1.5	1.7	0.8	0.9
Utility	Injuries	498	507	277	283	212	216	118	121
	PV Cost of Injuries	$156,449,582	$159,314,916	$86,815,948	$88,603,227	$66,492,795	$67,710,594	$36,897,734	$37,657,347
	% injury reduction	9.5	9.9	5.3	5.5	4.1	4.2	2.3	2.4
Van	Injuries	192	205	108	116	62	66	35	38
	PV Cost of Injuries	$60,654,496	$64,634,715	$34,044,349	$36,324,051	$19,544,914	$20,827,474	$10,970,232	$11,704,828
	% injury reduction	10.8	11.1	6.1	6.3	3.5	3.6	2.0	2.0
Unknown	Injuries	146	228	83	131	51	80	29	46
	PV Cost of Injuries	$46,510,310	$72,297,471	$26,289,553	$41,373,425	$16,151,333	$25,106,272	$9,129,402	$14,367,480
	% injury reduction	9.5	11.0	5.4	6.3	3.3	3.8	1.9	2.2

Table 17 : ***Estimated savings in fatal and serious injuries and their associated costs (2010 AU$) over 2011-2020 expected through fitment of LCWS or FWS to the Australian light passenger vehicle fleet.***

		Lane Change				Fatigue			
		Fitment model 1		Fitment model 2		Fitment model 1		Fitment model 2	
Ten year Reduction in		**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
ALL	Injuries	79	119	44	67	206	313	115	176
	PV Cost of Injuries	$24,501,421	$37,143,981	$13,583,367	$20,743,933	$64,742,980	$98,149,900	$35,892,925	$54,814,128
	% reduction in injuries	1.0	1.2	0.6	0.7	2.7	3.2	1.5	1.8
NSW	Injuries	20	30	12	17	62	94	35	53
	PV Cost of Injuries	$6,115,065	$9,229,114	$3,386,727	$5,141,167	$19,128,324	$28,869,274	$10,593,904	$16,081,908
	% reduction in injuries	0.9	1.1	0.5	0.6	2.8	3.3	1.6	1.9
QLD	Injuries	25	37	15	22	53	79	30	45
	PV Cost of Injuries	$7,651,143	$11,600,842	$4,224,278	$6,458,177	$16,628,026	$25,211,803	$9,180,512	$14,035,384
	% reduction in injuries	1.3	1.5	0.8	0.9	2.7	3.2	1.5	1.8
SA	Injuries	5	8	3	5	18	26	10	15
	PV Cost of Injuries	$1,401,407	$2,112,693	$774,010	$1,173,780	$5,238,033	$7,896,605	$2,893,013	$4,387,233
	% reduction in injuries	0.7	0.8	0.5	0.5	2.4	2.9	1.4	1.7
VIC	Injuries	15	22	8	13	33	49	18	28
	PV Cost of Injuries	$4,214,741	$6,372,417	$2,336,386	$3,554,822	$9,616,501	$14,539,531	$5,330,780	$8,110,807
	% reduction in injuries	1.0	1.2	0.6	0.7	2.3	2.7	1.3	1.5
WA	Injuries	15	22	10	14	50	76	29	44
	PV Cost of Injuries	$4,686,168	$7,162,632	$2,608,012	$4,025,027	$17,515,475	$26,771,745	$9,747,957	$15,044,329
	% reduction in injuries	0.9	1.0	0.6	0.6	3.1	3.5	1.8	2.0

Table 17 continued: *LCWS or FWS.*

		Lane Change				Fatigue			
		Fitment model 1		Fitment model 2		Fitment model 1		Fitment model 2	
	Ten year Reduction in	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
Light	Injuries	105	115	60	66	197	217	112	124
	PV Cost of Injuries	$33,256,910	$36,595,114	$18,869,412	$20,784,146	$62,574,330	$68,855,308	$35,503,623	$39,106,280
	% injury reduction	1.6	1.6	0.9	0.9	3.0	3.0	1.7	1.7
Small	Injuries	143	159	80	88	258	286	143	159
	PV Cost of Injuries	$44,720,569	$49,533,016	$24,711,252	$27,372,620	$80,887,180	$89,591,569	$44,695,842	$49,509,523
	% injury reduction	1.0	1.0	0.5	0.6	1.8	1.8	1.0	1.0
Medium	Injuries	44	46	25	26	84	88	48	50
	PV Cost of Injuries	$13,592,511	$14,178,326	$7,554,728	$7,886,353	$26,161,808	$27,289,340	$14,540,753	$15,179,039
	% injury reduction	1.2	1.2	0.7	0.7	2.3	2.3	1.3	1.3
Large	Injuries	73	76	40	42	181	187	97	100
	PV Cost of Injuries	$21,543,615	$22,312,576	$11,448,324	$11,845,521	$54,551,357	$56,498,471	$28,988,710	$29,994,467
	% injury reduction	0.5	0.5	0.3	0.3	1.2	1.3	0.7	0.7
People Mover	Injuries	9	11	5	6	21	25	11	14
	PV Cost of Injuries	$2,769,521	$3,308,874	$1,520,737	$1,822,005	$6,524,278	$7,794,854	$3,582,465	$4,292,175
	% injury reduction	0.9	1.0	0.5	0.5	2.1	2.3	1.1	1.3
SUV-Large	Injuries	2	2	1	1	7	8	4	4
	PV Cost of Injuries	$650,259	$720,648	$359,077	$394,929	$2,267,834	$2,513,321	$1,252,311	$1,377,348
	% injury reduction	0.2	0.2	0.1	0.1	0.6	0.7	0.3	0.4
SUV-Medium	Injuries	45	53	25	29	116	137	64	77
	PV Cost of Injuries	$14,011,610	$16,548,474	$7,767,087	$9,210,968	$36,443,002	$43,041,171	$20,201,532	$23,956,943
	% injury reduction	1.4	1.5	0.8	0.8	3.7	3.9	2.0	2.2
SUV-Compact	Injuries	31	37	16	20	74	89	40	47
	PV Cost of Injuries	$9,662,581	$11,573,078	$5,136,921	$6,132,277	$23,147,628	$27,724,404	$12,305,982	$14,690,452
	% injury reduction	0.7	0.8	0.4	0.4	1.6	1.8	0.9	1.0
Utility	Injuries	60	61	34	35	185	189	103	106
	PV Cost of Injuries	$18,724,925	$19,067,867	$10,390,709	$10,604,622	$58,112,803	$59,177,125	$32,247,566	$32,911,446
	% injury reduction	1.2	1.2	0.6	0.7	3.6	3.7	2.0	2.1
Van	Injuries	26	28	15	16	47	50	27	28
	PV Cost of Injuries	$8,231,127	$8,771,263	$4,619,993	$4,929,360	$14,665,549	$15,627,920	$8,231,526	$8,782,732
	% injury reduction	1.5	1.5	0.8	0.9	2.6	2.7	1.5	1.5
Unknown	Injuries	17	26	10	15	57	89	32	51
	PV Cost of Injuries	$5,108,868	$7,941,426	$2,887,744	$4,544,613	$17,970,197	$27,933,586	$10,157,499	$15,985,457
	% injury reduction	1.1	1.2	0.6	0.7	3.7	4.3	2.1	2.5

Table 18 : ***Estimated savings in fatal and serious injuries and their associated costs (2010 AU$) over 2011-2020 expected through fitment of LDWS to the Australian light vehicle fleet.***

		LD-2 +80km/hr or greater zones +no illegal alcohol/speeding				LD- + major highway expressway			
		Fitment model 1		Fitment model 2		Fitment model 1		Fitment model 2	
	Ten year Reduction in	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
ALL	Injuries	124	188	69	106	34	51	19	29
	PV Cost of Injuries	$38,727,780	$58,711,042	$21,470,333	$32,788,567	$10,349,310	$15,689,481	$5,737,564	$8,762,161
	% reduction in injuries	1.6	1.9	0.9	1.1	0.4	0.5	0.2	0.3
NSW	Injuries	38	57	21	32	7	10	4	6
	PV Cost of Injuries	$11,604,569	$17,514,106	$6,426,998	$9,756,402	$1,873,858	$2,828,106	$1,037,805	$1,575,424
	% reduction in injuries	1.7	2.0	1.0	1.1	0.3	0.3	0.2	0.2
QLD	Injuries	33	50	19	28	7	10	5	6
	PV Cost of Injuries	$10,295,514	$15,610,300	$5,684,264	$8,690,238	$1,743,958	$2,644,230	$962,858	$1,472,040
	% reduction in injuries	1.7	2.0	1.0	1.1	0.4	0.4	0.2	0.3
SA	Injuries	8	11	5	7	4	6	3	4
	PV Cost of Injuries	$2,095,903	$3,159,682	$1,157,586	$1,755,471	$1,097,952	$1,655,220	$606,409	$919,615
	% reduction in injuries	1.0	1.2	0.6	0.7	0.6	0.7	0.4	0.4
VIC	Injuries	20	30	11	17	9	13	5	8
	PV Cost of Injuries	$5,739,469	$8,677,709	$3,181,599	$4,840,818	$2,510,819	$3,796,197	$1,391,839	$2,117,690
	% reduction in injuries	1.4	1.6	0.8	0.9	0.6	0.7	0.4	0.4
WA	Injuries	22	32	13	19	13	18	8	11
	PV Cost of Injuries	$7,008,496	$10,712,223	$3,900,466	$6,019,713	$3,671,447	$5,611,668	$2,043,285	$3,153,466
	% reduction in injuries	1.3	1.5	0.8	0.9	0.8	0.8	0.5	0.5

Table 18 continued: *LDWS.*

		LD-2 +80km/hr or greater zones +no illegal alcohol/speeding				LD- + major highway expressway			
		Fitment model 1		Fitment model 2		Fitment model 1		Fitment model 2	
	Ten year Reduction in	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
Light	Injuries	112	123	64	70	29	32	17	18
	PV Cost of Injuries	$35,481,008	$39,042,459	$20,131,328	$22,174,112	$9,237,443	$10,164,663	$5,241,170	$5,773,007
	% injury reduction	1.7	1.7	1.0	1.0	0.4	0.4	0.2	0.3
Small	Injuries	146	161	81	90	39	43	22	25
	PV Cost of Injuries	$45,432,923	$50,322,027	$25,104,877	$27,808,638	$11,981,044	$13,270,342	$6,620,368	$7,333,372
	% injury reduction	1.0	1.0	0.6	0.6	0.3	0.3	0.2	0.2
Medium	Injuries	44	46	25	26	11	12	7	7
	PV Cost of Injuries	$13,612,623	$14,199,306	$7,565,907	$7,898,022	$3,210,910	$3,349,295	$1,784,626	$1,862,965
	% injury reduction	1.2	1.2	0.7	0.7	0.3	0.3	0.2	0.2
Large	Injuries	103	106	56	58	30	31	17	18
	PV Cost of Injuries	$30,561,469	$31,652,307	$16,240,431	$16,803,890	$8,136,912	$8,427,344	$4,323,972	$4,473,992
	% injury reduction	0.7	0.7	0.4	0.4	0.2	0.2	0.1	0.1
People Mover	Injuries	13	16	7	9	3	4	2	2
	PV Cost of Injuries	$4,120,138	$4,922,517	$2,262,358	$2,710,545	$927,335	$1,107,930	$509,197	$610,073
	% injury reduction	1.3	1.5	0.7	0.8	0.3	0.3	0.2	0.2
SUV-Large	Injuries	5	5	3	3	1	1	1	1
	PV Cost of Injuries	$1,555,315	$1,723,675	$858,854	$944,607	$290,550	$322,002	$160,444	$176,463
	% injury reduction	0.4	0.5	0.2	0.3	0.1	0.1	0.0	0.0
SUV-Medium	Injuries	80	95	44	53	18	21	10	12
	PV Cost of Injuries	$25,129,690	$29,679,532	$13,930,198	$16,519,785	$5,528,347	$6,529,279	$3,064,541	$3,634,231
	% injury reduction	2.5	2.7	1.4	1.5	0.6	0.6	0.3	0.3
SUV-Compact	Injuries	50	60	27	32	11	13	6	7
	PV Cost of Injuries	$15,577,381	$18,657,358	$8,281,408	$9,886,056	$3,467,936	$4,153,621	$1,843,660	$2,200,897
	% injury reduction	1.1	1.2	0.6	0.6	0.2	0.3	0.1	0.1
Utility	Injuries	127	129	71	72	28	28	16	16
	PV Cost of Injuries	$39,645,414	$40,371,510	$21,999,766	$22,452,675	$8,507,578	$8,663,392	$4,720,968	$4,818,159
	% injury reduction	2.4	2.5	1.4	1.4	0.5	0.6	0.3	0.3
Van	Injuries	32	34	18	19	9	10	5	6
	PV Cost of Injuries	$10,042,711	$10,701,726	$5,636,805	$6,014,261	$2,813,716	$2,998,355	$1,579,291	$1,685,045
	% injury reduction	1.8	1.9	1.0	1.1	0.5	0.5	0.3	0.3
Unknown	Injuries	102	159	58	92	44	68	25	39
	PV Cost of Injuries	$32,373,993	$50,323,420	$18,299,122	$28,798,410	$13,833,173	$21,502,833	$7,819,082	$12,305,352
	% injury reduction	6.6	7.7	3.8	4.4	2.8	3.3	1.6	1.9

7.1.5 Mandatory Fitment of Electronic Stability Control (ESC)

Table 19 presents the estimated 2011-2020 savings in fatal and serious injuries achieved through the fitment of ESC to light commercial vehicles. Mandatory fitment of this technology to utilities and van was estimated to prevent between 5% and 6% of all fatal and serious injuries in the five Australian states analysed. This amounted to AU$142-$143M savings in the burden of these injuries on society.

The proportion of injury savings estimated for Queensland was similar to those found in aggregate. The proportion of injury savings estimated for South Australia and New South Wales were slightly less than found nationally, whilst the proportions for Victoria and Western Australia were higher than observed nationally. The rates in injury reductions were almost 50% higher for utilities than vans.

Table 19 : ***Estimated savings in fatal and serious injuries and their associated costs (2010 AU$S) over 2011-2020 expected through fitment of ESC to the Australian light commercial vehicle fleet.***

		ESC	
	Ten year Reduction in	**A**	**B**
ALL	Injuries	440	442
	PV Cost of Injuries	$142,462,904	$142,862,262
	% reduction in injuries	5.7	4.5
NSW	Injuries	117	117
	PV Cost of Injuries	$37,009,481	$36,978,445
	% reduction in injuries	5.3	4.2
QLD	Injuries	103	103
	PV Cost of Injuries	$34,086,509	$34,272,645
	% reduction in injuries	5.3	4.2
SA	Injuries	43	43
	PV Cost of Injuries	$13,336,814	$13,380,097
	% reduction in injuries	5.9	4.7
VIC	Injuries	84	84
	PV Cost of Injuries	$25,552,101	$25,605,402
	% reduction in injuries	5.9	4.7
WA	Injuries	103	104
	PV Cost of Injuries	$38,170,188	$38,488,664
	% reduction in injuries	6.3	4.9
Utilities	Injuries	356	354
	PV Cost of Injuries	$115,471,599	$114,476,352
	% reduction in injuries	6.8	6.9
Vans	Injuries	83	88
	PV Cost of Injuries	$26,991,304	$28,385,910
	% reduction in injuries	4.7	4.8

7.2 NEW ZEALAND ANALYSIS

Analysis of the projected benefits of new vehicle crash avoidance technologies was undertaken for New Zealand in a manner mirroring the Australian analysis. Estimated crash reductions associated with each technology based on prior research were applied to the fatal and serious injury trends estimated in Figure 26 of Section 6.2.1 under two scenarios for technology penetration into the New Zealand light vehicle fleet. The two penetration scenarios considered are the same as in Australia being:

1. All vehicles mandated with the technology from 2014; and
2. Technology gradually penetrating the fleet according to a process of natural progression.

The resulting proportions of the New Zealand light vehicle fleet vehicles fitted with the technology under the two penetration scenarios are shown in Figure 29.

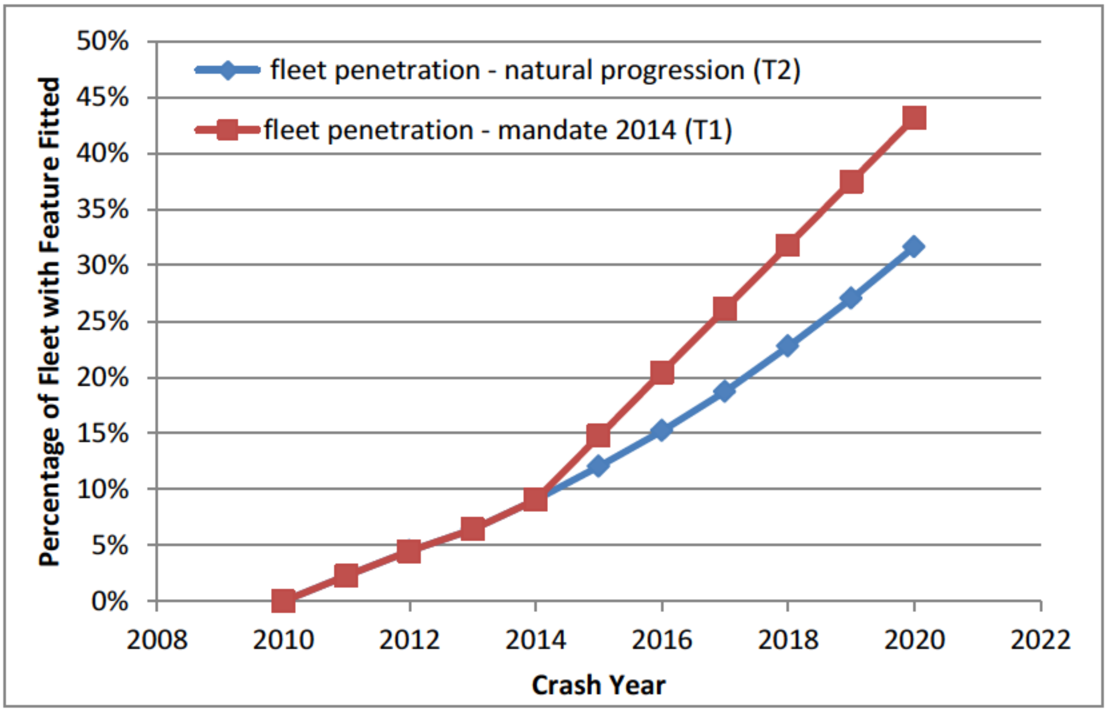

Figure 29: ***Proportion of New Zealand Light Vehicle Fleet with crash avoidance technologies fitted under 2 scenarios: 1- technology mandated for all vehicles from 2014 and 2- technology gradually penetrating the fleet at a rate of natural progression .***

Figures 30 and 31 show the number of fatal and serious injuries in the New Zealand light passenger vehicle fleet relative to 2010 in each year from 2011-2020 based on the fitment of crash avoidance technologies according to scenario 1 and 2 in Figure 29 respectively. A difference in the New Zealand analysis is that ESC fitment was considered for all light passenger vehicles and not just light commercial vehicles since at the time of the study New Zealand did not have a mandate for ESC fitment in any vehicle class.

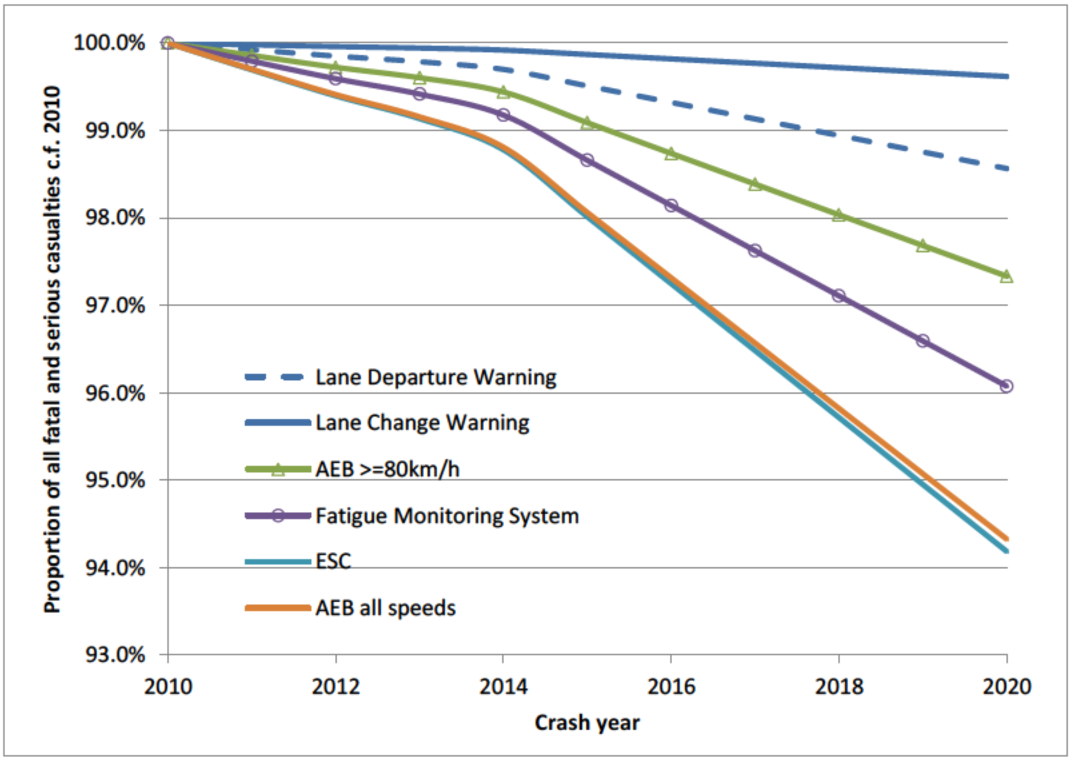

Figure 30: ***New Zealand projected fatal and serious injuries in light vehicle crashes relative to 2010 expected from the fitment of each crash avoidance technology under technology penetration scenario 1 (technology mandated for all vehicles from 2014).***

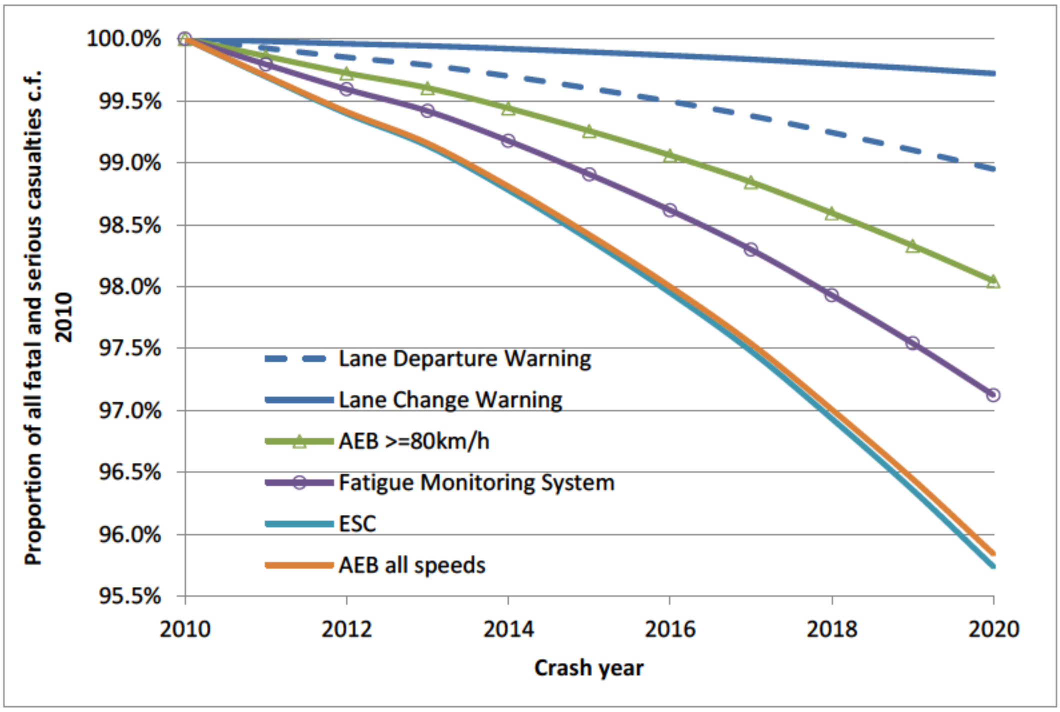

Figure 31: New Zealand projected fatal and serious injuries in light vehicle crashes relative to 2010 expected from the fitment of each crash avoidance technology under technology penetration scenario 2 (technology mandated for all vehicles from 2014).

Relative benefits estimated for each technology in New Zealand were similar to those estimated for Australia as were the estimated percentage crash savings by 2020 associated with each technology. AEB operational at all speeds was estimated to be the most effective technology in reducing fatal and serious injuries resulting in a nearly 6% reduction by 2020 under the mandate scenario. ESC showed similar reduction benefits to AEB in New Zealand and more than in Australia reflecting the lack of current mandate for ESC in New Zealand. Fatigue monitoring technologies and high speed only AEB were the next most beneficial technologies with estimated reductions of between 3% and 4% by 2020 followed by LDWS and LCWS with reductions of between 1% and 2% by 2020.

7.3 BREAK-EVEN COSTS

Break-even costs to the community for the fitment of each of the crash avoidance technologies considered were estimated by comparing the crash savings associated with each technology to the number of light vehicles in the fleet that would be fitted with the technology under the fitment scenarios considered. The break-even cost represents the maximum that can be invested in fitting the technology to each vehicle to achieve a benefit-to-cost ratio to the community of at least one.

Table 20 presents the numbers of Australian light vehicles projected to be entering the fleet between 2010 and 2020 and involved in crashes both overall and by market group and jurisdiction. It also presents the number of these vehicles expected to have fitment of the safety technologies based on the penetration scenarios considered. Those with ESC fitment are divided into vans and utilities and the remaining technologies are divided into those under the 'T1' (mandate) and 'T2' (gradual penetration) scenarios modelled. Only a proportion of the new vehicles entering the fleet with safety technology fitment will be involved in a crash.

Table 20 : ***Australian baseline projection light vehicles entering the fleet from 2011-2020 and crash involved.***

		Crashed vehicles with technology fitment			
	All	**ESC fitment**		**Other Technology Fitment**	
		Vans and Utes	**Utilities**	**T1**	**T2**
ALL	309,905	30,718	24,189	127,350	71,255
NSW	88,428	8,169	6,195	34,067	19,005
QLD	76,898	7,139	5,612	32,965	18,389
SA	28,071	2,913	2,266	10,468	5,824
VIC	56,386	5,819	4,577	22,224	12,418
WA	65,716	6,985	5,443	29,856	16,822
Light	25,303	-		12,592	7,182
Small	59,924	-		18,400	10,175
Medium	18,720	-		6,930	3,864
Large	65,939	-		10,593	5,601
People Mover	4,475	-		1,577	869
Utility	35,831	24,189	24,189	15,652	8,723
Van	9,859	6,529		4,400	2,480
SUV-Large	7,490	-		609	332
SUV-Medium	20,784	-	6,026	10,187	5,684
SUV-Compact	27,334	-	-	7,291	3,858
Unknown	63,662	-		32,251	18,526

The number of Australian new vehicles entering the fleet and crashed from 2011-2020 and fitted with the technology was scaled up by dividing by the appropriate proportion tabled in column 5 of Table 12 (Section 4.7) to estimate the total number of new vehicles registered vehicles fitted with the technology. The registered new light vehicles became the denominator in the break-even cost calculations. Australian break-even costs based on vehicles entering the fleet over 2011 to 2020 are presented in Appendix N for each technology scenario by vehicle market group and jurisdiction.

Table 21 shows a summary of the estimated break-even costs for the technologies considered for Australia and New Zealand. The range shown in Australia is based on the different penetration and baseline projection scenarios considered. The range shown for the New Zealand is based on using 6% and 4% discount rates for the injury savings. The Australian and New Zealand estimates are not directly comparable since the New Zealand estimates were calculated were based on crash cost savings over 20 years (with the mean crash savings value estimated to be the 2020 projection) compared to the Australian figures which are derived over a ten year period so are likely to be only half as large. The New Zealand estimates and are also based on crash costs valued using the willingness to pay methodology which values crash savings at a much higher value compared to the human capital costs used in the Australian analysis.

Table 21 : ***Summary of estimated break-even costs (present value 2010 $AUS and 2011 $NZ), for monetised benefits in terms of injuries prevented over a 20-year period.***

	Australia ($AU)	State ($AU), model 1B		New Zealand ($NZ)
Safety System	Range	Worst	Best	Range (6%-4% discount)
Autonomous Emergency Braking-All Speeds	60-130	60 VIC	160 WA	620-740
Autonomous Emergency Braking >=80km/hr	20-43	20 NSW	30 WA	320-380
Lane Departure	3-7	3 NSW,QLD	11 WA	130-160
Fatigue	20-40	20 VIC	50 WA	370-440
Lane Change	7-16	8 VIC	16 WA	50-60
ESC	250	180 VIC	480 WA	620-740

The scenario that produced the highest break-even cost in Australia was fitting ESC to commercial vehicles, with about AU$260 in crash savings per fitted vehicle. The *AEBS at all speeds* scenario produced the next best value per vehicle (AU$60-$130). Break-even costs were less than AU$100 per registered vehicle in the remaining scenarios. Although significantly higher in absolute value, the break-even costs for each technology in the New Zealand estimates showed the same order of relative value. Even using a higher cost basis and longer time frame for benefits, the estimated break even costs were less than NZ$750 per vehicle for all technologies.

To achieve cost beneficial fitment, the costs of the technologies should ideally be comparable with the break-even costs shown in Table 21. This presents a rational basis on which to prioritise efforts to have particular technologies adopted. However, the determination of costs is difficult for several reasons. Firstly, the more widespread the technology, the more there are economies of scale that lead to reduced costs. So per-unit real costs are likely to fall in the future. Secondly, technologies can be based on similar systems, with a combination of technologies costing marginally more than a single technology. A good example of this is ESC that makes use of the automated braking technologies used in ABS.

Anderson et al. (2011) estimated costs per vehicle of the following technologies as follows: AU$2,700 for forward collision avoidance technologies; AU$1,400 for LCWS; AU$1,500 for FWS; AU$1,000 as a minimum for ESC; AU$1,400 for LDWS. Although some of the break-even costs shown in Table 21 come closer to these costs (e.g. ESC), most technologies would not be considered cost-beneficial based on the criteria used in this study. On the assumption that future costs of the technologies will be reduced, as discussed above, the results shown in Table 21 do provide a basis for prioritising effort to encourage the adoption of the technologies with the greatest potential. This study indicates that forward collision avoidance technologies and ESC merit more effort in this regard than the other technologies considered.

8 SUMMARY

Analysis in this study has identified a strong trend to improving secondary safety of the light vehicle fleet ratings over the crash years 2000 to 2010 in all the jurisdictions studied. Over the years 2000 to 2010, the average crashworthiness of the Australian light vehicle fleet has improved by 27% representing a saving of around 2,000 deaths over the time period. Improvement in the crashworthiness of New Zealand fleet has also been significant with an improvement in average crashworthiness of 18%. This equates to a saving of 313 lives over 2000-2010. These can be largely attributed to gradual penetration of safer newer vehicles into the fleet; however patterns in the overall age profile of vehicles, and the trends in market group mix also play their part.

The future expected trend in light vehicle secondary safety due to these same factors was estimated to 2020, using fatal and serious injuries projections for passenger vehicle injury crashes. Future crashworthiness improvements were modelled under two scenarios: stalled at 2010 new vehicle levels and improving at the current trends for new vehicles entering the fleet. Future trauma savings due to vehicle secondary safety improvement were estimated by comparing the projected safety of the 2020 fleet to that of 2010.

The saving in fatal and serious injuries through projected future improvement in secondary safety of the Australian light vehicle fleet in 2020 compared to 2010 was 950 under the scenario of *stalled crashworthiness* and 1,470 if crashworthiness continues to improve according to past trends (*business as usual*). These benefits result from improvements in secondary safety of 25% and 38% respectively in 2020 compared to 2010. The annual economic benefit of these reductions was estimated to be between AU$815M and AU$968M. The corresponding fatal and serious injury improvements in the New Zealand fleet from 2010 to 2020 were estimated to be 18% and 20% respectively. If New Zealand crashworthiness improvement trends continue as in the past over the period 2010-2020, there are predicted to be aggregate savings of 1,002 fatal and serious casualties to light passenger vehicle occupants due to crashworthiness improvements relative to the years 2010 to 2020 representing an economic saving of between NZ$500M and NZ$600M respectively.

Further savings to fatal and serious injury counts may be made through fitment of emerging crash avoidance technologies to vehicles. The fatal and serious injuries prevented by these technologies were estimated for each year from 2010 to 2020 as newly manufactured vehicles with these technologies fitted penetrate the market. The penetration of safety technology was estimated by examining fitment rates in vehicles new to the fleet, at each vehicle year of manufacture for each crash year. The savings to fatal and serious injuries from these vehicles entering the fleet associated with technology fitment was estimated for AEBS, ESC, FWS, LDWS and LCWS. The savings associated with fitment of the selected safety technologies were on top of those expected purely through projected improvements to vehicle secondary safety.

In Australia, AEB operational at all speeds was the technology estimated to result in the largest savings in fatalities and serious injuries from light vehicle crashes with savings of between 5% and 10% possible in 2020 relative to 2010 depending on whether the technology is mandated or allowed to penetrate gradually due to market forces. Limiting AEB effectiveness to only high speed crashes (80km/hr or more) showed reductions of only 1.5%-3.1%. ESC for commercial vehicles was also estimated to have large potential benefits with reduction in fatal and serious injuries of between 4.5% and 5.7%. ESC will be mandated in light commercial vehicles in Australia from 2016. Potential fatal and serious injury savings from the remaining technologies were much smaller with estimated savings of 1.5% and 3.2% for FWS, 0.6% and 1.2% for LCWS/BSWS and 0.2%-0.5% for LDWS over a ten year period.

Projected absolute and relative effectiveness of these technologies in the New Zealand fleet were similar to that estimated for Australia. The only exception was for ESC which had estimated benefits similar to AEB in New Zealand reflecting that there is currently no mandate for ESC in any light vehicles in New Zealand.

Estimated possible injury savings for each technology were converted to community cost savings and related to the number of vehicles in the fleet required to be fitted with the technology. From this, a break-even cost was estimated to determine the expenditure per vehicle possible before the cost of trauma savings made equalled the cost of fitment. This estimate also represents the average trauma savings per fitted vehicle. Break-even costs estimated were different for Australia and New Zealand largely reflecting the different basis on which community costs from road crashes are calculated between the two countries.

ESC for commercial vehicles in Australia and all vehicles in New Zealand had the highest break-even value: AU$250 in Australia and NZ$620-NZ$740 in New Zealand. AEBS at all speeds also had the next highest break-even value, equivalent to ESC in New Zealand and between AU$60 and AU$130 in Australia depending on the fleet penetration rate. The break-even value for high speed AEB (>=80km/hr) and FWS was similar at AU$20-AU$40 in Australia and NZ$370-NZ$440 in New Zealand. The break-even point for the remaining technologies, LDWS and LCWS/BSWS were AU$16 or less in Australia and less then NZ$160 in New Zealand.

The savings estimated for individual safety technologies are not summative because crashes may be sensitive to more than one technology. The largest overlap in crash effects is likely to be between *FWS, LDWS* and *ESC*. Future studies need to focus on the interaction of these three technologies in crash prevention, and to specifically measure their effectiveness in combination as more vehicles enter the fleet with combinations of these technologies.

One limitation of the current study is the estimates of the crash effects of a number of the emerging technologies considered have not been derived from post-hoc evaluation of the technology in real world application. Instead they have been estimated prospectively through the analysis of crash causation factors to identify crashes that are likely to be prevented by the technology given its documented operation. ESC and low speed AEB have been evaluated retrospectively using real world crash data however the remaining technologies have not. Estimates of the projected effects of these technologies on overall road trauma as presented in this report need to be revisited as post-hoc evaluation of the real world effectiveness of these technologies becomes available. Undertaking these evaluations as early as possible is recommended.

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10 APPENDIX A1 – CRASH DATA AND DATA MANAGEMENT

Australian Crash Data

Table A1.1: ***Cases in Australian Police reported crash data, by crash year and jurisdiction (2000-2010).***

Year of Crash	NSW	QLD	SA	VIC	WA
2000	104,546	34,466	88,076	48,822	78,467
2001	103,319	58,271	87,696	45,160	76,745
2002	99,267	43,968	86,228	45,508	73,928
2003	97,167	44,194	66,289	45,094	73,202
2004	93,240	46,027	49,157	43,075	76,481
2005	89,735	45,011	46,324	42,426	78,968
2006	88,935	43,716	45,026	33,186	80,133
2007	88,991	44,976	47,244	33,828	83,912
2008	83,565	46,204	47,481	33,343	79,368
2009	83,777	44,818	47,064	35,264	75,423
2010	83,351	Not Available	48,492	33,613	90,975
Total	1,015,893	451,651	659,077		867,602

In every state, a *case* (data line) could represent a driver of a vehicle, a passenger of a vehicle or a pedestrian. Vehicles included planes, trains, trams, motor vehicles, motor cycles, agricultural vehicles, plant equipment, horse drawn vehicles, horses and bicycles. In addition a case could be a towed device (Queensland, New South Wales, Western Australia), a driver of a motorised wheel-chair (New South Wales, South Australia, Western Australia), an animal (Queensland, South Australia), a rider of a manual scooter (Western Australia) or even an object or obstruction such as a pole, bridge or tree (South Australia).

New South Wales, Queensland, South Australia and Western Australia crash data records were for crashes that resulted in death or injury or a vehicle being towed away. Western Australia and South Australia data records also included crashes where property damage was greater than a defined sum (which was defined as $3,000 after July 1 2003).

Crashes are reported to the Police in Victoria if a person is killed or injured, if property is damaged but names and addresses are not exchanged, or if a possible breach of the Road Traffic Regulations has occurred. This means that uninjured records from the Victorian data are incomplete and only crashes involving injury are reliably reported in Victoria.

Australian Crash Data Management

Data preparation first involved creating a single data set for each jurisdiction. Consistency was created in variable names and formatting to enable crash year merging. Model coding ('modelh, wmodel, vinmodel) and market groups were merged onto the jurisdictional data from the *UCSRs* data. Market group assignment was then updated to the 2010 groupings.

Universal variables across all jurisdictions were created prior to merging the passenger vehicle data for the five states into a single dataset. This included information specific to a passenger vehicle, such as counts of injured occupants by severity, as well as information specific to a crash. Sometimes this information was not available for all states. For example, the total number of occupants (and passengers) in a vehicle could not be known for Victoria, where only the number of persons involved in the crash was provided.

Whilst the data set used in this project consisted only of passenger vehicles, *crash* information on injuries to involved pedestrians and occupants or riders of other involved vehicles was maintained. The injured persons of the injury crash may have included cyclists, horse riders, motorcyclists, pedestrians and occupants of non-passenger vehicles such as tractors, trucks and prime movers. All cases were defined by the occupant as: ‘Controller’, ‘Passenger, ‘Pedestrian’, ‘vehicle with no occupants’ or ‘Non-vehicle unit such as tree, pole or trailer’. Pedestrians included people on skates, skateboards, manual scooters and riding motorised wheelchairs.

Total injuries, by severity for each crash were counted. New South Wales only provided two severity categories: injured and fatal. In the Queensland 2000 crash data, many crashes had a crash severity listed but no case severities, so this data could not be used in analysis where driver, passenger and pedestrian injuries were counted. Some assumptions were made to extract approximate injury numbers for this crash year.

In addition crash information also included vehicles per crash and counts of various crash types, including those in which at least one vehicle was towed were identified. Crash location (except for Queensland) as rural, remote or metropolitan was also identified. Crashes with parked vehicles (listed as cases in the crash data) were considered to be multi-vehicle crashes.

Single vehicle driver injury crashes were identified as sensitive to ESC technology. Crashes sensitive to the emerging technologies of the scenarios presented above were identified in all states except for South Australia because the data did not include a similar road user movement crash coding variable. Speed zones >=80km/hr were identified for forward collision and lane keeping technology sensitivity. Illegal speeding, driver fatigue, drivers over the alcohol limit and crashes on roads with edge line marking needed to be identified so that crashes sensitive to emerging technologies could be identified. Illegal speeding was able to be identified only for New South Wales, South Australia and Western Australia. Exceeded driver BAC limits were identifiable only for Queensland, South Australia, Victoria and Western Australia. Fatigue as a factor was only present in the Western Australia data. Identification of crashes at roads with edge line marking could be estimated with the use of various variables in all jurisdictions. Highways and expressways could be identified: for New South Wales and South Australia as divided roads and dual freeways; for Victoria and Queensland as divided roads, and for Western Australia as highways from the highway coding or highway road name. In addition, Victorian roads with edge lines were also identified by a road type variable: *BYPASS, FREEWAY, FREEWAY CN, FREEWAY EAST, FREEWAY WEST, HIGHWAY, HIGHWAY EAST, HIGHWAY WEST* and *TOLLWAY*; and by a variable called mel_hier: *AH, F, FW*. In Western Australia roads with edge lines were identified by strings within the Road Number, Intersection Road Names, Cross Road Name and Road Name variables. If the first four characters of the Road Number were '000H' or the first character was ‘H’, or the letters ‘HWY’ or ‘FWY’ appeared in the road names, then the crash was selected.

Driver and vehicle age at the time of crash were calculated and grouped so that older driver and younger driver crashes were identified. Age groupings were chosen to match those used in other MUARC studies.

Obviously to reduce a state data set to only passenger vehicles, it was essential to correctly identify vehicle type as passenger vehicles, motorcycles, heavy vehicles, other motor vehicle types (e.g. agricultural vehicles, fork lifts and plant vehicles), unknown motor vehicles and unknown case types. For the most part, make, model and body could be used to distinguish motor vehicles from non-motor vehicle cases, and passenger vehicles from heavy vehicles. However, when this was not possible, other methods to identify heavy vehicles were possible. Tare weight was a crash variable in Western Australia and Queensland data, and when present, vehicles with a weight greater than 3.5t were assigned as heavy vehicles. This was because light commercial vehicles (<=3.5t) were included in the passenger vehicle classifications. In New South Wales vehicles with a tare of >= 4.5t could identified as heavy vehicles. Unit type variables were also used to identify other heavy vehicle types, for example: 'Semi Trailer', 'Rigid Truck Large' 'BDouble', 'Road Train', 'Arctic Tanker', 'Rigid tanker', 'Coach', and 'Omnibus'. If still it was still not clear whether a vehicle was a passenger vehicle or a heavy vehicle, body type was looked at for New South Wales, Queensland and Western Australia. The body variable enabled identification of some heavy vehicle types; for example in Western Australia, tow truck classes could be identified by body shape then gazetted information could be used to find a tare weight range. Vehicles that could be identified as motor vehicles but not identified as motor-cycles, passenger, heavy vehicles or 'other motor vehicles' (agricultural and plant vehicles) were classed as *unknown motor vehicles*. Cases that could not even be identified as non-motor-vehicle or motor vehicle units were classified as *unknown units.*

Data for each state was reduced to just passenger vehicle crashes; motor vehicles of unknown type and unknown case types were included because they were likely to a) be passenger vehicles b) small in number and c) if they had no year of manufacture would be excluded from this analysis anyway.

The passenger vehicle crash data for each state was reduced to just those involved in injury crashes. Any vehicle without a market group but with a VIN was then decoded using the VIN decoding files used in the 2010 *UCSRs*. Any vehicle, still without a market group but with model information was manually decoded. This decoding was done using a modified version of manual decoding syntax used in the 2010 *UCSRs* which allowed for vehicles manufactured prior to 1982. When no market group was assigned, a vehicle with a panel van or utility body type was assigned as a commercial van or commercial utility respectively, unless other variables conflicted, for example: Western Australia data cases where *body* contained 'ute' and *uttypcd* contained 'wagon' or 'van'. The market group was left as unknown if other variables identified the vehicle as an SUV or wagon. The market group was left as unknown if the vehicle was a van or truck and no tare information was present. It is clear this method favours market group assignment success for vans and utilities, over that for sedans; however, the unknown market group has been included in the analysis. Furthermore, it is acknowledged that the unknown market group consists largely of sedans (Table A1.3).

Table A1.2 displays an analysis of missing information within the crashed passenger vehicle injury crash data. Cases of passenger vehicles without an assigned market group had no reliable information available for vehicle model. Vehicles with a year of manufacture but without a market group consisted mostly of passenger cars, station wagons or hatches. Vehicles without a year of manufacture, usually also had no make, model or body type listed.

In Queensland, Victoria and Western Australia, a large proportion of these could not even clearly be identified as passenger vehicles.

Table A1.2: ***Passenger (and unknown) vehicles by state and crash year.***

		NSW	QLD	SA	VIC	WA
Year of Crash	2000	87,846	30,846	73,981	28,096	68,401
	2001	87,160	47,696	73,305	26,057	67,022
	2002	83,682	35,049	71,883	26,303	64,590
	2003	82,203	35,523	54,095	26,072	64,237
	2004	78,663	37,047	38,225	24,992	67,141
	2005	75,462	36,098	35,675	24,247	69,327
	2006	74,979	35,089	34,621	18,967	70,146
	2007	74,809	35,650	36,371	19,086	73,812
	2008	70,105	36,458	36,628	18,823	69,186
	2009	70,268	35,628	36,731	19,626	65,423
	2010	70,061		38,121	19,317	70,950

	% Unknown motor vehicle type					% Unknown unit type				
	NSW	QLD	SA	VIC	WA	NSW	QLD	SA	VIC	WA
2000	.09%	.54%	7.92%	1.67%	.000%	.008%	.000%	.000%	.000%	2.66%
2001	.12%	3.07%	7.31%	2.20%	.000%	.001%	.377%	.000%	.000%	2.43%
2002	.10%	.72%	7.34%	2.65%	.000%	.006%	.220%	.000%	.000%	1.03%
2003	.18%	.74%	6.03%	1.81%	.000%	.002%	.146%	.000%	.000%	.93%
2004	.21%	.95%	2.00%	1.41%	.000%	.004%	.173%	.000%	.000%	1.16%
2005	.16%	5.40%	.60%	1.33%	.000%	.000%	.094%	.000%	.000%	3.20%
2006	.14%	.000%	.93%	1.01%	.000%	.000%	.128%	.000%	.005%	3.21%
2007	.18%	.02%	.77%	1.15%	.000%	.001%	.132%	.000%	.005%	3.57%
2008	.14%	.003%	.94%	1.16%	.000%	.000%	.173%	.000%	.000%	3.87%
2009	.19%	.003%	1.17%	1.05%	.000%	.001%	.152%	.000%	.000%	4.11%
2010	.23%		.92%	1.51%	.000%	.000%		.000%	.005%	4.87%
TOTAL	0.2	1.2	4.2	1.6	-	0.0	0.2	-	0.0	2.9

TableA1.3: ***Analysis of missing information for Passenger (and unknown) vehicles involved in an injury crash by state and crash year (YOM= Year of Manufacture).***

Injury crash passenger vehicles					
	NSW	QLD	SA	VIC	WA
All	338,969	208,391	120,530	251,545	211,238
WITH YOM AND MKTGRP	256,025	175,528	97,705	139,927	168,041
YOM AND NO MKTGRP	75,516	1,194	17,232	99,826	8,211
NO YOM	7,428	31,669	5,594	11,792	34,986
% with no YOM or no market group	25.0	18.6	19.9	46.6	24.5
<u>Analysis of those with YOM but no market group</u>					
% car, station wagon or hatch	78	93	91	98	96
% ute/van	0.0	1.8	0.1		1.6
% unknown motor vehicle	0.7	0	0	1.2	0.3
<u>Analysis of those with no YOM</u>					
% with MODEL information	0.0	0.2	0.0	0.7	4.4
% with market group	0.0	0.1	0.0	3.9	4.5
% with MAKE	67	0.2	0.2	6.1	4.7
% with listed BODY	0.0	0	n/a	n/a	4.7
% unknown motor vehicle	0.6	6.3	37.5	23.7	10
% unknown unit	0.1	0.7	0.0	0.0	0.0

Table A1.4 displays the portion of injury crash involved passenger vehicles with a valid year of manufacture which was able to be decoded into a market group. In Victoria, where low percentages were identified, the vehicles with unknown market groups were found to have no recorded information on model and make.

Table A1.4: ***Proportion with market groups identified for Passenger (& unknown) vehicles, with a known year of manufacture, involved in injury crashes, by state and crash year.***

Crash Year	NSW	VIC	QLD	WA	SA
2000	83%	70%	99%	91%	77%
2001	87%	41%	99%	92%	81%
2002	87%	46%	97%	92%	84%
2003	64%	46%	100%	92%	86%
2004	72%	50%	100%	93%	88%
2005	76%	86%	100%	95%	90%
2006	72%	83%	100%	98%	92%
2007	65%	43%	100%	98%	93%
2008	89%	47%	100%	99%	94%
2009	89%	48%	100%	98%	68%
2010	66%	87%	100%	99%	84%

For the purposes of data analysis, only passenger vehicles involved in injury crashes with a known year of manufacture were used. Vehicle counts by crash year are presented in Table 1. Since most of the unknown market groups were large, medium or small cars, they have been included in the analysis data set.

Table A1.5 demonstrates the market group distribution of the injury crash involved passenger vehicle set with known market group and year of manufacture.

At this stage, 2010 crashworthiness data: crashworthiness, aggressivity and total safety ratings, were merged onto the data for models with a year of manufacture >=1982. In addition, when there was no model data, crashworthiness, aggressivity and total safety ratings by market group and year of manufacture were merged for years of manufacture from 1982-2010. Finally for the remaining vehicles (without market information) manufactured from 1964, crashworthiness, aggressivity and total safety ratings by year of manufacture were merged. Vehicles without a year of manufacture were discarded from analysis.

Aggressivity ratings by market group and year of manufacture were only available up to a 2000 year of manufacture: a four wheel drive market group average was used for all SUVs, a commercial average was used for both vans and utilities, the small market group was used for light vehicles, and all market group averages excluded luxury and sport vehicles.

Table A1.5A: ***Proportions of market groups for passenger (and unknown) vehicles with a known year of manufacture and known market group, involved in injury crashes by state and crash year*** *(commercials and SUVs).*

		NSW	QLD	SA	VIC	WA
Commercial - Ute	2000	7.6	10.3	5.4	8.4	7.6
	2001	7.0	10.0	5.1	14.3	7.7
	2002	7.3	11.0	5.6	12.6	7.9
	2003	6.3	11.0	6.1	14.4	7.8
	2004	6.3	11.9	6.7	14.4	8.3
	2005	8.6	12.4	6.8	8.7	9.1
	2006	8.9	12.7	6.7	9.1	9.1
	2007	9.4	13.8	7.0	18.5	9.6
	2008	8.7	14.3	7.4	16.9	10.0
	2009	8.6	14.7	8.7	18.5	10.3
	2010	10.4		8.4	10.3	10.5
Commercial - Van	2000	3.5	2.8	2.1	4.7	2.6
	2001	2.9	2.8	2.2	8.2	2.3
	2002	2.7	2.8	2.0	5.3	2.3
	2003	3.3	2.5	2.1	5.3	2.2
	2004	3.0	3.0	2.1	5.7	2.1
	2005	3.0	2.8	2.0	3.7	2.1
	2006	2.9	2.7	2.0	4.5	1.9
	2007	3.0	2.6	2.2	7.3	2.0
	2008	2.6	2.8	2.2	6.8	2.0
	2009	2.6	2.5	2.4	6.3	1.9
	2010	2.8		2.2	3.3	1.7
SUV - Large	2000	2.4	4.7	2.6	3.0	5.1
	2001	2.7	4.4	2.4	4.2	5.1
	2002	2.7	4.4	2.5	4.1	4.8
	2003	0.6	4.6	2.4	3.9	5.0
	2004	2.4	4.6	2.5	3.8	5.1
	2005	2.7	4.9	2.4	2.8	5.1
	2006	2.6	4.7	2.5	2.8	4.8
	2007	2.8	4.6	2.5	3.9	4.9
	2008	2.3	4.5	2.6	3.3	4.6
	2009	2.4	4.7	2.5	3.6	4.7
	2010	2.6		2.8	3.2	4.4
SUV - Medium	2000	1.1	1.6	1.3	1.2	1.6
	2001	1.2	1.8	1.4	1.8	1.7
	2002	1.4	2.0	1.5	1.7	1.8
	2003	0.3	2.3	1.5	2.1	2.1
	2004	2.0	2.4	1.7	2.4	2.3
	2005	2.2	2.5	2.0	1.7	2.6
	2006	2.4	2.8	2.1	2.1	2.9
	2007	3.0	3.3	2.3	3.5	3.2
	2008	2.7	3.6	2.5	3.8	3.6
	2009	2.8	3.9	2.9	4.3	4.0
	2010	3.7		3.1	3.4	4.7
SUV - Compact	2000	1.8	1.6	1.5	1.4	1.8
	2001	2.2	1.8	1.6	1.8	2.2
	2002	2.4	2.1	1.9	2.0	2.4
	2003	0.6	2.4	2.1	2.7	2.6
	2004	3.7	2.8	2.5	2.8	2.9
	2005	4.0	2.8	2.8	2.8	3.6
	2006	4.4	3.5	2.9	3.3	3.6
	2007	4.7	3.7	3.2	3.6	4.0
	2008	4.5	4.4	3.6	4.1	4.6
	2009	4.9	4.8	3.8	4.1	4.8
	2010	5.4		3.8	4.1	5.8

Table A1.5 B: ***Proportions of market groups for passenger (and unknown) vehicles with a known year of manufacture and known market group, involved in injury crashes by state and crash year*** *(other passenger vehicles).*

		NSW	QLD	SA	VIC	WA
People Mover	2000	1.7	1.3	1.4	0.8	1.1
	2001	1.8	1.5	1.3	0.8	1.1
	2002	1.7	1.2	1.3	0.9	1.2
	2003	1.8	1.4	1.3	1.0	1.2
	2004	1.7	1.1	1.2	0.9	1.2
	2005	1.6	1.2	1.1	0.8	1.4
	2006	1.8	0.9	1.1	1.0	1.3
	2007	1.8	1.1	1.2	1.0	1.4
	2008	1.6	1.1	1.1	1.1	1.3
	2009	1.7	1.1	1.1	1.1	1.3
	2010	1.7		1.1	1.0	1.3
Large	2000	32.7	33.5	41.0	40.2	32.6
	2001	32.7	33.6	40.9	35.7	32.3
	2002	32.8	33.0	40.9	37.9	31.7
	2003	35.7	32.8	39.8	34.9	31.4
	2004	32.8	31.9	39.9	34.9	30.9
	2005	31.1	31.3	39.3	38.7	30.4
	2006	29.2	30.8	38.6	37.3	30.4
	2007	29.4	29.5	37.7	29.8	29.6
	2008	28.1	27.6	36.2	29.4	28.3
	2009	27.0	26.9	35.0	27.8	27.9
	2010	26.3		34.4	32.7	26.8
Medium	2000	16.5	15.5	14.0	14.6	14.2
	2001	15.8	15.0	13.8	11.1	13.5
	2002	15.2	13.7	13.2	11.9	12.8
	2003	14.7	13.7	12.9	11.0	12.3
	2004	14.1	12.4	12.2	11.0	11.6
	2005	13.4	11.8	12.0	12.4	10.8
	2006	12.8	10.7	11.5	11.9	11.1
	2007	12.3	10.0	11.3	9.5	10.2
	2008	12.6	9.3	11.1	9.9	9.8
	2009	12.1	8.8	10.7	9.4	9.4
	2010	11.1		10.5	10.1	8.8
Small	2000	25.7	22.8	22.7	20.8	26.1
	2001	26.5	22.9	23.5	18.4	26.9
	2002	26.8	23.4	23.8	20.0	28.0
	2003	29.7	23.1	24.4	20.7	28.3
	2004	27.3	23.6	23.9	19.8	28.3
	2005	26.7	23.2	24.5	23.0	27.8
	2006	27.8	23.5	25.3	22.3	27.5
	2007	26.3	23.8	24.9	18.8	27.2
	2008	28.6	24.0	25.3	20.0	27.2
	2009	29.0	24.0	25.0	19.7	26.9
	2010	27.8		26.0	24.5	26.7
Light	2000	6.9	6.0	8.0	4.9	7.3
	2001	7.2	6.2	7.7	3.8	7.2
	2002	6.8	6.4	7.3	3.7	7.1
	2003	6.9	6.2	7.4	4.0	7.1
	2004	6.8	6.2	7.3	4.2	7.3
	2005	6.6	7.0	7.1	5.4	7.1
	2006	7.2	7.6	7.4	5.8	7.5
	2007	7.5	7.7	7.7	4.2	7.9
	2008	8.3	8.4	8.0	4.8	8.4
	2009	8.8	8.5	8.0	5.2	8.7
	2010	8.2		7.8	7.4	9.3

Australian Crash Data Profiles

TableA1.6: ***Average number of vehicles (all types) per crash for passenger vehicles (with YOM) injury crashes (2000-2010) by jurisdiction.***

Year of Crash	NSW	QLD	SA	VIC	WA	Australia
2000	1.79	1.84	1.85	1.84	1.96	1.84
2001	1.80	1.80	1.84	1.81	1.96	1.83
2002	1.80	1.81	1.82	1.79	1.91	1.82
2003	1.80	1.82	1.85	1.81	1.91	1.83
2004	1.82	1.82	1.82	1.81	1.91	1.83
2005	1.81	1.82	1.77	1.81	2.01	1.84
2006	1.80	1.81	1.81	1.75	1.94	1.82
2007	1.82	1.82	1.82	1.76	1.95	1.83
2008	1.80	1.83	1.85	1.76	1.94	1.83
2009	1.80	1.82	1.84	1.72	1.95	1.82
2010	1.83		1.86	1.75	1.99	1.85
all years	1.81	1.82	1.83	1.79	1.95	1.83

Table A1.7: ***Average number of passenger vehicles (with YOM) involved in injury per crash for passenger vehicles (with YOM) injury crashes (2000-2010) by jurisdiction.***

Year of Crash	NSW	QLD	SA	VIC	WA
All years	1.66	1.59	1.69	1.63	1.65
2000	1.64	1.55	1.70	1.69	1.61
2001	1.66	1.59	1.70	1.66	1.62
2002	1.66	1.59	1.68	1.64	1.69
2003	1.67	1.60	1.72	1.65	1.68
2004	1.67	1.60	1.67	1.66	1.67
2005	1.66	1.60	1.64	1.60	1.59
2006	1.65	1.58	1.66	1.59	1.71
2007	1.67	1.58	1.68	1.59	1.65
2008	1.65	1.59	1.71	1.59	1.69
2009	1.65	1.59	1.69	1.57	1.64
2010	1.68	.	1.72	1.60	1.61

Table A1.8: ***Average number of occupants in passenger vehicles (with YOM) involved in injury per crashes (2000-2010) by jurisdiction and market group for 2010 (2009 in Queensland).***

	NSW	QLD	SA	WA	4 states
People Mover	1.94	2.21	2.12	2.31	2.11
SUV-Large	1.58	1.65	1.59	1.57	1.61
SUV-Medium	1.62	1.70	1.72	1.74	1.69
SUV-Compact	1.45	1.48	1.50	1.58	1.50
Large	1.53	1.57	1.58	1.56	1.56
Medium	1.39	1.41	1.44	1.41	1.41
Small	1.39	1.43	1.39	1.41	1.41
Light	1.35	1.37	1.34	1.37	1.36
Commercial - Ute	1.29	1.27	1.31	1.31	1.29
Commercial - Van	1.32	1.38	1.32	1.36	1.35
Unknown	1.45	1.33	1.54	1.54	1.47

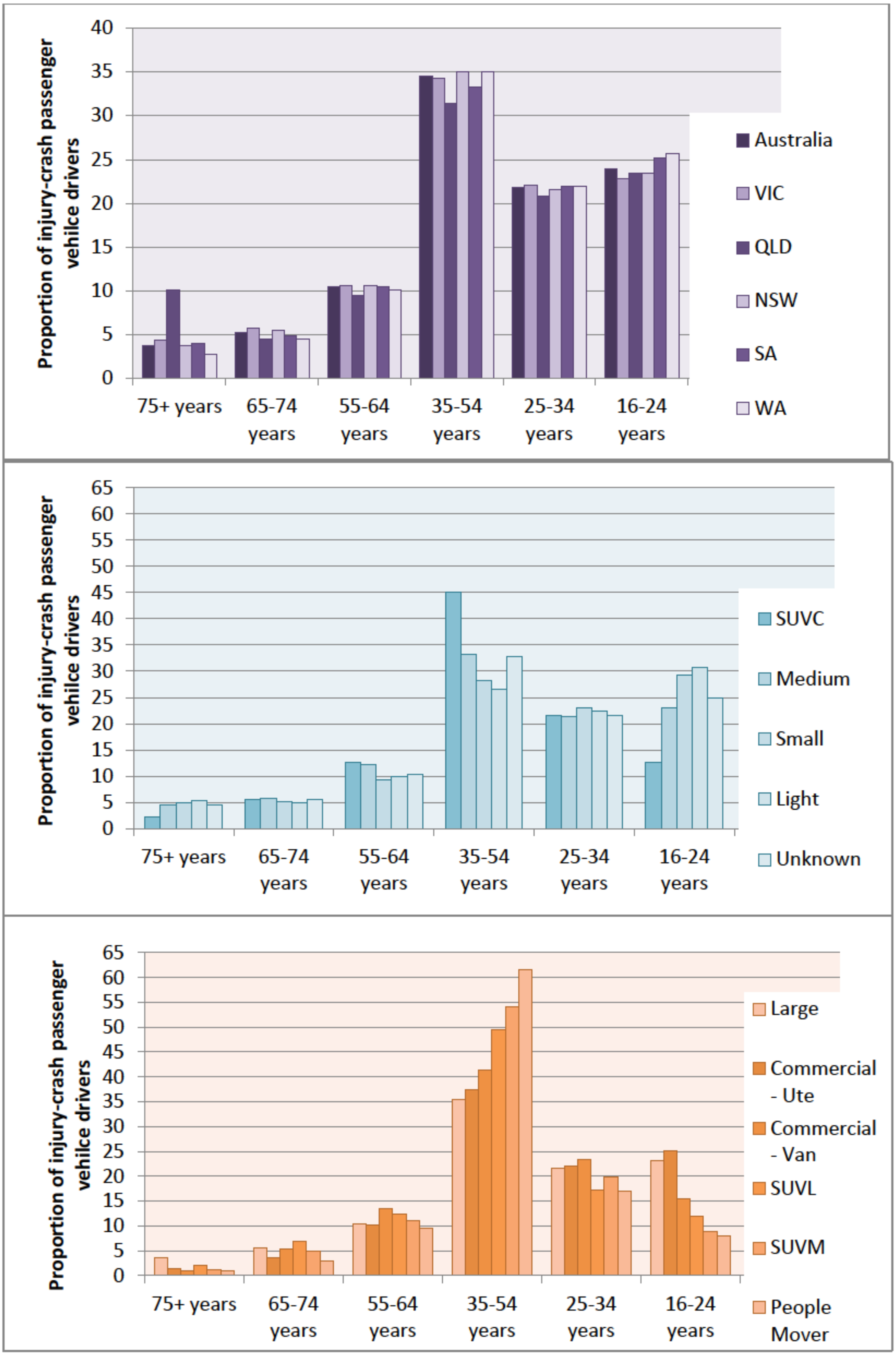


Figure A1.1: ***2010 Proportions of drivers of injury-crash passenger vehicles within age groupings, for Australia, and by jurisdiction or market group.***

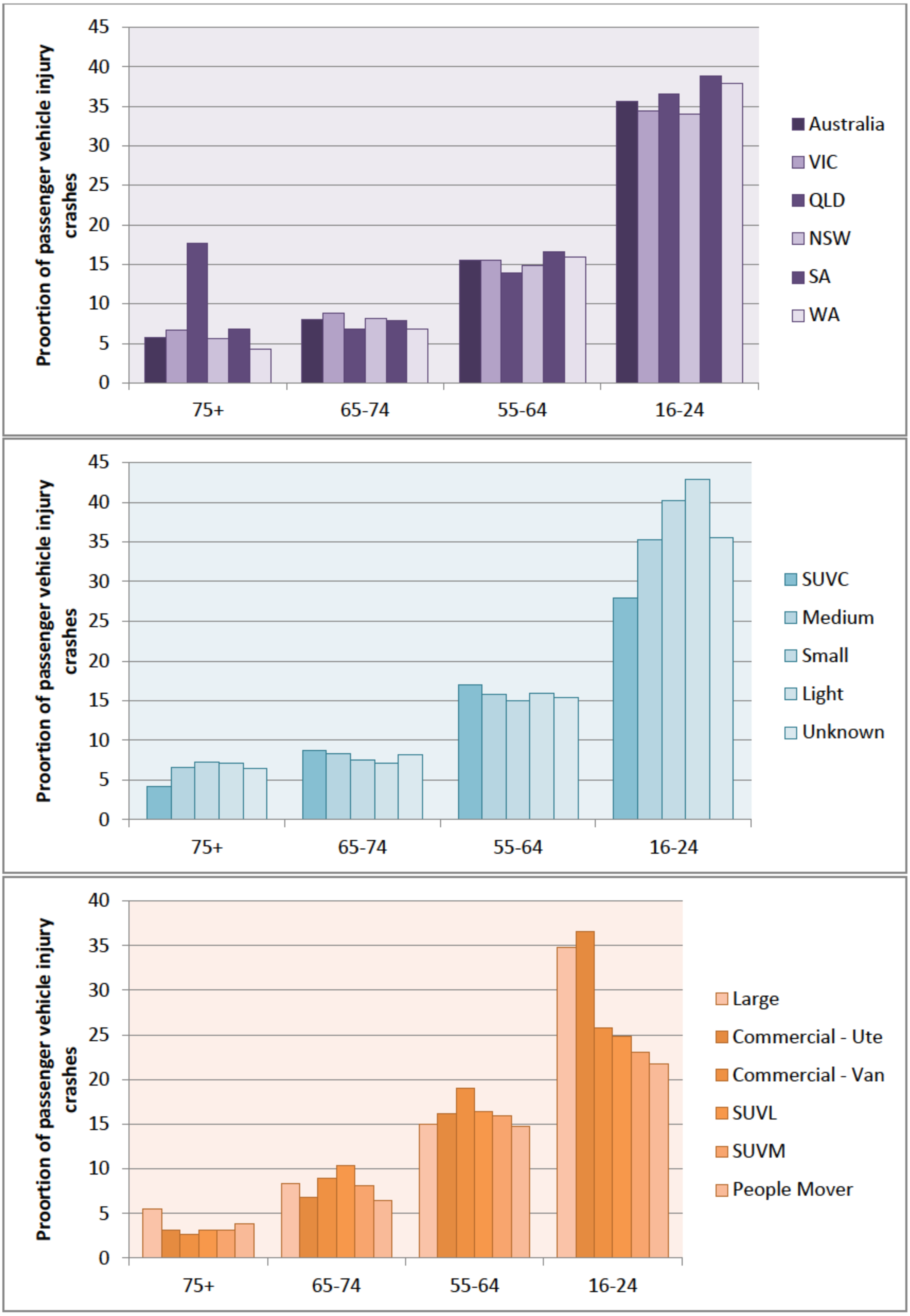


Figure A1.2: ***2010 Proportion of passenger vehicle injury crashes that involve young or old drivers, for Australia, and by jurisdiction or market group.***

Figure A1.2 examines driver age profiling of crashes. Each vehicle crash was coded according to the age of the involved drivers. If a young driver was involved, the crash was labelled a young driver crash. If an older driver was involved, the crash was labelled as an older driver crash. It was possible for a crash to be both a young and an older driver crash if it involved more than one vehicle. By jurisdiction, similar proportions of crashes were seen for the three youngest age groupings, with the same exception as was seen for crashed vehicle driver age distribution: Queensland presented a higher proportion of 75+ drivers involved in injury crashes. A similar pattern of driver age was observed in market group disaggregated injury crash data, as was observed for the crashed vehicle data of Figure A1.1.

11 APPENDIX A2 – CRASH COSTS

Australian Crash Costs

The BITRE (2009) produced two separate average cost estimates. The first was the average cost of crashes, disaggregated by jurisdiction and crash severity (fatal crash, serious injury crash, minor injury crash and property damage-only crash). The other set of estimates gave the total jurisdiction injury cost, disaggregated by severity (fatality, serious injury, minor injury and vehicle related costs). Presented in Table A2.1, these costs are totalled for both the whole of Australia and also the five states of this analysis.

Table A2.1: ***Estimated social cost of road crashes by cost type and jurisdiction, million dollars, 2006 (BITRE, 2009).***

	Fatalities	Serious injuries	Minor injuries	Vehicle and general costs
NSW	1,187	2,183	150	2,216
Victoria	817	1,761	121	1,731
Queensland	828	1,280	88	1,353
South Australia	275	513	35	519
Western Australia	481	535	37	622
5 states	3,589	6,271	430	6,442
Australia	3,842	6,680	458	6,869

The general and vehicle related costs of Table A2.1 are the non-human costs and include the cost of repair, towing and (un)availability of the damaged vehicles, costs to society related to traffic congestion caused by the crash (delays, pollution, additional vehicle operating costs), cost of emergency service response, cost of repair of street furniture and insurance administration costs. The general and vehicle related costs that could be assigned to passenger vehicles of injury crashes were determined. BITRE listed the cost of a property damage only (PDO) crash in 2006 in Australia as, $9,942 and the number of PDO crashes in 2006 as 438,700. Multiplying these two figures gives the cost of PDO crashes in 2006 as $4,361,555,400. BITRE also gives the Australian 2006 vehicle related costs as $6,869,100,000. By subtraction, vehicle related costs assigned to injury crashes are $2,507,540,000. However this figure includes motorcycles and heavy vehicles. BITRE gives passenger vehicles as making up 91.70% (408,015) of their total Australian 2006 figure of (444,932) vehicles involved in fatal and injury crashes; 91.7% of $2,507 540,000 is $2,299,490,00.

It is not known how the general costs differ with severity of injury; however an approximation using proportions has been applied to estimate the general costs per injury type. The proportion of total vehicle related costs by state was applied to the total Australian passenger vehicle related costs associated with fatal and injury crashes to apportion the cost by jurisdiction. Then as a rough estimation of the general and vehicle related costs per injury type, the proportion of injury costs for each injury type for each jurisdiction (from Table A2.1) was applied to the passenger vehicle related costs associated with injury crashes for each state. The resulting general and passenger vehicle related costs for each injury is presented in Table A2.2

To determine the cost of a single fatal, serious or minor injury, the human, general and vehicle costs disaggregated by injury level, must be totalled and then divided by the number of persons per injury type. BITRE gives the jurisdictional numbers of injured persons by injury type for fatal and serious injuries and the Australian figures for minor injuries. The ratio of minor injuries to all injuries for Australia was calculated to be 0.868. By assuming that this ratio is the same for all states, the number of minor injuries by jurisdiction was calculated. The injury numbers and costs per individual injury for 2006 are presented in Table A2.3.

Table A2.2: ***Estimated social cost of general and vehicle related costs associated with passenger vehicles in injury crashes by jurisdiction, million dollars, 2006 (BITRE, 2009).***

	2006 general and Vehicle related costs		2006 general and passenger vehicle related costs associated with injury crashes , 2006$ millions			
	$ millions	%	all	fatalities	Serious	Minor
NSW	2,216	32	742	250	460	32
Victoria	1,731	25	580	175	378	26
Queensland	1,353	20	453	171	264	18
South A	519	8	174	58	108	7
Western A	622	9	208.	95	106	7
5 states	6,442	94	2,156	750	1,316	90
Australia	6,869		2,299	805	1,399	96

Table A2.3: ***Estimated social cost of road crash injuries by jurisdiction, million dollars, 2006 (BITRE, 2009).***

	2006 persons with injury			2006 Total cost per injury				
	fatal	Serious	Minor*	fatal injury	Serious	minor	non-fatal†	Fatal and serious†
NSW	496	10,196	70,561	$ 2,898,563	$ 259,186	$ 2,570	$ 34,970	$ 381,626
Victoria	337	8,225	56,504	$ 2,945,316	$ 260,023	$2,597	$ 35,308	$ 365,716
Queens-land	335	5,981	41,682	$ 2,980,411	$ 258,197	$ 2,541	$ 34,622	$ 402,583
South A	117	2,397	16,591	$ 2,846,756	$ 259,312	$ 2,570	$ 34,980	$ 379,730
Western A	203	2,498	17,825	$ 2,839,866	$ 256,339	$ 2,466	$ 33,671	$ 450,510
5 states	1,488	29,297	203,163	$ 2,915,497	$ 258,987	$ 2,563	$ 34,880	$ 387,390
Australia	1,602	31,204	216,500	$ 2,900,799	$ 258,888	$ 2,560	$ 34,850	$ 387,899

*minor injuries are estimated for the states. †weighted averages

To update 2006 costs to 2010 costs the Consumer Price Index (CPI) in 2006 was compared with the CPI in 2010. The Australian Bureau of Statistics (2006) reported that the weighted average CPI for Australian capital cities in the December quarter of 2006 was 155.5, while in the December quarter of 2012, it was 174.0. Therefore, the ratio of the CPI for December

2010 to December 2006 was 1.119. Multiplying the estimated average costs by this ratio gave the estimates of the average costs in year 2010 prices, which are shown in Table A2.4.

The unit costs associated with road crashes that are shown in Table A2.4 represent the costs associated with these events if they occurred in 2010. Care must be taken when measuring the cost associated with events that occur in the future. There are two reasons for this. Firstly, inflation will change the value of certain items at different rates. For example, the cost of health care may escalate dramatically in the future when compared to other services or commodities. This will mean that the ratio of the cost of road crashes to the other services or commodities will increase. However, it is difficult to predict whether some of the real costs associated with road crashes and injury will change in the future. Therefore, in the present report, we assume that inflation will have no effect on the relative cost of road crashes in the future when compared with other services or commodities.

Table A2.4: ***Estimated social cost of road crash injuries by jurisdiction, dollars, 2010.***

	fatal injury	Serious injury	Minor injury	non-fatal injury*	Fatal and Serious Injury*
NSW	3,243,408	290,022	2,876	39,130	427,029
Victoria	3,295,723	290,958	2,906	39,508	409,225
Queensland	3,334,993	288,915	2,843	38,741	450,479
South A	3,185,437	290,162	2,875	39,142	424,907
Western A	3,177,728	286,836	2,760	37,677	504,108
5 states	3,262,357	289,799	2,867	39,030	433,478
Australia	3,245,910	289,688	2,865	38,997	434,048

*weighted averages

The second reason why estimating costs associated with future events must be calculated carefully is that the amount of money required today to pay for a future event is generally assumed to be less than the amount of money that would be required to pay for that event when it occurs in the future. This is because a sum of money can be invested in a zero-risk investment (such as government bonds) from now up until the time when the event occurs. In this time the original amount increases in value. The magnitude of this increase depends on the rate of the return of the investment.

In the present report, the costs of crashes occurring in the future are defined as the amount of money that must be available for investment in 2010 so that there is enough money available to pay for the costs of the crashes when they occur. This metric of future costs is generally referred to as the present value of a future cost. Measuring future costs in terms of their present values enables the costs accrued over a long period of time to be measured in today's dollar values. The extent to which the present value of a future cost differs from the cost of the same event occurring today depends on the assumed discount rate. The discount rate is the net interest rate at which a sum of money is expected to accrue in the time between the present and the time when the cost must be paid. The formula to calculate the present value of a cost associated with an event occurring n years in the future is

$$PV = \frac{C}{(1+dr)^n}$$

where C is the cost of the event if it was to occur today and '*dr*' is the assumed discount rate.

Present value estimates of future costs are very sensitive to the assumed discount rate. Figure A2.1 shows the present value of costs associated with different injury outcomes for injury occurring in each year for a ten year period. Costs are given when a discount rate of 4% is assumed as well as when a discount rate of 6% is assumed. The vertical axis on the left shows costs for serious and fatal injuries only, while the right vertical axis is for the estimated average present value cost of minor injuries. The present values of costs derived using a 4% discount rate are shown using unbroken lines, while costs derived using a 6% discount rate are shown with dashed lines. It can be seen that the present values of costs incurred in the period immediately after 2010 are only slightly less than the costs of that would have been incurred if the same events occurred in 2010. However, present values of future costs decrease as the year in which the cost was incurred increases. The rate at which the present value of future costs decreases is greater when a discount rate of 6% is assumed than when a discount rate of 4% is assumed.

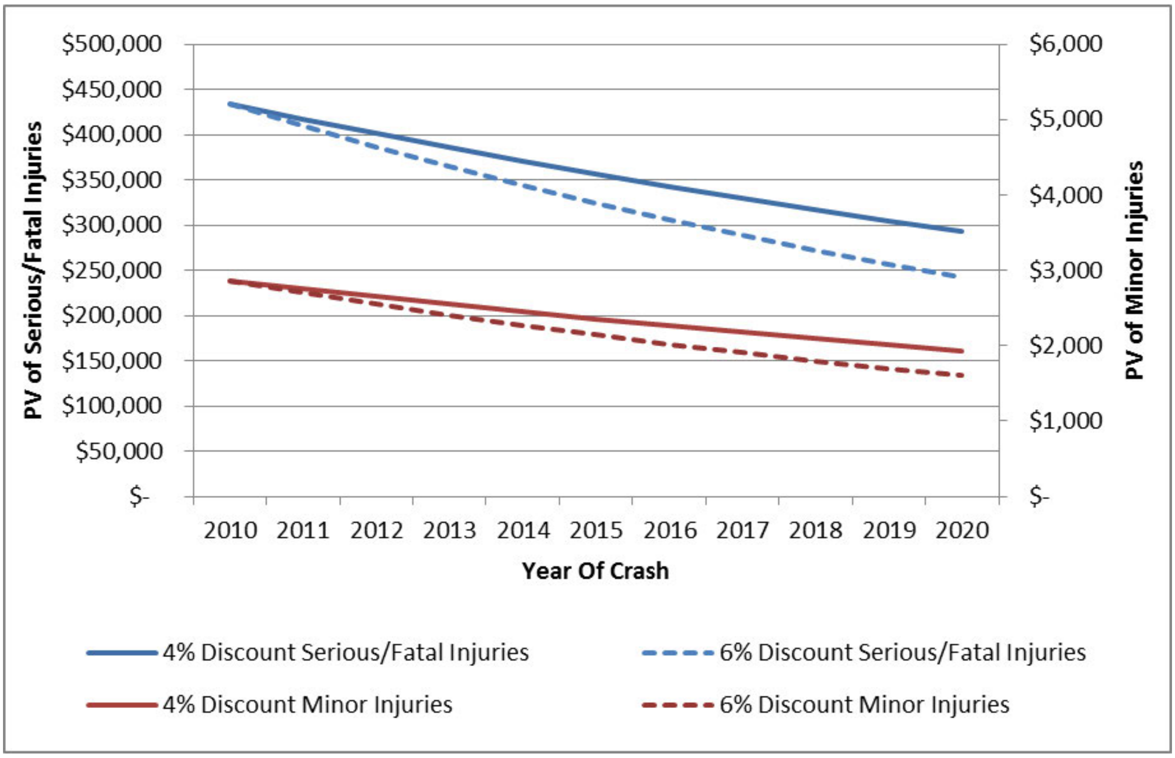


Figure A2.1: ***Australian Present value of costs per injured road user by the year of crash for assumed discount rates of 4% and 6%.***

BITRE (2009) assumed a discount rate of 4% when estimating the cost of the loss of future income and productive capacity for people injured in road crashes. For consistency, the present report also assumes a discount rate of 4% when estimating the cost of injuries suffered in future crashes. Table A2.5 displays the 2010-2020 estimated injury costs for fatal and serious injuries.

Table A2.5: ***Estimated average present value cost of road crash fatal and serious injuries by jurisdiction and crash year, $2010, 4% discount .***

	NSW	Victoria	Queensland	South A	Western A	5 states	Australia
2010	427,029	409,225	450,479	424,907	504,108	433,478	434,048
2011	410,605	393,486	433,153	408,564	484,719	416,806	417,353
2012	394,812	378,352	416,493	392,850	466,076	400,775	401,301
2013	379,627	363,800	400,474	377,740	448,150	385,360	385,867
2014	365,026	349,808	385,071	363,212	430,913	370,539	371,026
2015	350,987	336,353	370,261	349,242	414,340	356,287	356,755
2016	337,487	323,417	356,020	335,810	398,404	342,584	343,034
2017	324,507	310,978	342,327	322,894	383,080	329,408	329,841
2018	312,026	299,017	329,161	310,475	368,347	316,738	317,154
2019	300,025	287,516	316,501	298,534	354,179	304,556	304,956
2020	288,485	276,458	304,328	287,052	340,557	292,842	293,227

12 APPENDIX B – CRASHWORTHINESS FORECASTS AND DATA

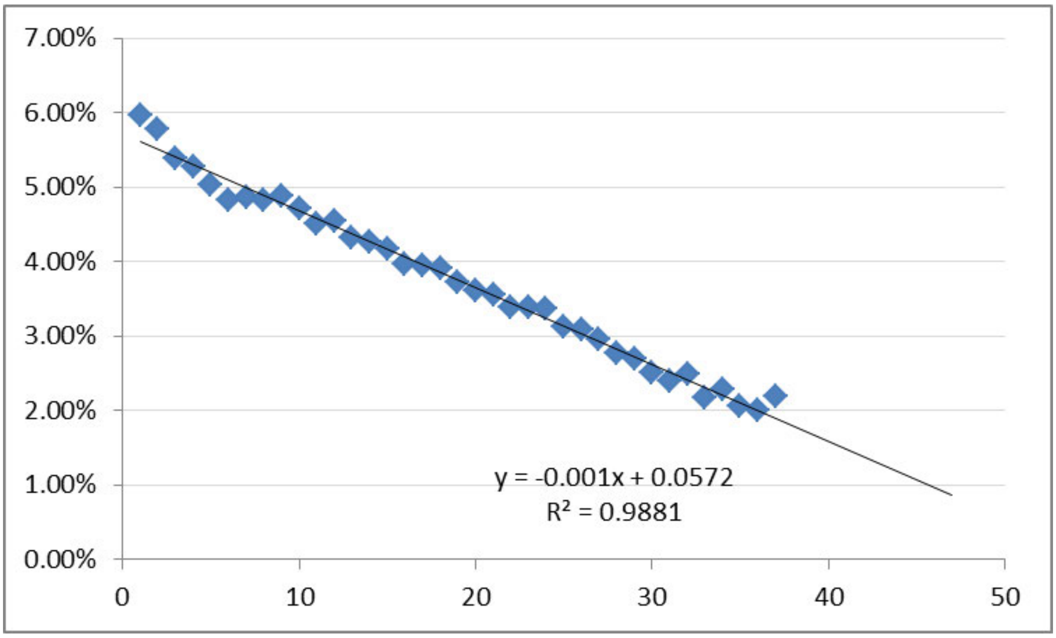


Figure B1: ***Crashworthiness rating by year of manufacture, (All market groups from 1=1974 to 47=2020).***

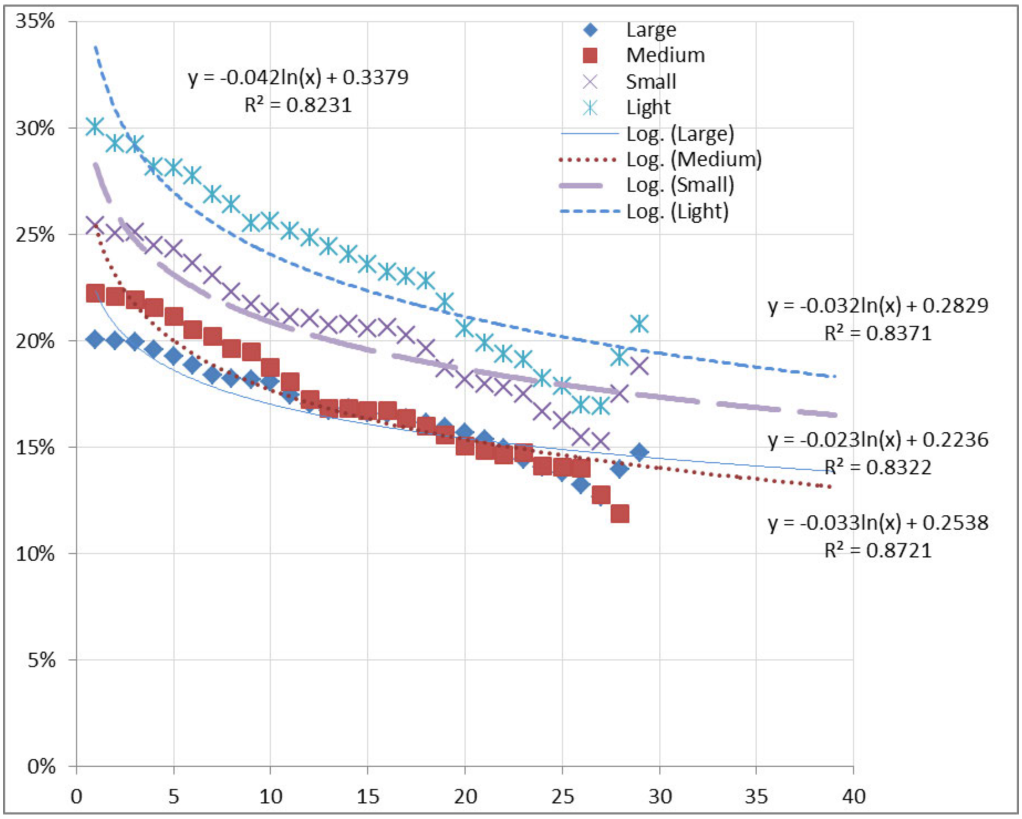


Figure B2: ***Crashworthiness rating by year of manufacture and market group, (From 1=1982 to 39=2020).***

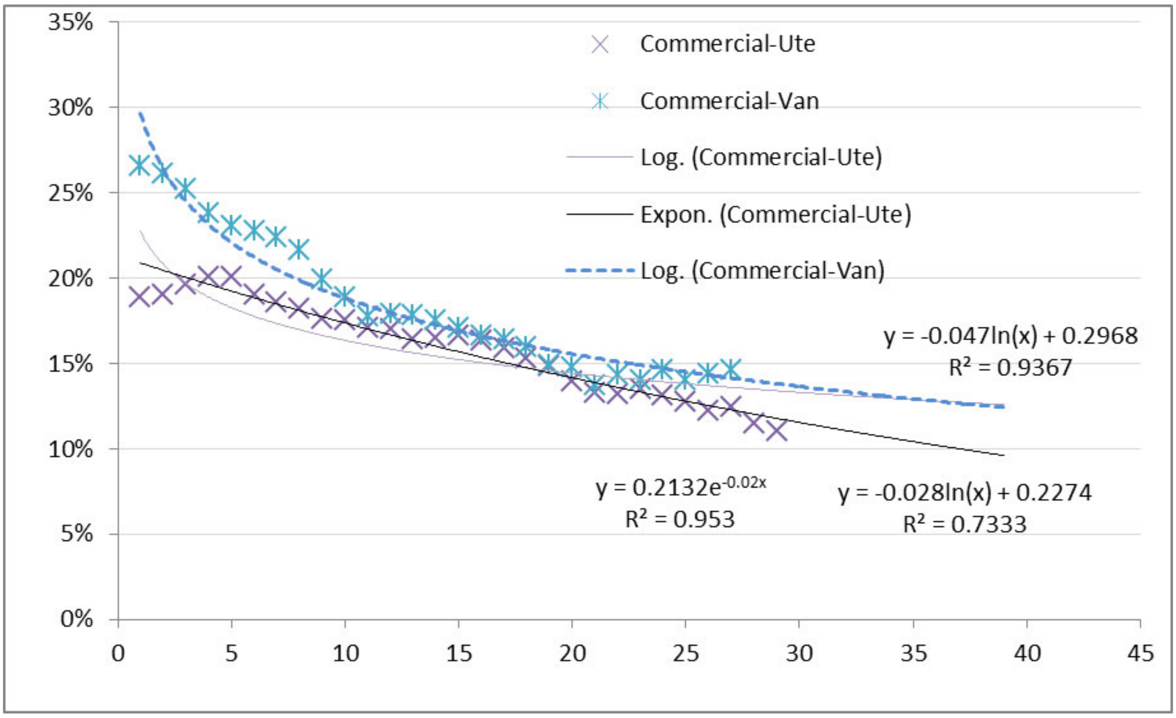


Figure B3: ***Crashworthiness rating by year of manufacture and market group, (From 1=1982 to 39=2020).***

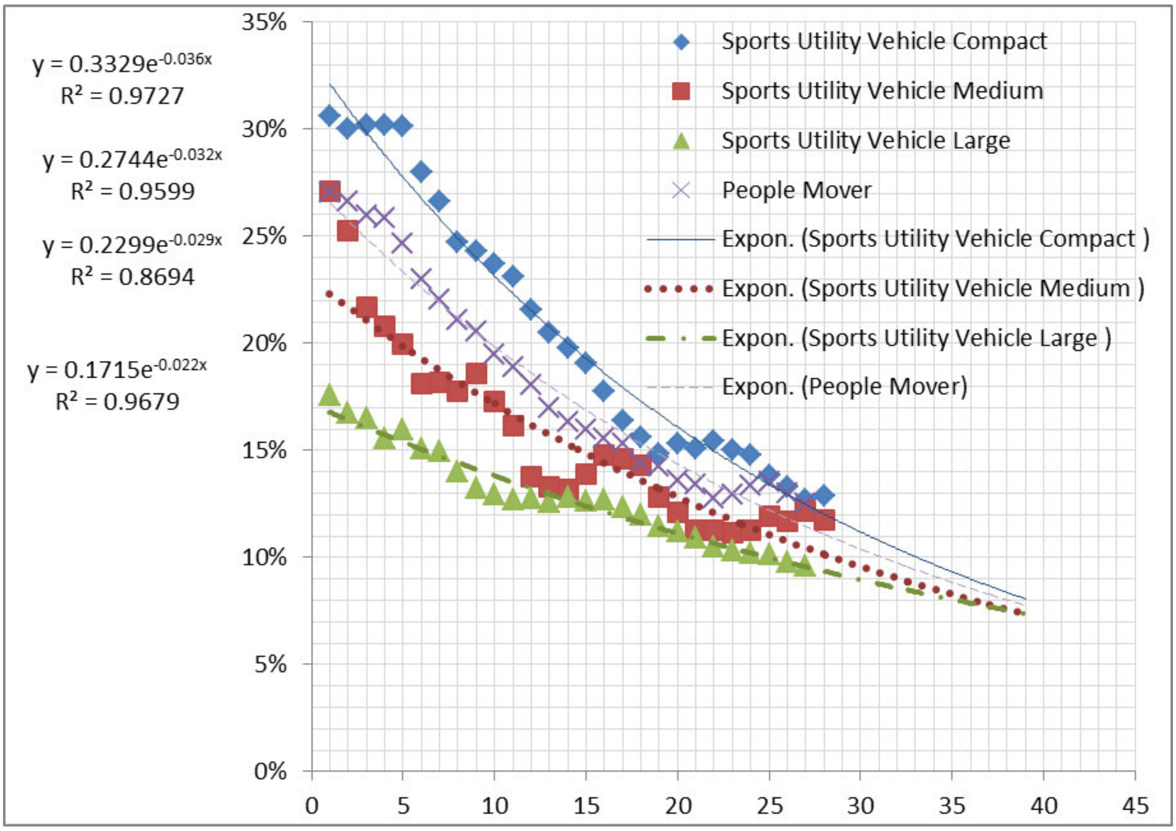


Figure B4: ***Crashworthiness rating by year of manufacture and market group, (From 1=1982 to 39=2020).***

Table B1: ***Crashworthiness ratings*** *(Newstead, S., Watson, L. & Cameron, M., 2012)* ***and forecasted crashworthiness ratings (red) by year of manufacture and market group.***

	All	Light	Small	Medium	Large	People Mover	Sports Utility Vehicle Large	Sports Utility Vehicle Medium	Sports Utility Vehicle Compact	Commercial-Ute	Commercial-Van
1964	7.2%										
1965	6.3%										
1966	6.1%										
1967	6.6%										
1968	6.2%										
1969	7.3%										
1970	6.7%										
1971	6.3%										
1972	6.5%										
1973	6.7%										
1974	6.0%										
1975	5.8%										
1976	5.4%										
1977	5.3%										
1978	5.0%										
1979	4.8%										
1980	4.9%										
1981	4.8%										
1982	4.9%	30.0%	25.4%	22.2%	20.1%	27.0%	17.6%	27.1%	30.6%	18.9%	26.6%
1983	4.7%	29.3%	25.1%	22.1%	20.0%	26.6%	16.7%	25.3%	30.0%	19.0%	26.2%

Table B1 continued: ***Crashworthiness ratings** (Newstead, S., Watson, L. & Cameron, M., 2012)* ***and forecasted crashworthiness ratings (red) by year of manufacture and market group.***

	All	Light	Small	Medium	Large	People Mover	Sports Utility Vehicle Large	Sports Utility Vehicle Medium	Sports Utility Vehicle Compact	Commercial-Ute	Commercial-Van
1984	4.5%	29.2%	25.1%	21.9%	20.0%	26.0%	16.5%	21.7%	30.2%	19.6%	25.2%
1985	4.6%	28.2%	24.5%	21.6%	19.6%	25.9%	15.6%	20.8%	30.2%	20.1%	23.9%
1986	4.3%	28.1%	24.3%	21.2%	19.3%	24.6%	16.0%	20.0%	30.1%	20.1%	23.0%
1987	4.3%	27.7%	23.7%	20.5%	18.9%	23.0%	15.1%	18.1%	28.0%	19.0%	22.8%
1988	4.2%	26.9%	23.1%	20.2%	18.4%	22.1%	15.0%	18.2%	26.6%	18.6%	22.4%
1989	4.0%	26.4%	22.3%	19.6%	18.3%	21.1%	14.0%	17.7%	24.7%	18.2%	21.6%
1990	4.0%	25.5%	21.7%	19.5%	18.2%	20.6%	13.3%	18.6%	24.3%	17.7%	19.9%
1991	3.9%	25.6%	21.4%	18.8%	18.1%	19.5%	13.0%	17.3%	23.7%	17.6%	18.9%
1992	3.7%	25.2%	21.1%	18.1%	17.4%	18.9%	12.7%	16.1%	23.1%	17.1%	17.7%
1993	3.6%	24.9%	21.0%	17.3%	17.1%	18.1%	12.7%	13.8%	21.6%	17.0%	17.9%
1994	3.6%	24.4%	20.7%	16.9%	16.7%	17.0%	12.6%	13.3%	20.5%	16.5%	17.9%
1995	3.4%	24.1%	20.8%	16.8%	16.8%	16.3%	12.8%	13.2%	19.8%	16.5%	17.5%
1996	3.4%	23.6%	20.6%	16.7%	16.6%	16.0%	12.6%	13.9%	19.1%	16.6%	17.1%
1997	3.4%	23.2%	20.6%	16.7%	16.6%	15.6%	12.7%	14.8%	17.8%	16.3%	16.7%
1998	3.1%	23.0%	20.3%	16.4%	16.4%	15.3%	12.3%	14.6%	16.4%	15.9%	16.4%
1999	3.1%	22.8%	19.7%	16.0%	16.2%	14.4%	12.0%	14.3%	15.6%	15.3%	16.0%
2000	3.0%	21.8%	18.7%	15.6%	16.0%	14.2%	11.4%	12.8%	14.9%	14.8%	14.9%
2001	2.8%	20.6%	18.2%	15.1%	15.7%	13.6%	11.2%	12.1%	15.3%	14.0%	14.7%
2002	2.7%	19.9%	18.0%	14.8%	15.4%	13.4%	10.9%	11.3%	15.1%	13.3%	13.7%
2003	2.5%	19.4%	17.8%	14.7%	14.9%	12.8%	10.5%	11.3%	15.4%	13.2%	14.3%
2004	2.4%	19.1%	17.5%	14.8%	14.4%	12.9%	10.3%	11.2%	15.0%	13.5%	14.0%
2005	2.5%	18.3%	16.7%	14.2%	14.1%	13.4%	10.2%	11.3%	14.8%	13.1%	14.6%

Table B1 continued: ***Crashworthiness ratings** (Newstead, S., Watson, L. & Cameron, M., 2012)* ***and forecasted crashworthiness ratings** (red)* ***by year of manufacture and market group.***

	All	Light	Small	Medium	Large	People Mover	Sports Utility Vehicle Large	Sports Utility Vehicle Medium	Sports Utility Vehicle Compact	Commercial-Ute	Commercial-Van
2006	2.2%	17.9%	16.3%	14.1%	13.8%	13.6%	10.1%	11.9%	13.8%	12.7%	14.0%
2007	2.3%	17.0%	15.5%	14.0%	13.3%	13.0%	9.8%	11.7%	13.3%	12.2%	14.4%
2008	2.1%	16.9%	15.3%	12.8%	12.7%	12.5%	9.6%	12.2%	12.7%	12.5%	14.6%
2009	2.0%	19.2%	17.5%	11.9%	14.0%	11.2%	9.3%	11.7%	12.9%	11.5%	14.0%
2010	2.2%	20.8%	18.8%	14.3%	14.8%	10.8%	9.1%	9.9%	11.7%	11.1%	13.9%
2011	1.9%	19.5%	17.4%	14.2%	14.5%	10.5%	8.9%	9.6%	11.3%	11.9%	13.7%
2012	1.8%	19.4%	17.3%	14.0%	14.5%	10.2%	8.7%	9.4%	10.9%	11.7%	13.5%
2013	1.7%	19.2%	17.2%	13.9%	14.4%	9.9%	8.5%	9.1%	10.5%	11.5%	13.4%
2014	1.6%	19.1%	17.1%	13.8%	14.3%	9.5%	8.3%	8.8%	10.1%	11.2%	13.2%
2015	1.5%	19.0%	17.0%	13.7%	14.2%	9.2%	8.1%	8.6%	9.8%	11.0%	13.1%
2016	1.4%	18.9%	16.9%	13.6%	14.2%	9.0%	7.9%	8.3%	9.4%	10.8%	13.0%
2017	1.3%	18.7%	16.8%	13.6%	14.1%	8.7%	7.8%	8.1%	9.1%	10.6%	12.8%
2018	1.2%	18.6%	16.7%	13.5%	14.1%	8.4%	7.6%	7.9%	8.8%	10.4%	12.7%
2019	1.1%	18.5%	16.6%	13.4%	14.0%	8.1%	7.4%	7.6%	8.5%	10.2%	12.6%
2020	1.0%	18.4%	16.6%	13.3%	13.9%	7.9%	7.3%	7.4%	8.2%	10.0%	12.5%

13 APPENDIX C – 2000-2010 CRASHES SENSITIVE TO VEHICLE SAFETY TECHNOLOGIES

A data subset over all crash years: 2000-2010 was used to produce the tables in this appendix.

Table C1: ***Crashes sensitive to vehicle technologies: Australia.***

				All States											
Crash Type				Narrow						Broad				Ratio of serious to (serious+minor)	
				NSW estimate						NSW estimate					
All	2000-2010	Fatal	Serious Injury	Minor Injury	Serious Injury	Minor Injury	Injury	Fatal	Serious Injury	Minor Injury	Serious Injury	Minor Injury	Injury	Broad	Narrow
	incl. SA	11,430	115228	310,450	53,006	142,811	195,817							0.271	
	excl. SA	10,316	105417	253,387	57,531	138,286	195,817							0.294	
Forward Collision	All speeds	520	16,890	94,608	7,658	42,893	50,551	5,181	51,280	102,309	29,096	58,051	87,147	0.151	0.334
	Speeds >=80 km/hr	591	6,567	23,333	1,828	6,495	8,323	3,242	12,219	17,610	3,848	5,546	9,394	0.220	0.410
Lane Change warnings		180	45,11	12,702	2,224	6,262	8,486	7	386	1,537	353	1,404	1,757	0.262	0.201
Lane Departure	All speeds							5,820	32,109	39,041	23,378	28,424	51,802		0.451
	+80km/hr or greater zones +no illegal alcohol/speeding							3,609	15,074	18,329	10,117	12,302	22,419		0.451
	+ major highway expressway							902	4,991	6,077	1,752	2,134	3,886		0.451
Fatigue	"Loss of control" with no illegal alcohol							4,056	29,171	37,180	19,478	24,826	44,304		0.440

Table C2: ***Crashes sensitive to vehicle technologies: New South Wales.***

		New South Wales							
Crash Type		Narrow				Broad			
			NSW estimate				NSW estimate		
		Fatal	Serious Injury	Minor Injury	Injury	Fatal	Serious Injury	Minor Injury	Injury
All		4,053	57,531	138,286	195,817		-	-	
Forward Collision	All speeds	183	7,658	42,893	50,551	2115	29,096	58,051	87,147
	Speeds >=80km/hr	99	1,828	6,495	83,23	1114	3,848	5,546	9,394
Lane Change warnings		69	2,224	6,262	84,86	2	353	1,404	1,757
Lane Departure	All speeds					2,365	23,378	28,424	51,802
	+80km/hr or greater zones +no illegal alcohol/speeding					1,390	10,117	12,302	22,419
	+ major highway expressway					159	1,752	2,134	3,886
Fatigue	"Loss of control" with no illegal alcohol					1,518	19,478	24,826	44,304

Table C3: ***Crashes sensitive to vehicle technologies: Victoria.***

		Victoria					
Crash Type		Narrow			Broad		
		Fatal	Serious Injury	Minor Injury	Fatal	Serious Injury	Minor Injury
All		2,919	50,293	94,104			
Forward Collision	All speeds	1,90	7,855	26,549	1,454	24,949	43,378
	Speeds >=80km/hr	109	2,543	7,236	858	5,869	7,421
Lane Change warnings		58	2158	5,051	3	237	757
Lane Departure	All speeds				1,609	16,097	18,499
	+80km/hr or greater zones +no illegal alcohol/speeding				1,003	7,118	8,549
	+ major highway expressway				447	2,943	3,312
Fatigue	"Loss of control" with no illegal alcohol				1,152	13,570	16,060

Table C4: ***Crashes sensitive to vehicle technologies: Queensland.***

		Queensland					
Crash Type		Narrow			Broad		
		Fatal	Serious Injury	Minor Injury	Fatal	Serious Injury	Minor Injury
All		1,906	36,991	72,246			
Forward Collision	All speeds	92	6,250	25,228	993	17,382	28,273
	Speeds >=80km/hr	59	1,709	4,636	531	2,977	3,230
Lane Change warnings		35	1,808	4,303	2	109	417
Lane Departure	All speeds				1,002	10,686	12,235
	+80km/hr or greater zones +no illegal alcohol/speeding				752	5638	6,091
	+ major highway expressway				94	1059	1,290
Fatigue	"Loss of control" with no illegal alcohol				716	10,419	12,526

Table C5: ***Crashes sensitive to vehicle technologies: Western Australia.***

		Western Australia					
Crash Type		Narrow			Broad		
		Fatal	Serious Injury	Minor Injury	Fatal	Serious Injury	Minor Injury
All		1,438	18,133	87,037			
Forward Collision	All speeds	55	2,785	42,831	619	8,949	30,658
	Speeds >=80km/hr	32	636	6,083	307	1,123	2,045
Lane Change warnings		18	545	3,348	0	40	363
Lane Departure	All speeds				8,44	5,326	8,307
	+80km/hr or greater zones +no illegal alcohol/speeding				319	1,881	2,953
	+ major highway expressway				182	933	1,360
Fatigue	"Loss of control" with no illegal alcohol				670	5,182	8,594

14 APPENDIX D – 2000-2010 INJURIES FROM CRASHES SENSITIVE TO VEHICLE SAFETY TECHNOLOGIES

A data subset over all crash years: 2000-2010 was used to produce the tables in this appendix. The same set was used for Appendix C.

Table D1: ***Fatal and Serious Injuries from crashes sensitive to vehicle technologies: Australia.***

		All States													
Crash Type		Narrow						Broad						Ratio of serious to (serious+minor)	
				NSW estimate						NSW estimate					
All	2000-2010	Fatal	Serious Injury	Minor Injury	Serious Injury	Minor Injury	Injury	Fatal	Serious Injury	Minor Injury	Serious Injury	Minor Injury	Injury	Broad	Narrow
	incl. SA	12,733	145,174	437,947	64,645	195,013	259,658							0.249	
	excl. SA	11,463	132,539	362,484	69,522	190,136	259,658							0.268	
Forward Collision	All speeds	567	20,596	131,608	8,822	56,369	65,191	5,843	65,676	154,076	35,876	84,164	120,040		0.135
	Speeds >=80km/hr	660	8,517	34,636	2,313	9,405	11,718	3,876	19,253	33,279	6,426	11,108	17,534		0.197
Lane Change warnings		233	5,218	16,274	2,512	7,835	10,347	7	427	1,879	393	1,731	2,124		0.243
Lane Departure	All speeds							6,613	43,108	59,229	30,787	42,300	73,087		
	+80km/hr or greater zones +no illegal alcohol/speeding							4,165	21,011	28,918	13,892	19,120	33,012		
	+ major highway expressway							1,067	7,052	9,481	2,321	3,121	5,442		
Fatigue	"Loss of control" with no illegal alcohol							4,441	36,989	52,509	23,882	33,902	57,784		0.413

Table D2: ***Fatal and Serious Injuries from crashes sensitive to vehicle technologies: New South Wales.***

		New South Wales							
		Narrow				Broad			
		Fatal	Serious Injury	Minor Injury	Injury	Fatal	Serious Injury	Minor Injury	Injury
All crashes		4,515	69,522	190,136	259,658				
Forward Collision	All speeds	198	8,822	56,369	65,191	2,393	35,876	84,164	120,040
	Speeds >=80km/hr	110	2,313	9,405	11,718	1,345	6,426	11,108	17,534
Lane Change warnings		78	2,512	7,835	10,347	2	393	1,731	2,124
Lane Departure	All speeds					2,705	30,787	42.300	73,087
	+80km/hr or greater zones +no illegal alcohol/speeding					1,604	13,892	19,120	33,012
	+ major highway expressway					181	2,321	3,121	5,442
Fatigue	"Loss of control" with no illegal alcohol					1661	23,836	33,902	57,784

Table D3: ***Fatal and Serious Injuries from crashes sensitive to vehicle technologies: Victoria.***

		Victoria					
		Narrow			Broad		
		Fatal	Serious Injury	Minor Injury	Fatal	Serious Injury	Minor Injury
		3,229	62,741	140,014			
Forward Collision	All speeds	209	9,430	38,500	1,636	31,971	68,110
	Speeds >=80km/hr	120	3,240	11,448	1,016	9,227	15,150
Lane Change warnings		63	2,500	6,665	3	258	937
Lane Departure	All speeds				1,809	21,270	28,936
	+80km/hr or greater zones +no illegal alcohol/speeding				1,144	9,682	13,767
	+ major highway expressway				547	4,189	5,342
Fatigue	"Loss of control" with no illegal alcohol				1,252	16,887	23,166

Table D4: ***Fatal and Serious Injuries from crashes sensitive to vehicle technologies: Queensland.***

		Queensland					
		Narrow			Broad		
		Fatal	Serious Injury	Minor Injury	Fatal	Serious Injury	Minor Injury
		2,105	46,246	101,079			
Forward Collision	All speeds	98	7,723	34,332	1,107	21,964	41,707
	Speeds >=80km/hr	63	2,258	7,006	630	4,686	6,061
Lane Change warnings		36	2,076	5,474	2	120	501
Lane Departure	All speeds				1,132	14,366	17,990
	+80 km/hr or greater zones +no illegal alcohol/speeding				862	7,828	9,152
	+ major highway expressway				100	1,372	1,755
Fatigue	"Loss of control" with no illegal alcohol				787	13,248	17,215

Table D5: ***Fatal and Serious Injuries from crashes sensitive to vehicle technologies: Western Australia.***

		Western Australia					
		Narrow			Broad		
		Fatal	Serious Injury	Minor Injury	Fatal	Serious Injury	Minor Injury
		1,614	23,552	121,391			
Forward Collision	All speeds	62	3,443	58,776	707	11,763	44,260
	Speeds >=80km/hr	35	852	8,678	366	1,895	3,629
Lane Change warnings		19	642	4,135	0	49	441
Lane Departure	All speeds				967	7,472	12,303
	+80km/hr or greater zones +no illegal alcohol/speeding				371	2,668	4,581
	+ major highway expressway				214	1,378	2,169
Fatigue	"Loss of control" with no illegal alcohol				741	6,854	12,128

Table D6: ***Fatal and Serious Injuries from crashes sensitive to vehicle technologies: Market Groups.***

		Narrow: Fatal	Narrow: Serious Injury	Narrow: Minor Injury	Narrow NSW estimate: Serious Injury	Narrow NSW estimate: Minor Injury	Narrow: Injury	Broad: Fatal	Broad: Serious Injury	Broad: Minor Injury	Broad NSW estimate: Serious Injury	Broad NSW estimate: Minor Injury	Broad: Injury
Utility													
		1306	13178	31581	4,739	12,962	17701	1306	13178	31581			17701
Forward Collision	All speeds	80	2154	11611	690	4,408	5098	633	5896	11852	2,125	4,986	7111
	Speeds >=80km/hr	110	975	3535	222	903	1125	469	2430	3834	586	1,013	1599
Lane Change warnings		19	505	1357	152	476	628	1	38	135	17	76	93
Lane Departure	All speeds							723	4693	6589	2,357	3,238	5595
	+80km/hr or greater zones +no illegal alcohol/speeding							483	2659	3687	1,274	1,753	3027
	+ major highway expressway							83	720	962	145	194	339
Fatigue	"Loss of control" with no illegal alcohol							515	4162	5954	1,796	2,549	4345
Van													
		356	4146	10735	2,370	6,481	8851	356	4146	10735			8851
Forward Collision	All speeds	29	779	4204	388	2,477	2865	196	1970	4235	1,107	2,598	3705
	Speeds >=80km/hr	16	347	1087	92	375	467	114	564	1022	167	289	456
Lane Change warnings		7	188	556	107	334	441	0	12	48	13	56	69
Lane Departure	All speeds							173	1063	1408	783	1,075	1858
	+80km/hr or greater zones +no illegal alcohol/speeding							132	610	808	394	542	936
	+ major highway expressway							33	217	343	68	92	160
Fatigue	"Loss of control" with no illegal alcohol							103	923	1208	633	898	1531
SUV-Large													
		557	5009	12369	1,370	3,748	5118	557	5009	12369			5118
Forward Collision	All speeds	32	827	4764	221	1,413	1634	266	2021	4284	580	1,362	1942
	Speeds >=80km/hr	28	398	1258	66	266	332	198	853	1374	165	284	449
Lane Change warnings		6	189	468	35	109	144	0	10	53	8	34	42
Lane Departure	All speeds							275	1687	2449	640	879	1519
	+80km/hr or greater zones +no illegal alcohol/speeding							187	1097	1515	409	562	971
	+ major highway expressway							39	229	290	48	65	113
Fatigue	"Loss of control" with no illegal alcohol							221	1730	2467	517	734	1251

Table D6 continued: ***Fatal and Serious Injuries from crashes sensitive to vehicle technologies: Market Groups.***

		Narrow						Broad					
					NSW estimate						NSW estimate		
		Fatal	Serious Injury	Minor Injury	Serious Injury	Minor Injury	Injury	Fatal	Serious Injury	Minor Injury	Serious Injury	Minor Injury	Injury
SUV-Medium													
		238	2775	7886	1,079	2,952	4031	238	2775	7886			4031
Forward Collision	All speeds	14	399	3018	152	973	1125	94	1230	2911	524	1,230	1754
	Speeds >=80km/hr	10	154	745	39	157	196	70	406	714	99	172	271
Lane Change warnings		2	128	374	35	110	145	0	5	38	6	24	30
Lane Departure	All speeds							122	876	1263	422	580	1002
	+80km/hr or greater zones +no illegal alcohol/speeding							87	570	809	251	345	596
	+ major highway expressway							20	149	218	31	41	72
Fatigue	"Loss of control" with no illegal alcohol							99	860	1296	357	508	865
SUV-Small													
		213	2857	9517	1,622	4,435	6057	213	2857	9517			6057
Forward Collision	All speeds	10	437	3865	213	1,363	1576	107	1459	3774	845	1,982	2827
	Speeds >=80km/hr	7	149	861	54	219	273	65	367	639	131	227	358
Lane Change warnings		2	106	439	67	209	276	0	8	60	12	53	65
Lane Departure	All speeds							113	794	1215	612	842	1454
	+80km/hr or greater zones +no illegal alcohol/speeding							91	480	660	318	437	755
	+ major highway expressway							14	133	142	49	65	114
Fatigue	"Loss of control" with no illegal alcohol							84	732	1216	490	695	1185
SUV-People Movers													
		103	1287	3336	910	2,487	3397	103	1287	3336			3397
Forward Collision	All speeds	5	196	1285	126	807	933	60	631	1381	489	1,146	1635
	Speeds >=80km/hr	3	48	324	24	100	124	35	148	244	62	106	168
Lane Change warnings		3	55	166	29	92	121	0	2	21	4	20	24
Lane Departure	All speeds							55	362	383	315	432	747
	+80km/hr or greater zones +no illegal alcohol/speeding							45	214	239	141	193	334
	+ major highway expressway							8	67	59	15	20	35
Fatigue	"Loss of control" with no illegal alcohol							33	348	409	252	357	609

Table D6 continued: ***Fatal and Serious Injuries from crashes sensitive to vehicle technologies: Market Groups.***

		Large											
		Narrow						Broad					
					NSW estimate						NSW estimate		
		Fatal	Serious Injury	Minor Injury	Serious Injury	Minor Injury	Injury	Fatal	Serious Injury	Minor Injury	Serious Injury	Minor Injury	Injury
		2809	32541	92958	15,687	42,904	58591	2809	32541	92958			58591
Forward Collision	All speeds	123	4755	33628	1,944	12,421	14365	1365	16185	39563	8,417	19,746	28163
	Speeds >=80km/hr	192	1443	9419	432	1,840	2292	928	4483	8209	1,363	2,357	3720
Lane Change warnings		43	1345	4232	571	1,779	2350	2	102	503	91	403	494
Lane Departure	All speeds							1717	10620	14688	6,674	9,169	15843
	+80km/hr or greater zones +no illegal alcohol/speeding							1004	4871	6646	2,737	3,768	6505
	+ major highway expressway							240	1490	2251	563	757	1320
Fatigue	"Loss of control" with no illegal alcohol							1174	9165	13350	5,034	7,146	12180

		Medium											
		855	10772	33486	6,853	18,743	25596	855	10772	33486			25596
Forward Collision	All speeds	47	1685	13238	898	5,738	6636	474	5840	14346	3,830	8,984	12814
	Speeds >=80km/hr	58	624	3059	191	778	969	280	1283	2321	493	853	1346
Lane Change warnings		12	479	1588	281	875	1156	1	37	184	39	171	210
Lane Departure	All speeds							462	2899	4036	2,420	3,294	5744
	+80km/hr or greater zones +no illegal alcohol/speeding							270	1264	1739	861	1,186	2047
	+ major highway expressway							52	368	570	145	195	340
Fatigue	"Loss of control" with no illegal alcohol							305	2474	3579	1,825	2,590	4415

Table D6 continued: ***Fatal and Serious Injuries from crashes sensitive to vehicle technologies: Market Groups.***

		Narrow						Broad					
					NSW estimate						NSW estimate		
		Fatal	Serious Injury	Minor Injury	Serious Injury	Minor Injury	Injury	Fatal	Serious Injury	Minor Injury	Serious Injury	Minor Injury	Injury
Small													
		1515	21344	73814	13,539	37,029	50568	1515	21344	73814			50568
Forward Collision	All speeds	62	3681	30979	1,879	12,006	13885	913	11701	31154	7,366	17,281	24647
	Speeds >=80km/hr	66	1335	6859	468	1,902	2370	458	2473	4614	953	1,648	2601
Lane Change warnings		30	915	3416	566	1,764	2330	0	86	410	90	398	488
Lane Departure	All speeds							791	5263	7735	4,680	6,429	11109
	+80km/hr or greater zones +no illegal alcohol/speeding							509	2539	3582	1,735	2,389	4124
	+ major highway expressway							128	805	1110	328	442	770
Fatigue	"Loss of control" with no illegal alcohol							464	4493	6873	3,559	5,053	8612
Light													
		381	6205	20513	3,747	10,249	13996	381	6205	20513			13996
Forward Collision	All speeds	21	1097	8395	507	3,240	3747	226	3318	8594	2,022	4,744	6766
	Speeds >=80km/hr	25	393	1878	125	510	635	126	675	1318	262	452	714
Lane Change warnings		13	259	1013	157	488	645	0	28	119	29	127	156
Lane Departure	All speeds							194	1533	2343	1,358	1,865	3223
	+80km/hr or greater zones +no illegal alcohol/speeding							123	746	1161	563	776	1339
	+ major highway expressway							40	231	345	102	137	239
Fatigue	"Loss of control" with no illegal alcohol							109	1363	2136	1,054	1,497	2551
Unknown													
		3141	32601	66712	17,618	48,185	65803	3141	32601	66712			65803
Forward Collision	All speeds	144	4586	16621	1,803	11,524	13327	1509	15425	31982	8,570	20,106	28676
	Speeds >=80km/hr	143	1851	5611	559	2,356	2935	1071	5571	8990	2,145	3,707	5852
Lane Change warnings		59	1049	2665	513	1,598	2111	3	99	308	84	369	453
Lane Departure	All speeds							1988	13318	17120	10,528	14,465	24993
	+80km/hr or greater zones +no illegal alcohol/speeding							1244	5961	80723	5,209	7,169	12378
	+ major highway expressway							410	2643	31691	857	1,113	1940
Fatigue	"Loss of control" with no illegal alcohol							1334	10739	14021	8,365	11,875	20240

15 APPENDIX E – 2000-2010 CRASHES SENSITIVE TO ESC-SINGLE VEHICLE DRIVER INJURY CRASHES

Table E1: ***Crashes sensitive to ESC: Australia.***

	Commercial - Ute					Commercial - Van				
	Driver injury crash by severity					Driver injury crash by severity				
	Fatal Driver injury	Estimated Serious driver Injury	Estimated Minor driver Injury	All non-fatal Injury	ratio of si/(si+mi)	Fatal Driver injury	Estimated Serious driver Injury	Estimated Minor driver Injury	All non-fatal Injury	ratio of si/(si+mi)
all years	471	4,724	7,190	11913	0.396	77	1,129	1,624	2753	0.410
2000	52	410	633	1043	0.393	13	128	216	344	0.373
2001	35	381	662	1043	0.365	12	134	180	314	0.426
2002	41	450	677	1127	0.399	8	133	159	292	0.455
2003	37	384	573	957	0.401	7	127	122	249	0.509
2004	36	401	612	1013	0.396	3	103	163	266	0.385
2005	38	373	563	936	0.398	3	81	142	223	0.365
2006	48	453	664	1117	0.406	9	101	127	228	0.443
2007	56	510	718	1228	0.415	6	97	153	250	0.388
2008	34	512	741	1253	0.408	4	87	129	216	0.403
2009	56	559	823	1382	0.405	9	92	128	220	0.420
2010	38	280	534	814	0.344	3	42	109	151	0.277

Table E2: ***Crashes sensitive to ESC: New South Wales.***

	Commercial - Ute				Commercial - Van			
	Driver injury crash by severity				Driver injury crash by severity			
	Fatal Driver injury	Estimated Serious driver Injury	Estimated Minor driver Injury	All non-fatal Injury	Fatal Driver injury	Estimated Serious driver Injury	Estimated Minor driver Injury	All non-fatal Injury
all years	127	1,251	1,905	3,156	18	374	538	912
2000	12	119	183	302	3	40	68	108
2001	9	124	215	339	2	48	64	112
2002	11	134	202	336	1	41	50	91
2003	8	72	107	179	0	40	38	78
2004	10	84	129	213	0	29	46	75
2005	12	114	172	286	1	31	55	86
2006	12	102	150	252	2	31	39	70
2007	11	108	152	260	3	33	52	85
2008	14	131	189	320	1	25	37	62
2009	16	153	226	379	3	32	45	77
2010	12	100	190	290	2	19	49	68

Table E3: ***Crashes sensitive to ESC: Victoria.***

	Commercial - Ute					Commercial - Van				
	Driver injury crash by severity					Driver injury crash by severity				
	Fatal Driver injury	Estimated Serious driver Injury	Estimated Minor driver Injury	All non-fatal Injury	ratio of si/(si+mi)	Fatal Driver injury	Estimated Serious driver Injury	Estimated Minor driver Injury	All non-fatal Injury	ratio of si/(si+mi)
all years	108	1,123	1,474	2,597	0.432	25	301	366	667	0.451
2000	11	77	134	211	0.365	3	44	58	102	0.431
2001	7	80	137	217	0.369	6	29	48	77	0.377
2002	11	102	118	220	0.464	4	21	26	47	0.447
2003	9	93	145	238	0.391	1	24	31	55	0.436
2004	6	96	137	233	0.412	1	26	31	57	0.456
2005	12	107	158	265	0.404	0	26	44	70	0.371
2006	8	98	110	208	0.471	2	39	26	65	0.600
2007	11	124	109	233	0.532	2	31	26	57	0.544
2008	7	128	120	248	0.516	1	26	28	54	0.481
2009	15	129	150	279	0.462	4	22	23	45	0.489
2010	11	89	156	245	0.363	1	13	25	38	0.342

Table E4: ***Crashes sensitive to ESC: Queensland.***

	Commercial - Ute					Commercial - Van				
	Driver injury crash by severity					Driver injury crash by severity				
	Fatal Driver injury	Estimated Serious driver Injury	Estimated Minor driver Injury	All non-fatal Injury	ratio of si/(si+ mi)	Fatal Driver injury	Estimated Serious driver Injury	Estimated Minor driver Injury	All non-fatal Injury	ratio of si/(si+ mi)
all years	101	1,355	1,930	3,285	0.412	14	241	298	539	0.447
2000	12	143	173	316	0.453	5	25	45	70	0.357
2001	13	128	175	303	0.422	1	30	23	53	0.566
2002	8	118	177	295	0.400	3	33	20	53	0.623
2003	10	125	167	292	0.428	0	32	19	51	0.627
2004	13	111	166	277	0.401	1	29	43	72	0.403
2005	2	57	82	139	0.410	0	6	14	20	0.300
2006	13	152	213	365	0.416	2	15	29	44	0.341
2007	14	174	276	450	0.387	0	22	38	60	0.367
2008	5	160	241	401	0.399	1	23	35	58	0.397
2009	11	187	260	447	0.418	1	26	32	58	0.448
2010										

Table E5: ***Crashes sensitive to ESC: Western Australia.***

	Commercial - Ute					Commercial - Van				
	Driver injury crash by severity					Driver injury crash by severity				
	Fatal Driver injury	Estimated Serious driver Injury	Estimated Minor driver Injury	All non-fatal Injury	ratio of si/(si+ mi)	Fatal Driver injury	Estimated Serious driver Injury	Estimated Minor driver Injury	All non-fatal Injury	ratio of si/(si+ mi)
all years	80	645	1,203	1,848	0.349	12	139	243	382	0.364
2000	11	45	77	122	0.369	1	8	28	36	0.222
2001	5	26	87	113	0.230	2	20	24	44	0.455
2002	8	58	100	158	0.367	0	23	46	69	0.333
2003	6	64	97	161	0.398	4	23	16	39	0.590
2004	2	75	119	194	0.387	0	15	26	41	0.366
2005	4	60	76	136	0.441	1	10	12	22	0.455
2006	9	72	138	210	0.343	2	12	21	33	0.364
2007	13	67	129	196	0.342	0	5	19	24	0.208
2008	6	61	134	195	0.313	1	9	16	25	0.360
2009	6	53	127	180	0.294	1	7	16	23	0.304
2010	10	64	119	183	0.350	0	7	19	26	0.269

Table E6: ***Crashes sensitive to ESC: South Australia.***

	Commercial - Ute					Commercial - Van				
	Driver injury crash by severity					Driver injury crash by severity				
	Fatal Driver injury	Estimated Serious driver Injury	Estimated Minor driver Injury	All non-fatal Injury	ratio of si/(si+mi)	Fatal Driver injury	Estimated Serious driver Injury	Estimated Minor driver Injury	All non-fatal Injury	ratio of si/(si+mi)
all years	55	350	682	1,032	0.339	8	88	206	294	0.299
2000	6	26	67	93	0.280	1	13	20	33	0.394
2001	1	23	48	71	0.324	1	9	23	32	0.281
2002	3	38	80	118	0.322	0	17	20	37	0.459
2003	4	30	57	87	0.345	2	11	20	31	0.355
2004	5	35	61	96	0.365	1	5	24	29	0.172
2005	8	35	77	112	0.313	1	8	19	27	0.296
2006	6	29	53	82	0.354	1	5	14	19	0.263
2007	7	37	52	89	0.416	1	6	20	26	0.231
2008	2	32	58	90	0.356	0	5	15	20	0.250
2009	8	38	60	98	0.388	0	6	14	20	0.300
2010	5	27	69	96	0.281	0	3	17	20	0.150

16 APPENDIX F – 2000-2010 INJURIES FROM CRASHES SENSITIVE TO ESC-SINGLE VEHICLE DRIVER INJURY CRASHES

Table F1: *Crashes sensitive to ESC - single vehicle driver injury crashes – Australia.*

	Commercial - Ute					Commercial - Van				
	Driver injury crash by severity					Driver injury crash by severity				
	Estimate of minorly injured persons in crash	Estimate of seriously injured persons in crash	number of killed persons in crash	number of non-fatally injured persons in crash	ratio of si/(si+mi)	Estimate of minorly injured persons in crash	Estimate of seriously injured persons in crash	Estimated Minor driver Injury	All non-fatal Injury	ratio of si/(si+mi)
all years	48,394	19,285	1458	67,679	0.285	19,011	6,711	384	25,722	0.261
2000	4333	1485	137	5818	0.2552	2340	714	61	3054	0.2339
2001	4687	1610	137	6297	0.256	2384	648	53	3032	0.214
2002	4570	1791	115	6361	0.282	1996	664	40	2660	0.250
2003	3979	1723	131	5702	0.302	1670	658	33	2328	0.282
2004	4223	1771	116	5994	0.295	1746	634	33	2380	0.266
2005	3907	1513	134	5420	0.279	1678	484	19	2162	0.224
2006	4323	1903	142	6226	0.306	1529	704	41	2233	0.315
2007	4686	2110	153	6796	0.310	1561	602	36	2163	0.278
2008	5022	2024	126	7046	0.287	1530	655	22	2185	0.300
2009	4974	2064	156	7038	0.293	1408	593	27	2001	0.296
2010	3757	1224	111	4981	0.246	1193	336	19	1529	0.220

Table F2: ***Crashes sensitive to ESC - single vehicle driver injury crashes – New South Wales.***

	Commercial - Ute				Commercial - Van			
	Driver injury crash by severity				Driver injury crash by severity			
	Estimate of minor injured persons in crash	Estimate of seriously injured persons in crash	number of killed persons in crash	number of non-fatally injured persons in crash	Estimate of minor injured persons in crash	Estimate of seriously injured persons in crash	Estimated Minor driver Injury	All non-fatal Injury
all years	12,657	5,044	444	17,701	6,542	2,309	143	8,851
2000	1,330	456	43	1786	771	235	19	1006
2001	1,420	488	38	1908	819	222	17	1041
2002	1,328	520	37	1848	697	232	15	929
2003	783	339	36	1122	574	226	12	800
2004	881	370	32	1251	591	215	15	806
2005	1,150	445	40	1595	633	182	8	815
2006	1,062	467	40	1529	465	214	11	679
2007	1,045	471	45	1516	518	199	16	717
2008	1,259	507	39	1766	496	213	12	709
2009	1,241	515	45	1756	488	206	7	694
2010	1,225	399	49	1624	511	144	11	655

Table F3: ***Crashes sensitive to ESC - single vehicle driver injury crashes – Victoria.***

	Commercial - Ute					Commercial - Van				
	Driver injury crash by severity					Driver injury crash by severity				
	Estimate of minor injured persons in crash	Estimate of seriously injured persons in crash	number of killed persons in crash	number of non-fatally injured persons in crash	ratio of si/(si+ mi)	Estimate of minor injured persons in crash	Estimate of seriously injured persons in crash	Estimated Minor driver Injury	All non-fatal Injury	ratio of si/(si+ mi)
all years	9,777	4,872	341	14,649	0.333	4,249	1,887	105	6,136	0.308
2000	1,051	374	33	1425	0.2625	633	205	15	838	0.2446
2001	892	379	30	1271	0.298	542	165	20	707	0.233
2002	896	383	26	1279	0.299	378	148	10	526	0.281
2003	993	434	26	1427	0.304	365	158	5	523	0.302
2004	992	428	29	1420	0.301	415	132	6	547	0.241
2005	1,088	456	43	1544	0.295	500	158	6	658	0.240
2006	678	461	33	1139	0.405	304	241	15	545	0.442
2007	652	572	32	1224	0.467	263	200	6	463	0.432
2008	687	472	27	1159	0.407	293	205	4	498	0.412
2009	869	470	40	1339	0.351	260	154	13	414	0.372
2010	979	443	22	1422	0.312	296	121	5	417	0.290

Table F4: ***Crashes sensitive to ESC - single vehicle driver injury crashes - Queensland.***

	Commercial - Ute					Commercial - Van				
	Driver injury crash by severity					Driver injury crash by severity				
	Estimate of minor injured persons in crash	Estimate of seriously injured persons in crash	number of killed persons in crash	number of non-fatally injured persons in crash	ratio of si/(si+ mi)	Estimate of minor injured persons in crash	Estimate of seriously injured persons in crash	Estimated Minor driver Injury	All non-fatal Injury	ratio of si/(si+ mi)
all years	12,000	5,675	315	17,675	0.321	3,008	1,464	64	4,472	0.327
2000	727	381	24	1108	0.3439	259	168	12	427	0.3934
2001	1,163	508	43	1671	0.304	352	144	8	496	0.290
2002	1,189	514	28	1703	0.302	330	144	11	474	0.304
2003	1,135	602	35	1737	0.347	252	155	6	407	0.381
2004	1,201	590	36	1791	0.329	358	184	7	542	0.339
2005	491	254	13	745	0.341	136	70	1	206	0.340
2006	1,310	629	38	1939	0.324	317	156	8	473	0.330
2007	1,641	718	31	2359	0.304	364	131	6	495	0.265
2008	1,626	714	31	2340	0.305	327	157	2	484	0.324
2009	1,517	765	36	2282	0.335	313	155	3	468	0.331
2010										

Table F5: ***Crashes sensitive to ESC - single vehicle driver injury crashes - Western Australia.***

	Commercial - Ute					Commercial - Van				
	Driver injury crash by severity					Driver injury crash by severity				
	Estimate of minor injured persons in crash	Estimate of seriously injured persons in crash	number of killed persons in crash	number of non-fatally injured persons in crash	ratio of si/(si+ mi)	Estimate of minor injured persons in crash	Estimate of seriously injured persons in crash	Estimated Minor driver Injury	All non-fatal Injury	ratio of si/(si+ mi)
all years	9,797	2,629	206	12,426	0.212	3,462	788	43	4,250	0.185
2000	840	174	21	1014	0.1716	460	65	9	525	0.1238
2001	894	145	15	1039	0.140	440	87	4	527	0.165
2002	735	262	15	997	0.263	421	107	4	528	0.203
2003	723	263	21	986	0.267	324	95	8	419	0.227
2004	771	281	9	1052	0.267	259	84	1	343	0.245
2005	845	250	16	1095	0.228	278	51	1	329	0.155
2006	926	242	18	1168	0.207	291	69	5	360	0.192
2007	976	248	31	1224	0.203	266	54	3	320	0.169
2008	1,042	249	15	1291	0.193	274	65	4	339	0.192
2009	964	232	16	1196	0.194	206	55	2	261	0.211
2010	1,081	283	29	1364	0.207	243	56	2	299	0.187

Table F6: ***Crashes sensitive to ESC - single vehicle driver injury crashes - South Australia.***

	Commercial - Ute					Commercial - Van				
	Driver injury crash by severity					Driver injury crash by severity				
	Estimate of minor injured persons in crash	Estimate of seriously injured persons in crash	number of killed persons in crash	number of non-fatally injured persons in crash	ratio of si/(si+ mi)	Estimate of minor injured persons in crash	Estimate of seriously injured persons in crash	Estimated Minor driver Injury	All non-fatal Injury	ratio of si/(si+ mi)
all years	4,205	1,079	152	5,284	0.204	1,965	363	34	2,328	0.156
2000	386	100	16	486	0.2058	237	51	6	288	0.1771
2001	321	91	11	412	0.221	255	38	5	293	0.130
2002	424	113	9	537	0.210	211	52	1	263	0.198
2003	346	88	13	434	0.203	179	34	4	213	0.160
2004	382	102	10	484	0.211	159	32	4	191	0.168
2005	341	109	22	450	0.242	140	29	3	169	0.172
2006	350	104	13	454	0.229	163	31	2	194	0.160
2007	375	103	14	478	0.215	168	25	5	193	0.130
2008	414	85	14	499	0.170	155	26	1	181	0.144
2009	394	85	19	479	0.177	155	30	2	185	0.162
2010	472	99	11	571	0.173	143	15	1	158	0.095

17 APPENDIX G – CRASHED VEHICLE COUNT FORECASTS: PASSENGER VEHICLE CRASHED VEHICLES WITH A YEAR OF MANUFACTURE

X-Axis scales 1=2000, 11=2010, Beyond 2010 are forecasted crash counts.

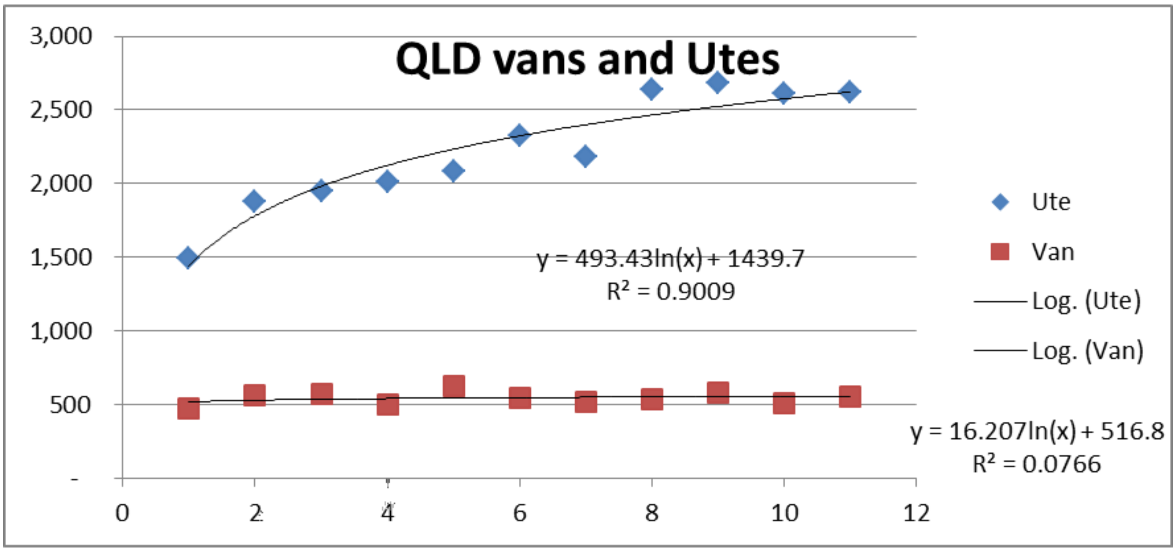


Figure G1: ***Queensland Crashed passenger commercial vehicles involved in injury crashes, with a year of manufacture.***

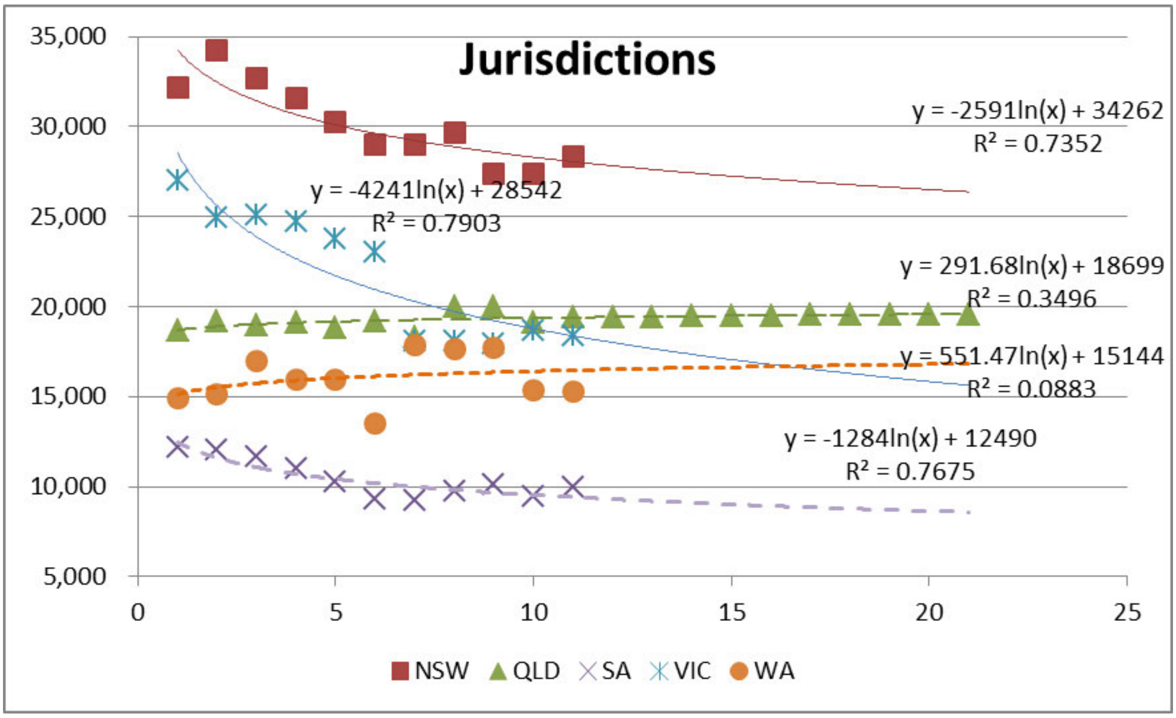
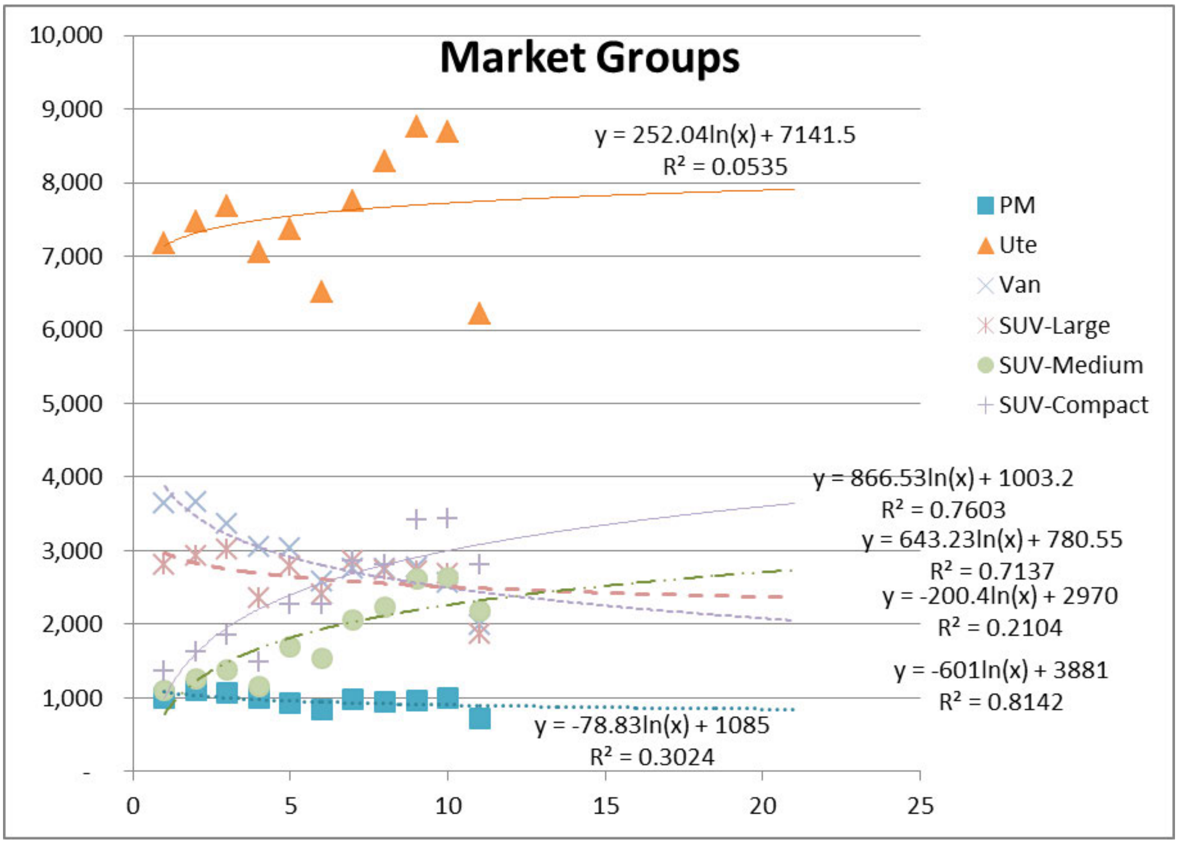


Figure G2: ***Australian crashed passenger vehicles involved in injury crashes, with a year of manufacture, by jurisdiction.***



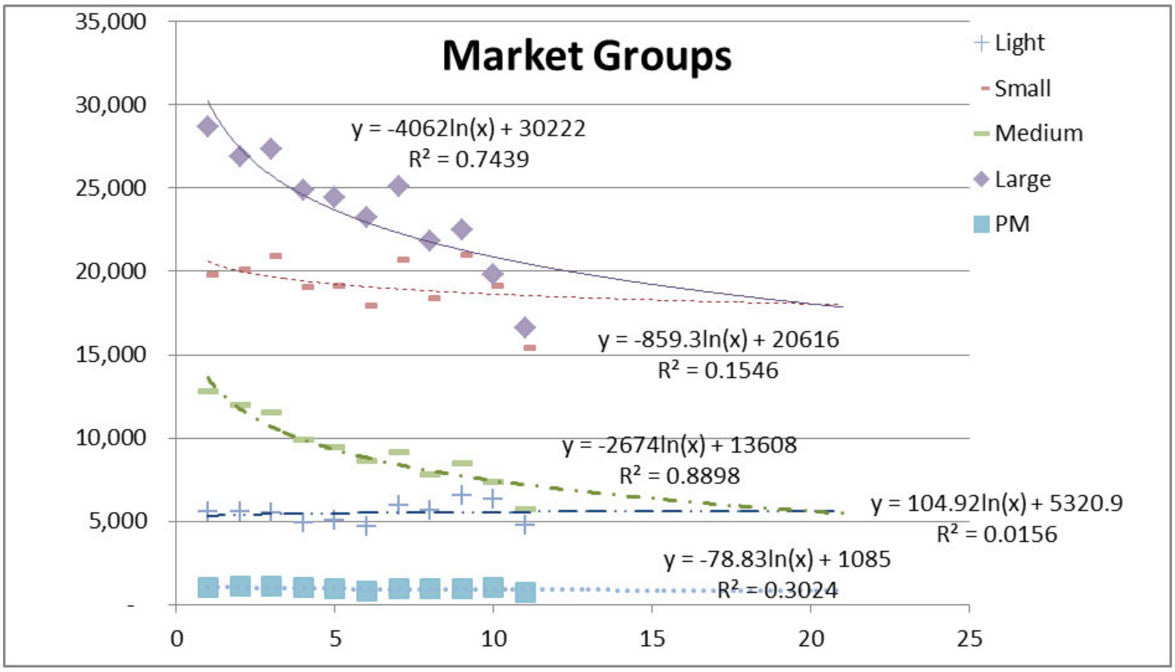


Figure G3: ***Australian crashed passenger vehicles involved in injury crashes, with a year of manufacture, by market group.***

18 APPENDIX H – CRASHED VEHICLE PROPORTION FORECASTS: PASSENGER VEHICLE CRASHED VEHICLES WITH A YEAR OF MANUFACTURE

X-Axis scales 1=2000, 11=2010, Beyond 2010 are forecasted crash proportions.

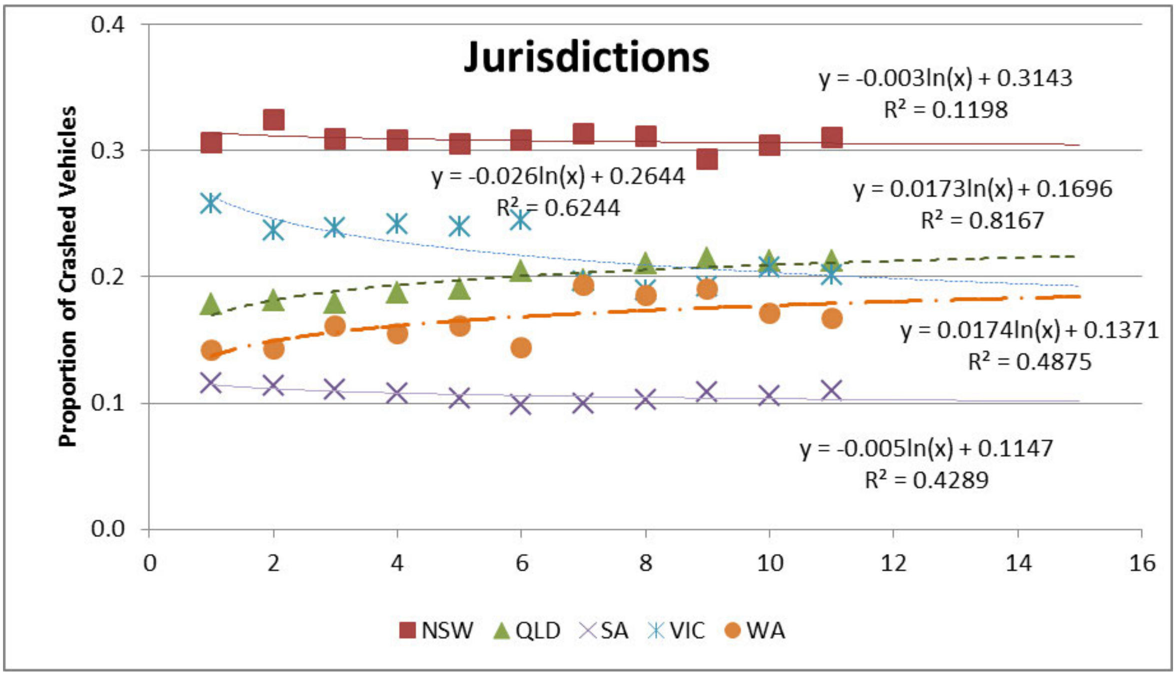


Figure H1: ***Proportion of Australian crashed passenger vehicles involved in injury crashes, with a year of manufacture, in each jurisdiction.***

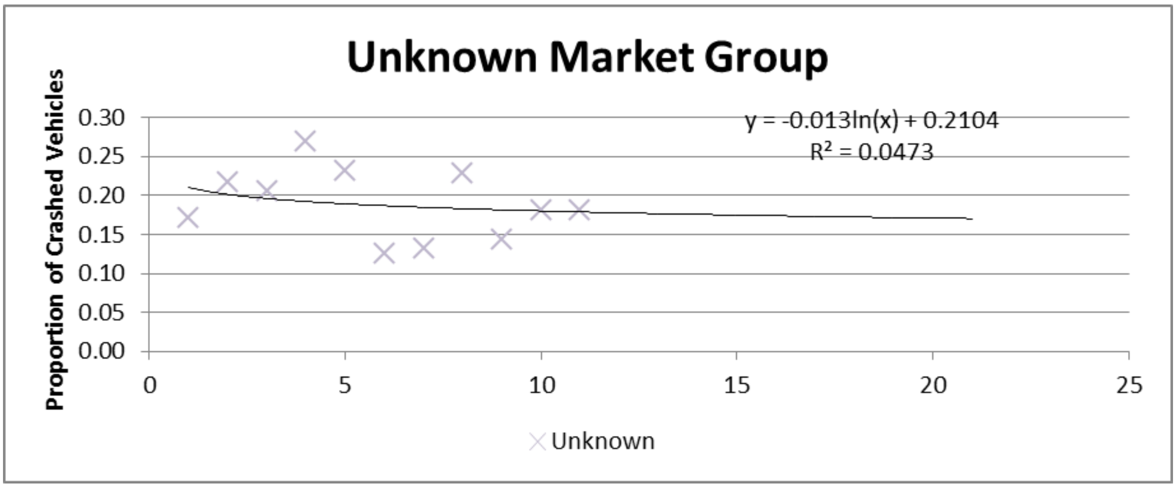


Figure H2: ***Proportion of Australian crashed passenger vehicles involved in injury crashes, with a year of manufacture, in the unknown market group.***

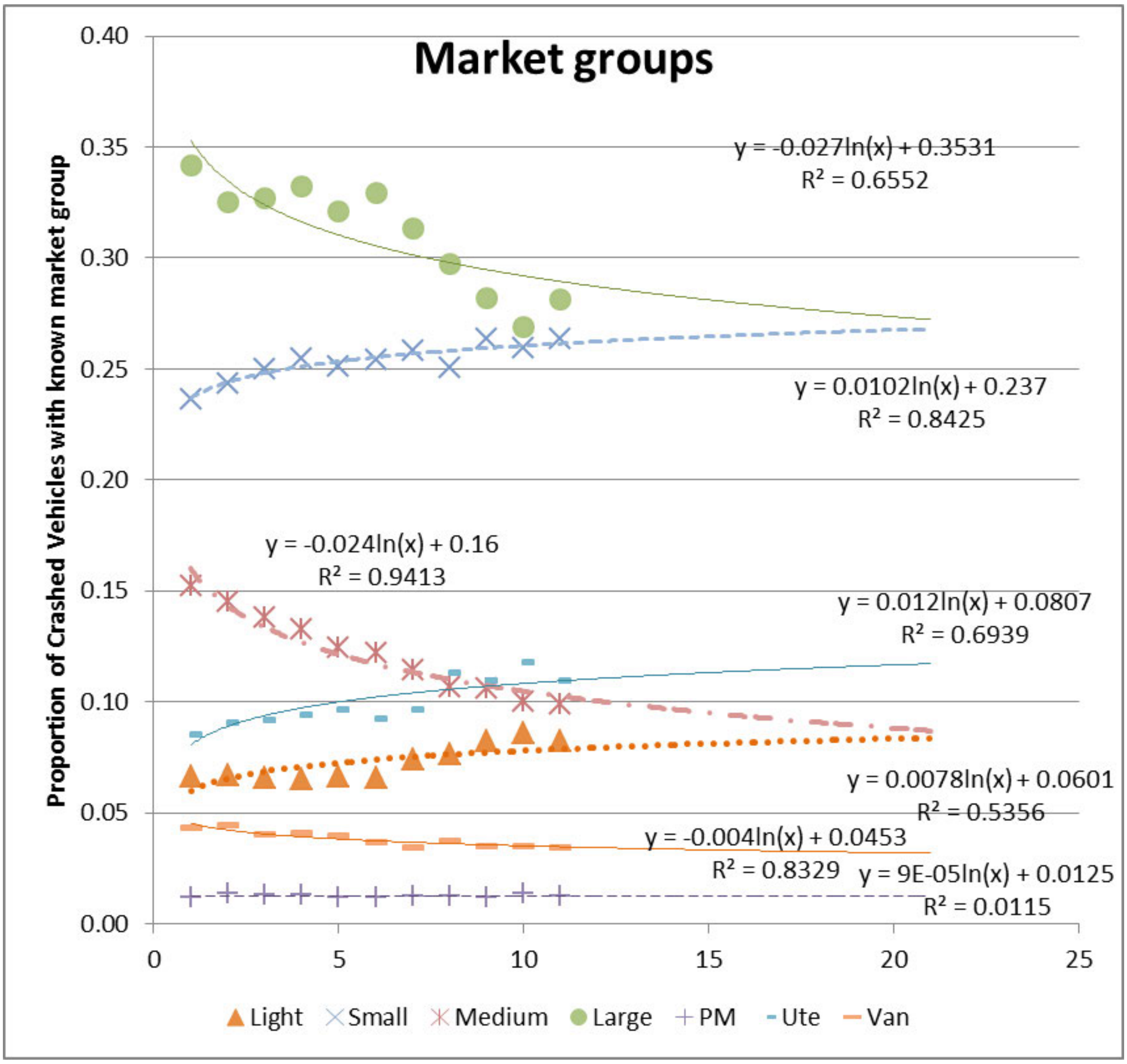


Figure H3: ***Proportion of Australian crashed passenger vehicles involved in injury crashes, with a year of manufacture and a known market group, in each market group.***

19 APPENDIX I – FLEET PROJECTIONS, 2011-2020: PASSENGER VEHICLE CRASHED VEHICLES WITH A YEAR OF MANUFACTURE

Table I1: ***Estimated Crashed passenger vehicles (with YOM) involved in injury crashes (2011-2020) by jurisdiction and market group for vehicles age 0 to 46 years, using the current trend of decreasing crashed passenger vehicles.***

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
All States	91,422	91,033	90,453	89,916	89,416	88,949	88,510	88,096	87,705	87,334
NSW	28,352	27,884	27,683	27,497	27,324	27,163	27,011	26,868	26,734	26,606
QLD	19,396	19,322	19,322	19,321	19,320	19,317	19,313	19,309	19,304	19,299
SA	9,981	9,292	9,196	9,108	9,026	8,950	8,878	8,811	8,748	8,689
VIC	18,396	18,153	17,848	17,569	17,310	17,070	16,846	16,636	16,438	16,252
WA	15,294	16,388	16,408	16,426	16,441	16,454	16,465	16,475	16,484	16,491
LIGHT	6,160	5,865	5,857	5,847	5,835	5,821	5,806	5,790	5,772	5,754
SMALL	19,733	19,357	19,241	19,125	19,010	18,895	18,781	18,668	18,556	18,444
MEDIUM	7,403	7,404	7,197	7,004	6,824	6,656	6,498	6,348	6,207	6,072
LARGE	21,068	21,104	20,754	20,425	20,115	19,819	19,538	19,270	19,022	18,761
PM	948	939	931	923	916	909	901	894	887	880
SUVL	2,481	2,597	2,576	2,555	2,535	2,515	2,496	2,477	2,458	2,440
SUVM	2,771	2,944	3,107	3,268	3,427	3,583	3,737	3,888	4,037	4,184
SUVC	3,589	3,874	4,087	4,298	4,505	4,708	4,909	5,107	5,302	5,494
UTE	8,180	8,145	8,141	8,134	8,124	8,110	8,094	8,077	8,057	8,036
VAN	2,567	2,609	2,562	2,518	2,476	2,437	2,399	2,364	2,330	2,297
UNKNOWN	16,523	16,197	16,003	15,824	15,659	15,505	15,362	15,227	15,105	14,974

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Table I2: ***Estimated Crashed passenger vehicles (with YOM) involved in injury crashes (2011-2020) by jurisdiction and market group for commercial vehicles, all vehicle ages, using the current trend of decreasing crashed passenger vehicles.***

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
New South Wales										
Ute	2,495	2,491	2,487	2,482	2,476	2,470	2,463	2,455	2,447	2,439
Van	799	784	770	757	744	732	721	710	700	690
Queensland										
Ute	1,731	1,741	1,748	1,756	1,763	1,767	1,771	1,775	1,777	1,778
Van	554	547	541	535	529	523	518	513	507	502
South Australia										
Ute	830	827	823	819	815	811	807	803	799	795
Van	266	261	255	250	245	241	236	232	229	225
Victoria										
Ute	1,623	1,606	1,589	1,572	1,556	1,540	1,525	1,510	1,495	1,481
Van	520	506	492	479	468	457	446	437	427	419
Western Australia										
Ute	1,468	1,478	1,487	1,495	1,502	1,507	1,512	1,515	1,518	1,520
Van	470	465	460	455	451	446	442	438	434	430

20 APPENDIX J – AGE PROFILES AND PROJECTIONS, 2011-2020: PASSENGER VEHICLE CRASHED VEHICLES WITH A YEAR OF MANUFACTURE

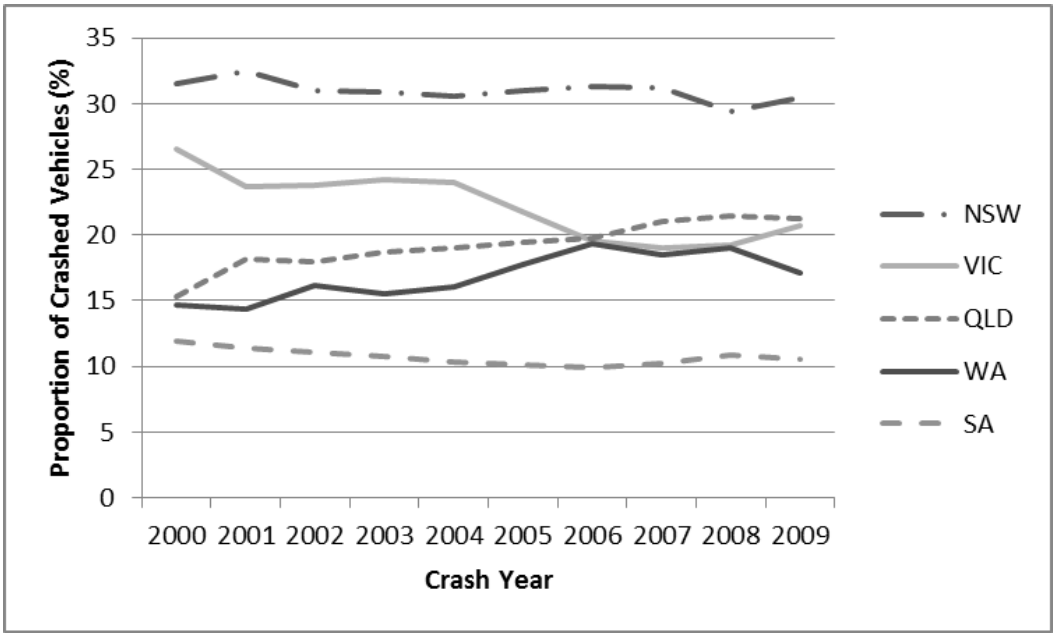

Figure J1: ***Proportion of Australian crashed passenger vehicles involved in injury crashes, with a year of manufacture, in each jurisdiction, by crash year.***

<u>Figures J2 to J18</u>

Current Age Profiles of crashed passenger vehicles with a year of manufacture: 2000-2010.

Total= aggregated years 2000-2010 (2000-2009 for Queensland data).

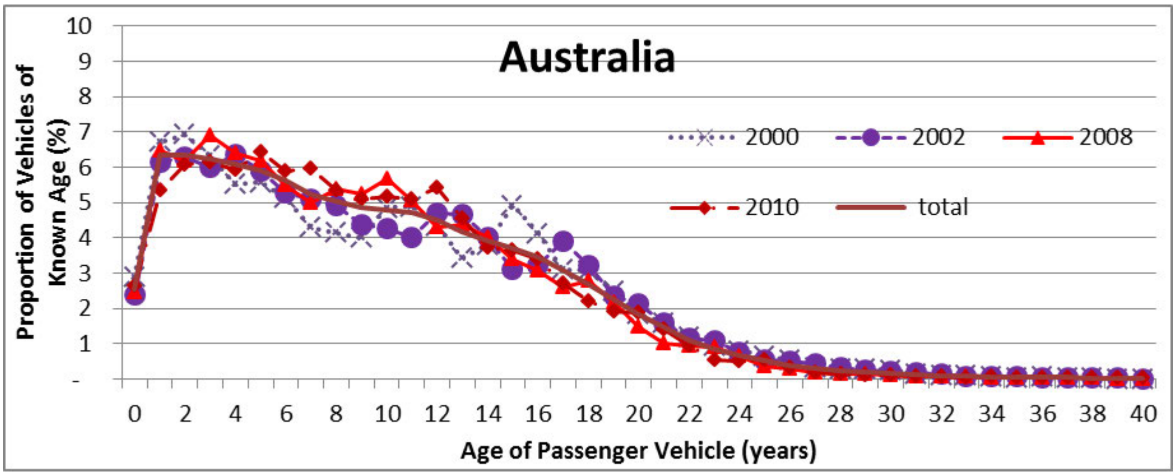

Figure J2: ***Proportion of Australian crashed passenger vehicles involved in injury crashes, by vehicle age.***

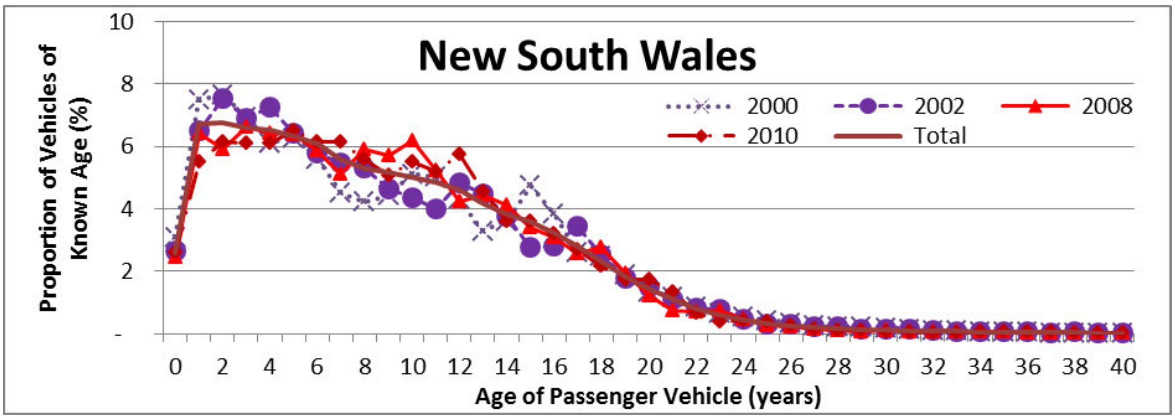

Figure J3: ***Proportion of crashed passenger vehicles in New South Wales involved in injury crashes, by vehicle age.***

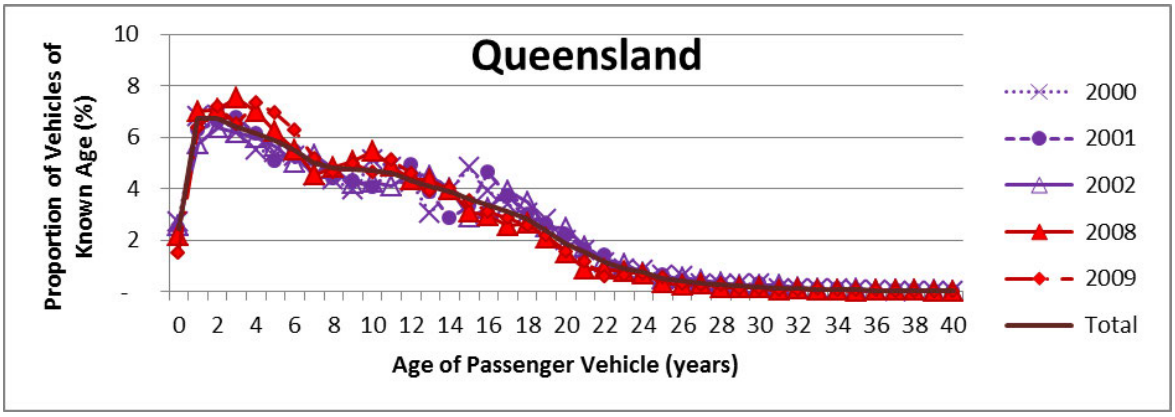

Figure J4: ***Proportion of Queensland's crashed passenger vehicles involved in injury crashes, by vehicle age.***

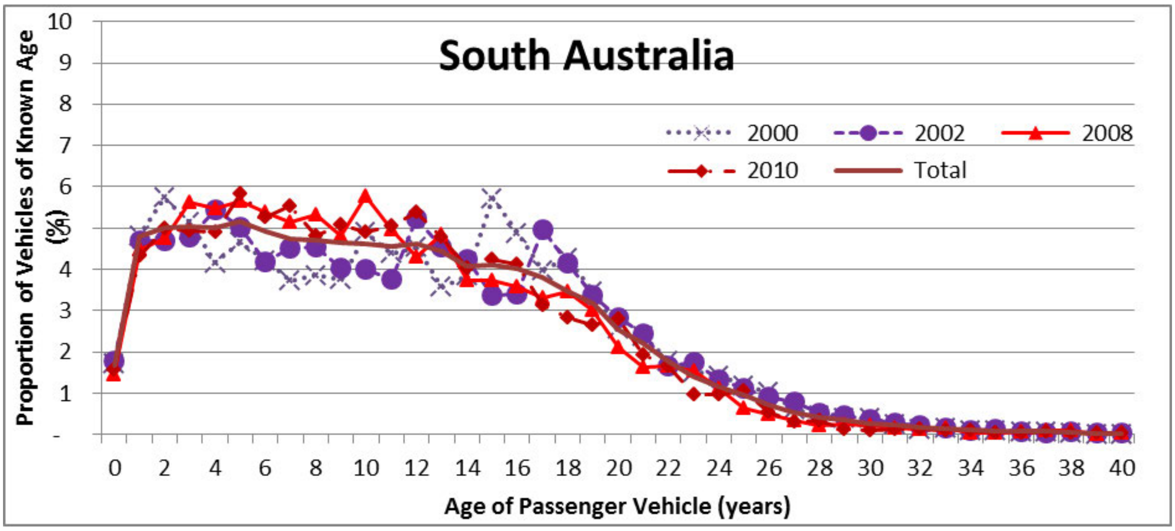

Figure J5: ***Proportion of South Australian crashed passenger vehicles involved in injury crashes, by vehicle age.***

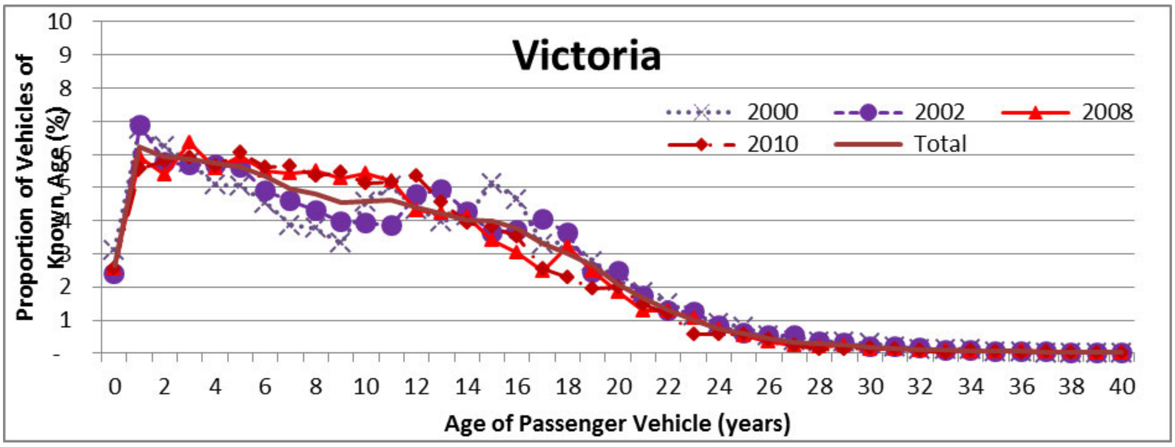

Figure J6: ***Proportion of Victorian crashed passenger vehicles involved in injury crashes, by vehicle age.***

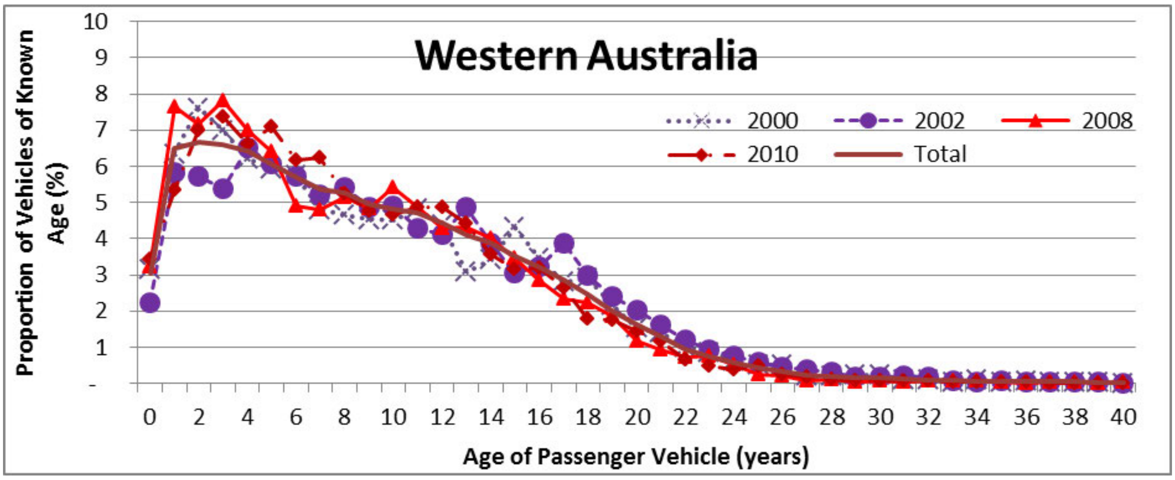

Figure J7: ***Proportion of Western Australian crashed passenger vehicles involved in injury crashes, by vehicle age.***

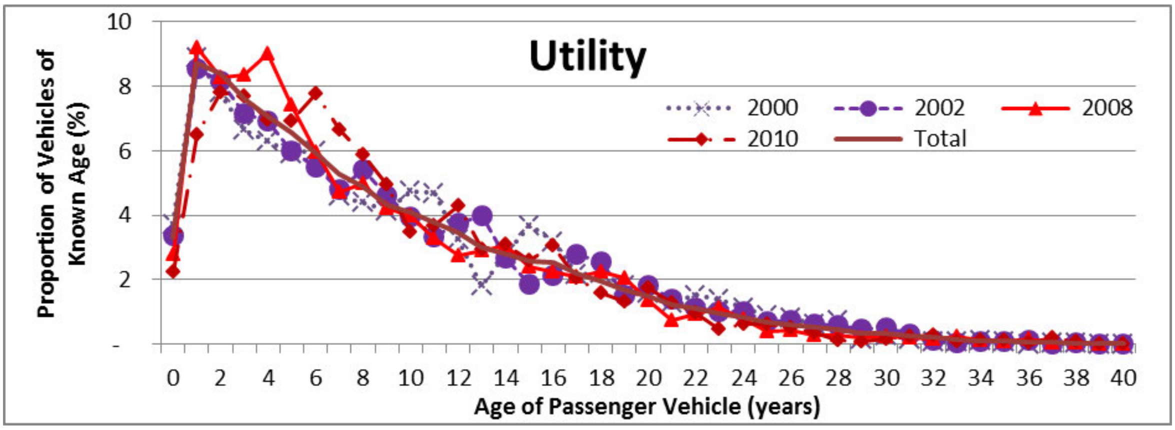

Figure J8: ***Proportion of Australian crashed Light Commercial Utilities involved in injury crashes, by vehicle age.***

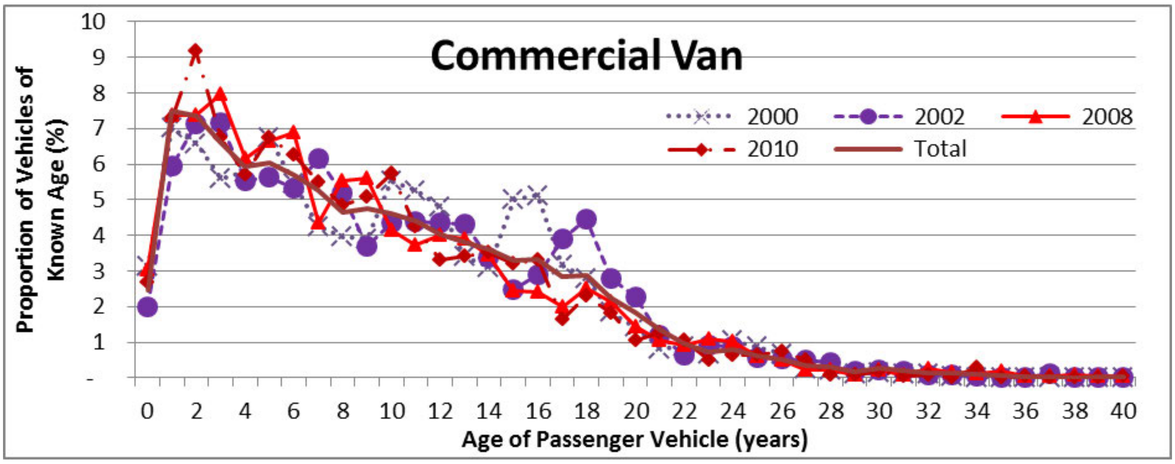

Figure J9: ***Proportion of Australian crashed Light Commercial Vans involved in injury crashes, by vehicle age.***

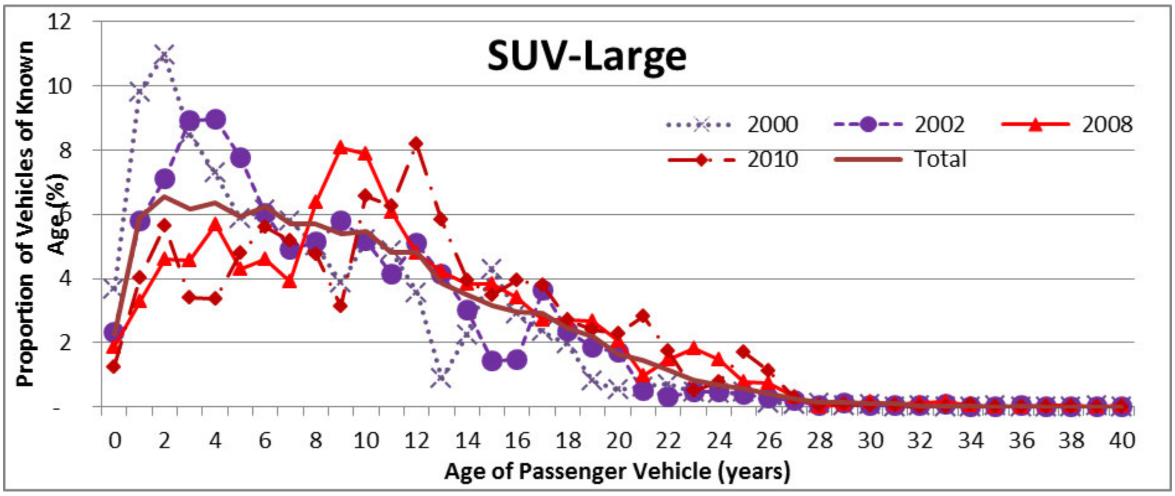

Figure J10: ***Proportion of Australian crashed Large SUVs involved in injury crashes, with by vehicle age.***

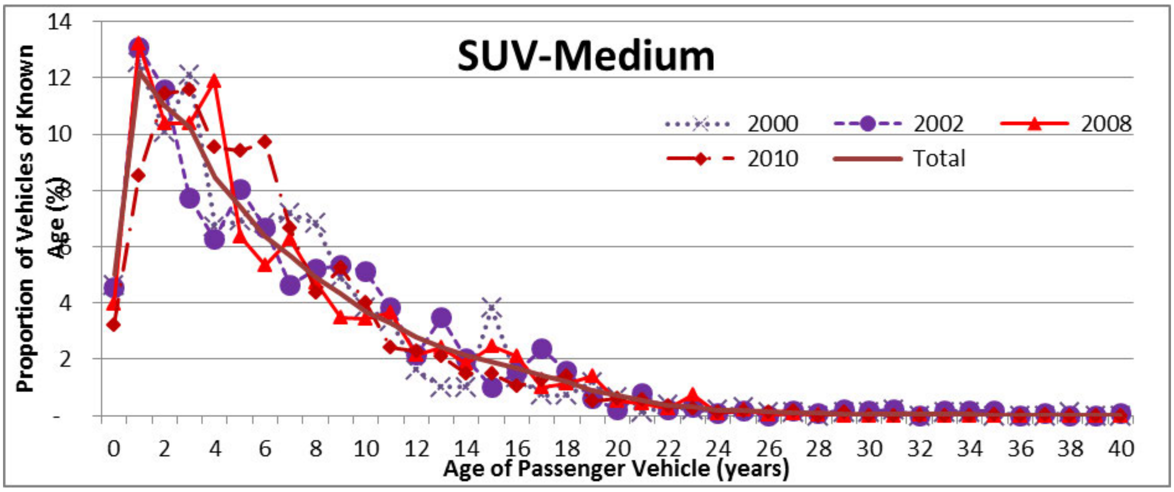

Figure J11: ***Proportion of Australian crashed Medium SUVs involved in injury crashes, by vehicle age.***

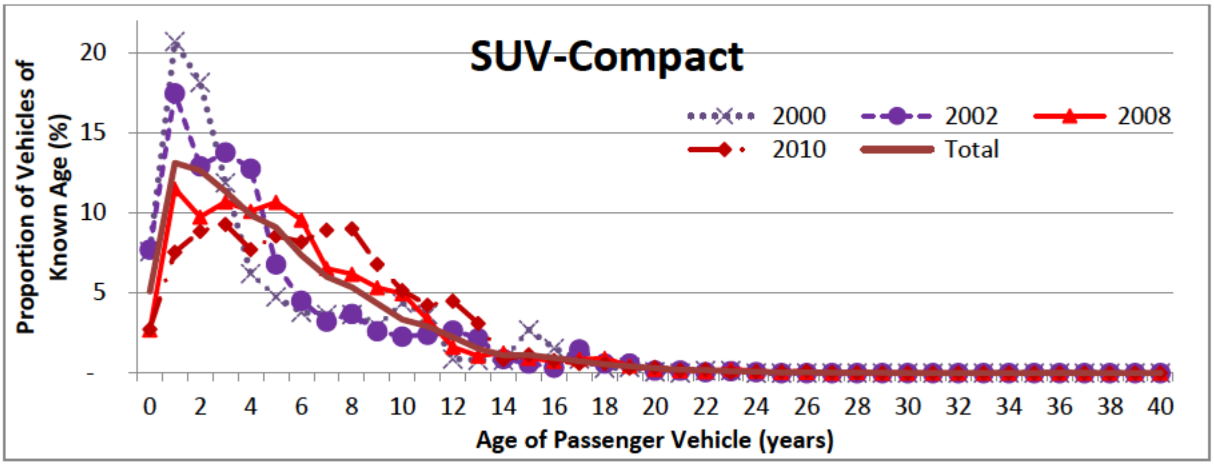

Figure J12: ***Proportion of Australian crashed Compact SUVs involved in injury crashes, by vehicle age.***

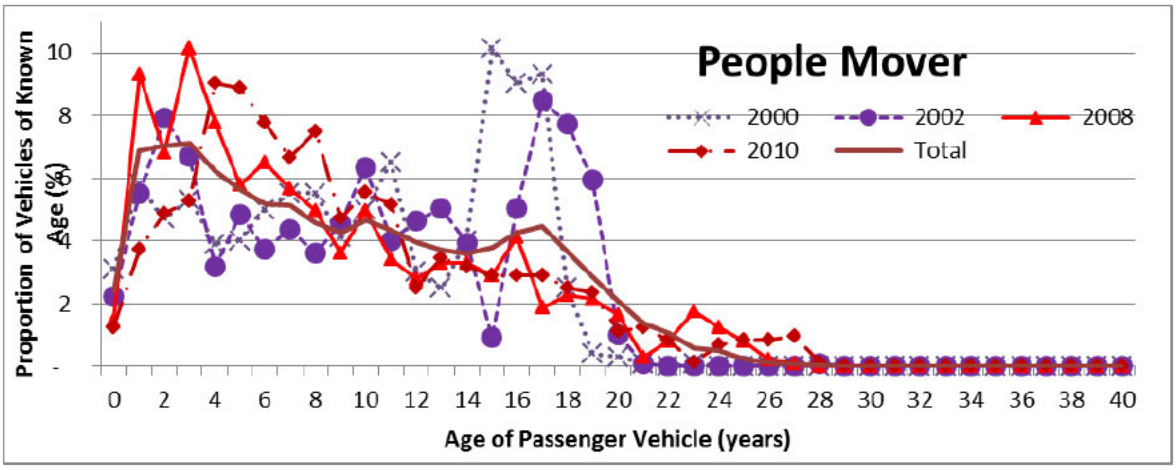

Figure J13: ***Proportion of Australian crashed People Movers involved in injury crashes, by vehicle age.***

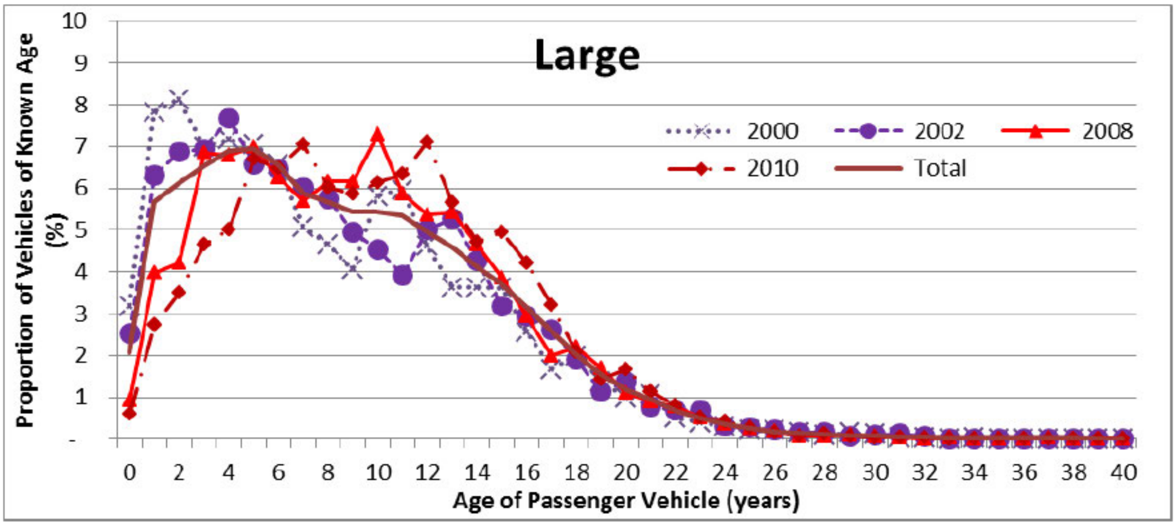

Figure J14: ***Proportion of Australian Large crashed passenger vehicles involved in injury crashes, by vehicle age.***

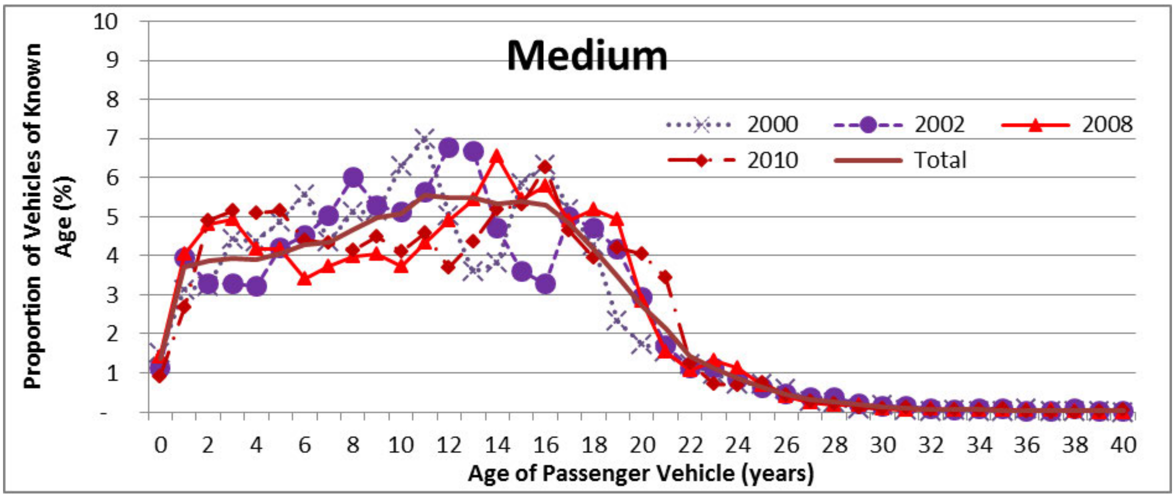

Figure J15: ***Proportion of Australian Medium crashed passenger vehicles involved in injury crashes, by vehicle age.***

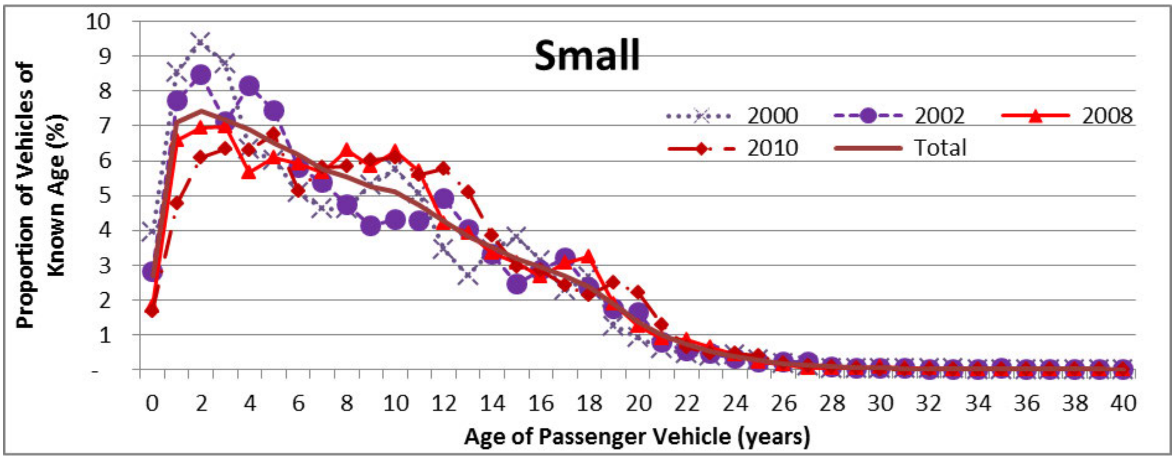

Figure J16: ***Proportion of Australian Small crashed passenger vehicles involved in injury crashes, by vehicle age.***

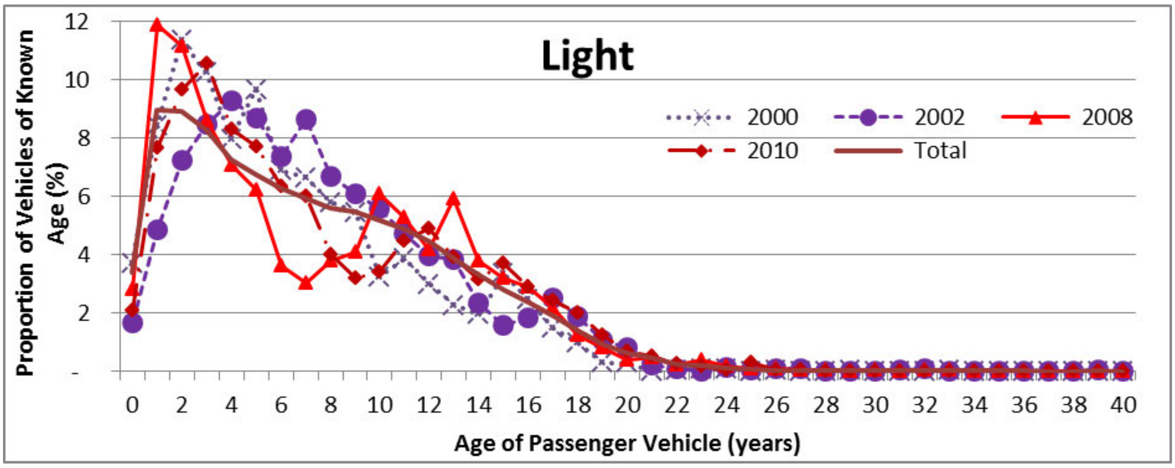

Figure J17: ***Proportion of Australian Light crashed passenger vehicles involved in injury crashes, by vehicle age.***

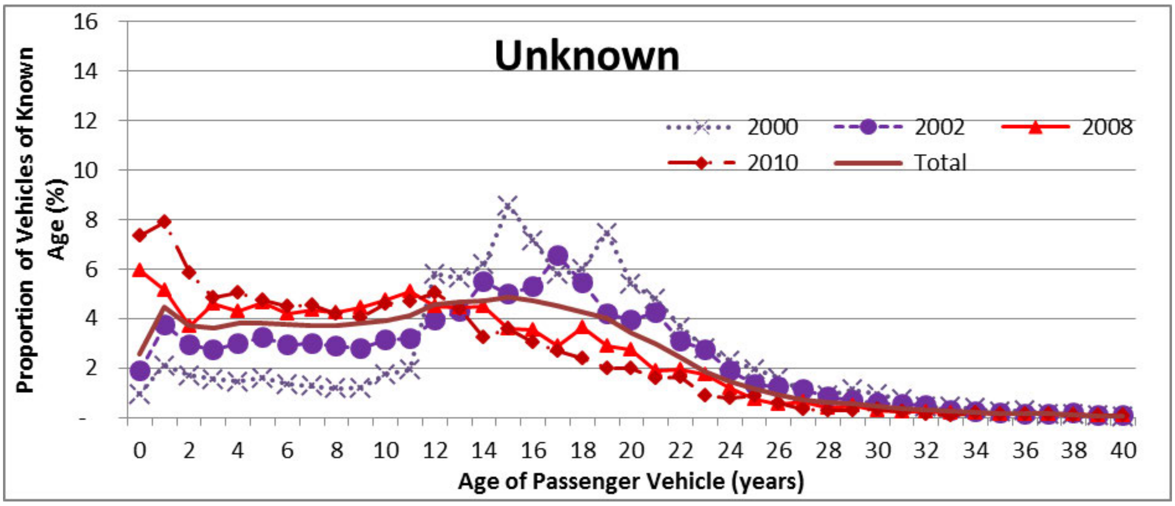

Figure J18: ***Proportion of Australian crashed passenger vehicles with an unknown market group, involved in injury crashes, by vehicle age for motor vehicles.***

Figures J19 to J35 give current age group profiles of crashed passenger vehicles with a year of manufacture: 2000-2010.

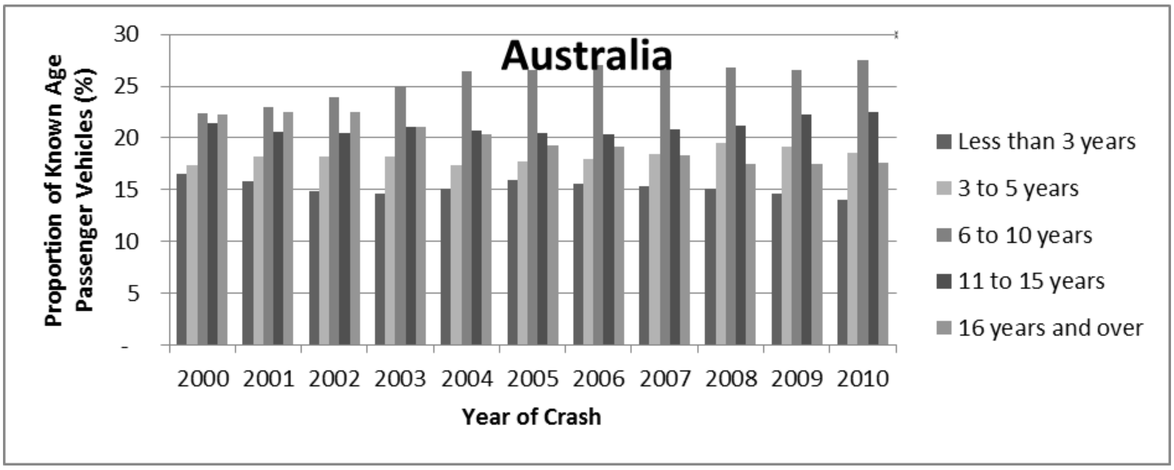

Figure J19: ***Proportion of Australian crashed passenger vehicles involved in injury crashes, with a year of manufacture, by vehicle age and crash year.***

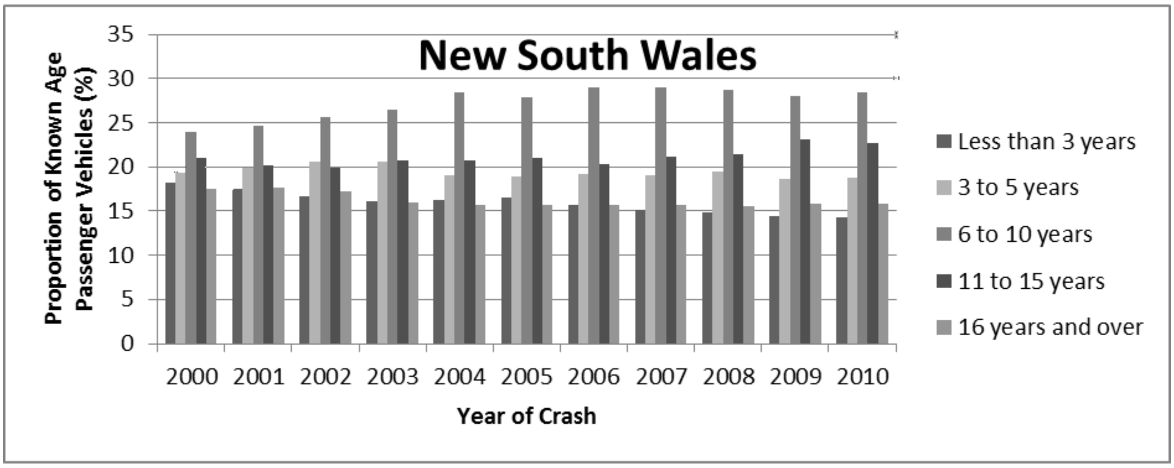

Figure J20: ***Proportion of crashed passenger vehicles involved in New South Wales in injury crashes, with a year of manufacture, by vehicle age and crash year.***

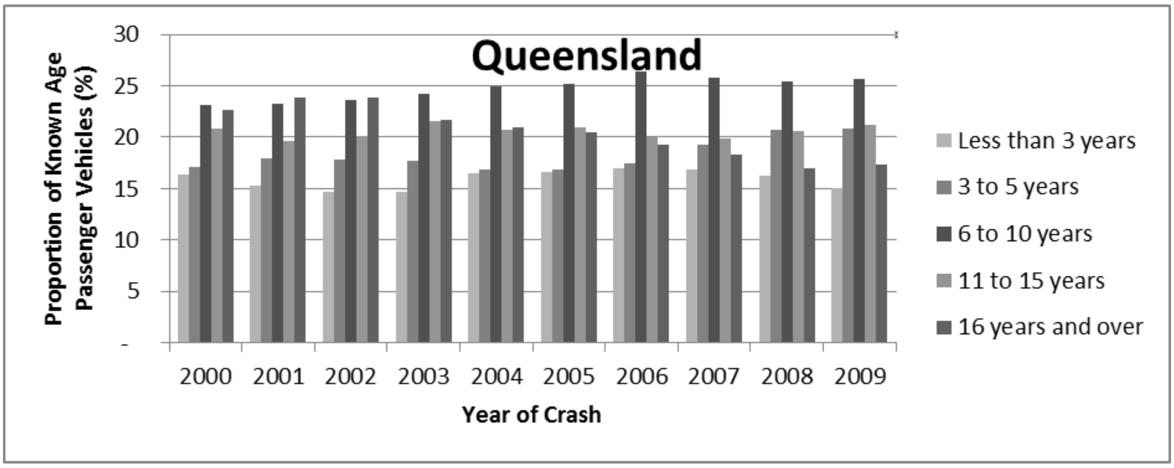

Figure J21: ***Proportion of crashed passenger vehicles in Queensland involved in injury crashes, with a year of manufacture, by vehicle age and crash year.***

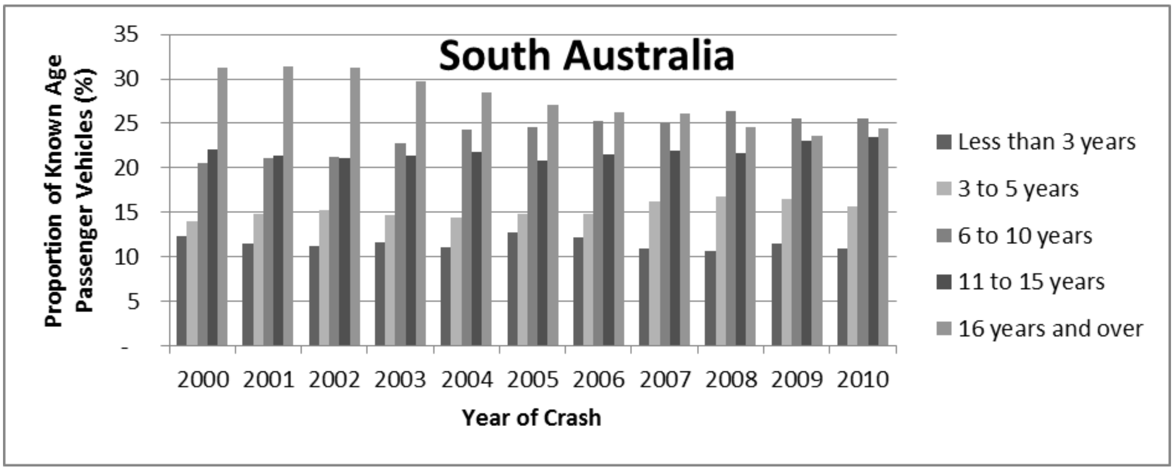

Figure J22: ***Proportion of South Australian crashed passenger vehicles involved in injury crashes, with a year of manufacture, by vehicle age and crash year.***

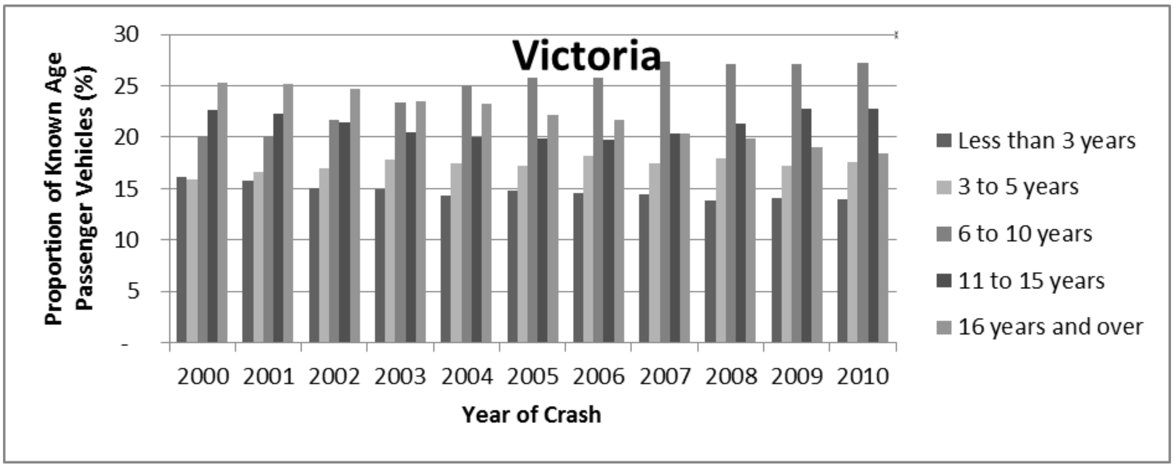

Figure J23: ***Proportion of Victorian crashed passenger vehicles involved in injury crashes, with a year of manufacture, by vehicle age and crash year.***

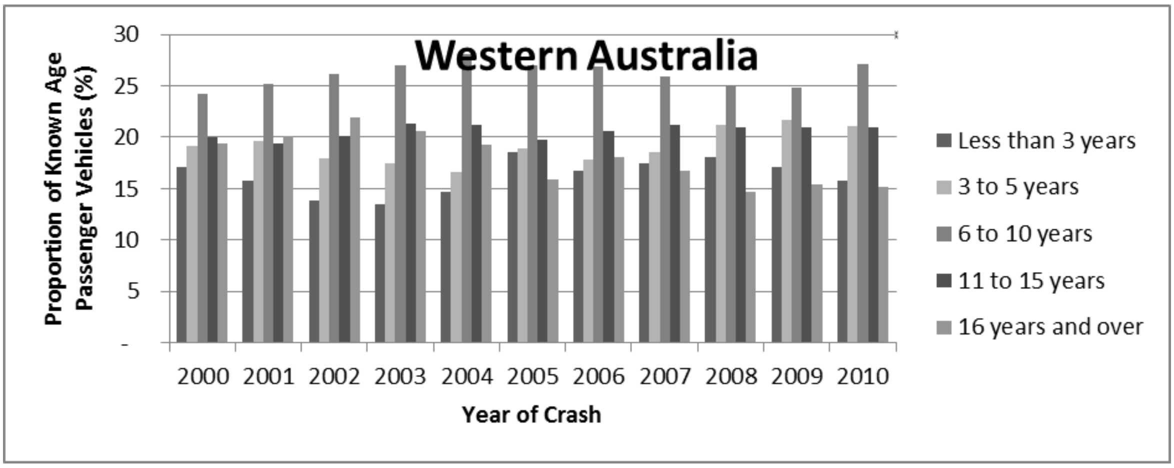

Figure J24: ***Proportion of Western Australian crashed passenger vehicles involved in injury crashes, with a year of manufacture, by vehicle age and crash year.***

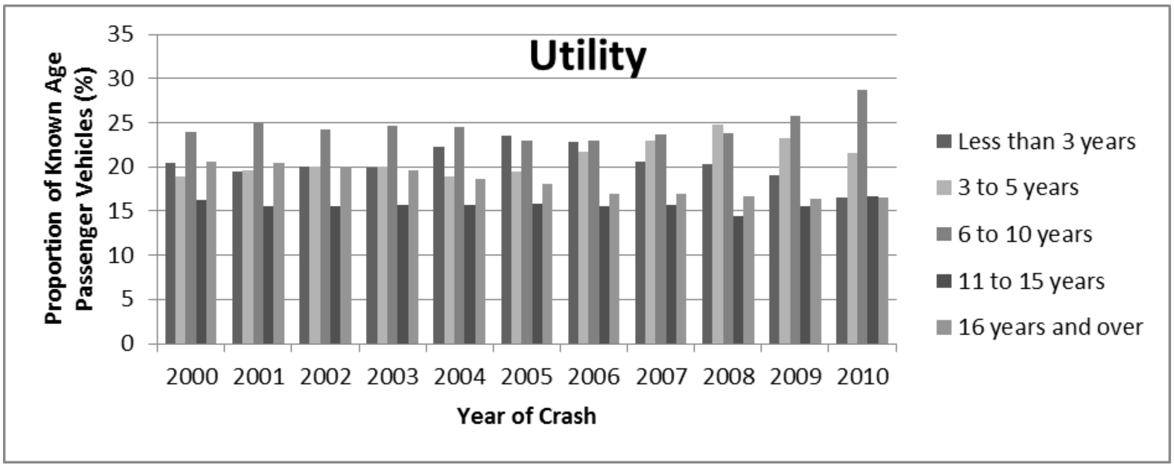

Figure J25: ***Proportion of crashed Light Commercial Utilities involved in injury crashes, with a year of manufacture, by vehicle age and crash year.***

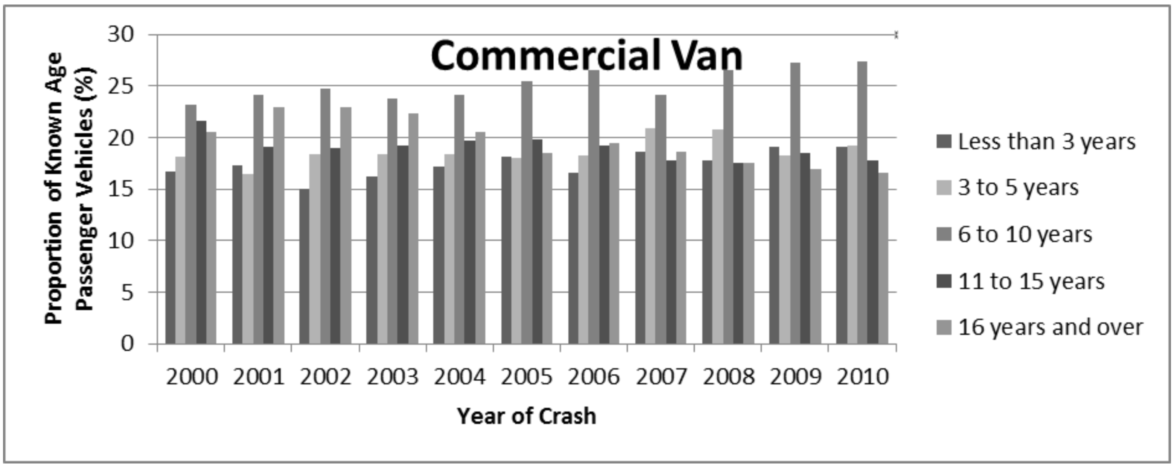

Figure J26: ***Proportion of crashed Light Commercial Vans involved in injury crashes, with a year of manufacture, by vehicle age and crash year.***

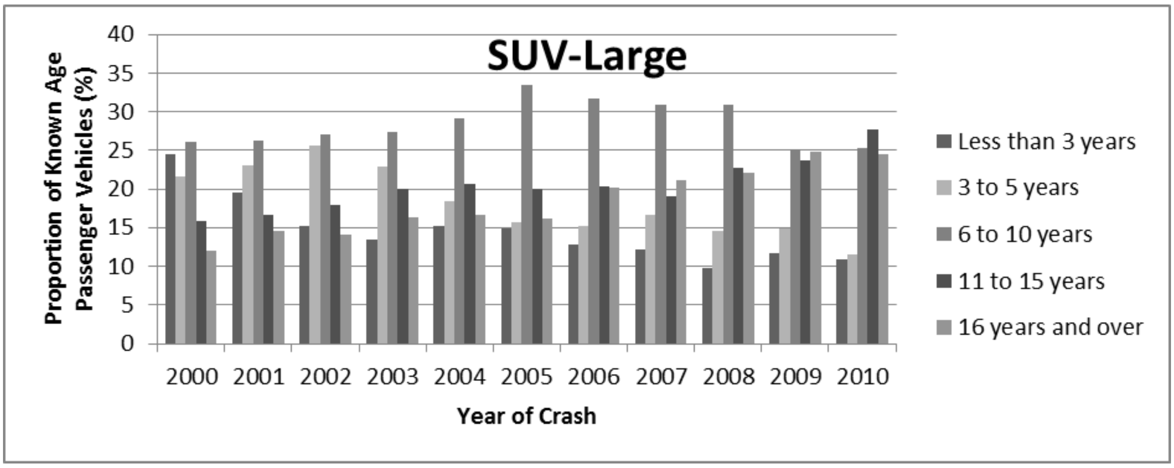

Figure J27: ***Proportion of crashed Large SUVs involved in injury crashes, with a year of manufacture, by vehicle age and crash year.***

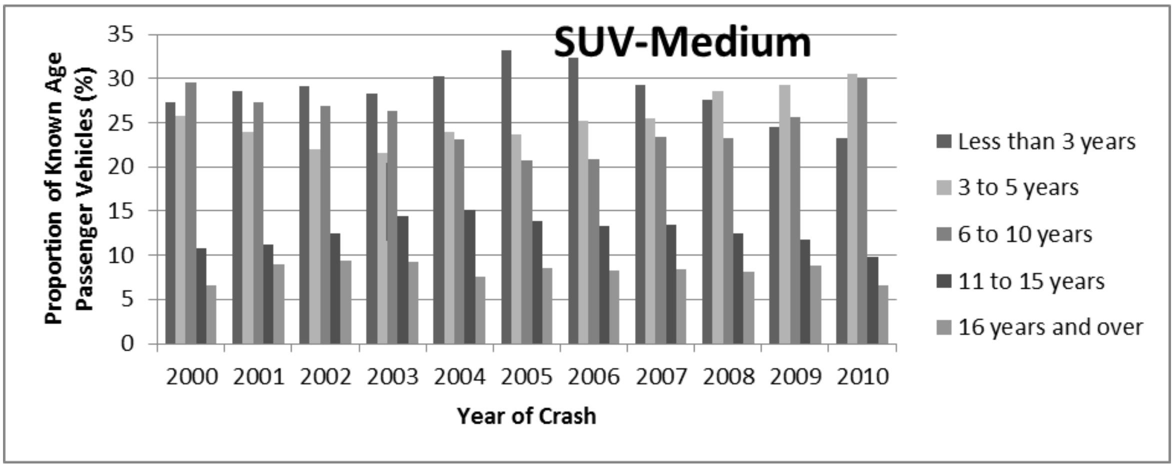

Figure J28: ***Proportion of crashed Medium SUVs involved in injury crashes, with a year of manufacture, by vehicle age and crash year.***

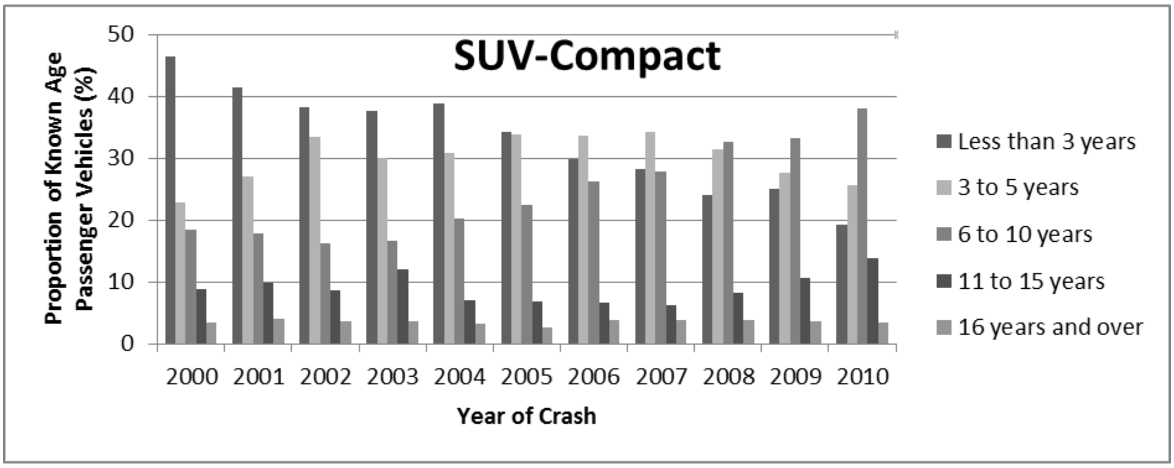

Figure J29: ***Proportion of crashed Compact SUVs involved in injury crashes, with a year of manufacture, by vehicle age and crash year.***

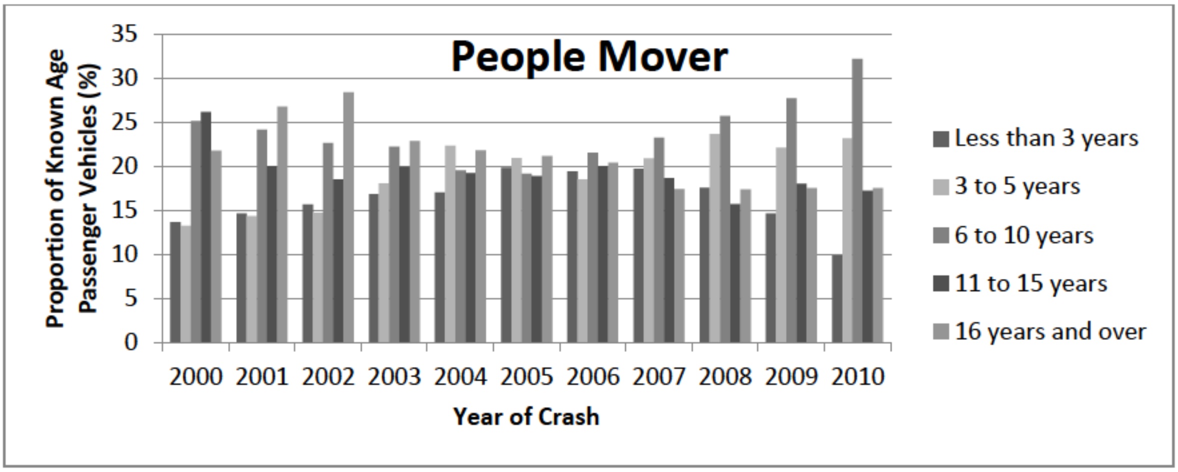

Figure J30: ***Proportion of crashed Compact SUVs involved in injury crashes, with a year of manufacture, by vehicle age and crash year.***

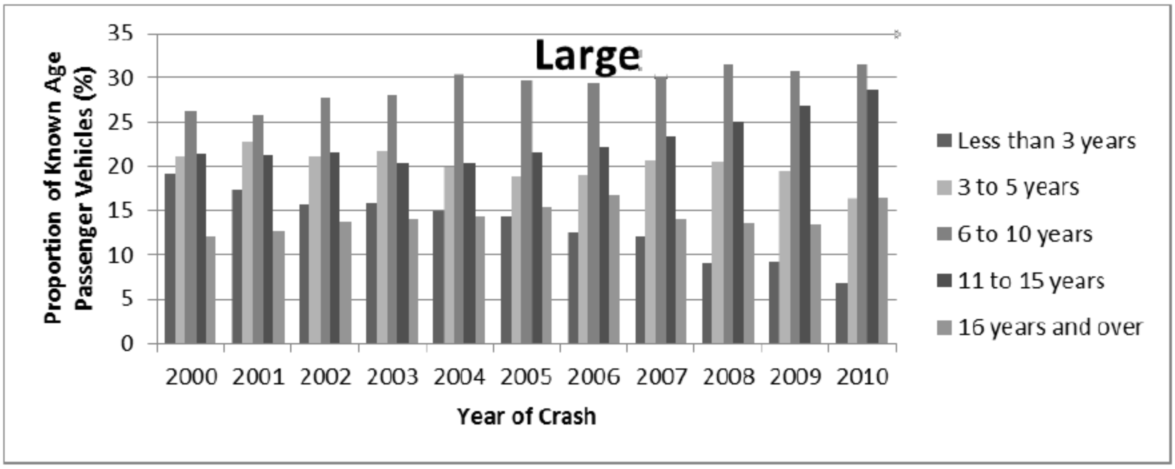

Figure J31: ***Proportion of crashed Large passenger vehicles involved in injury crashes, with a year of manufacture, by vehicle age and crash year.***

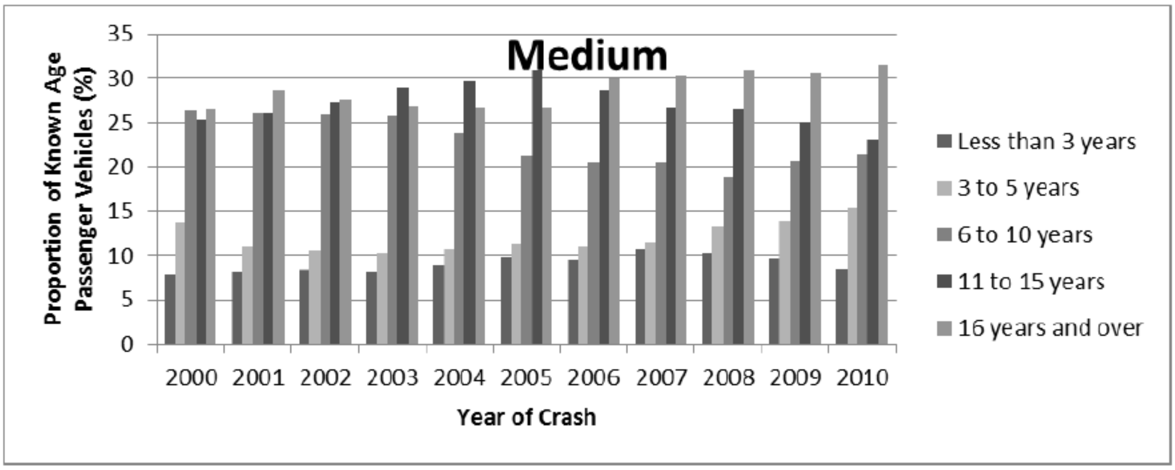

Figure J32: ***Proportion of crashed Medium passenger vehicles involved in injury crashes, with a year of manufacture, by vehicle age and crash year.***

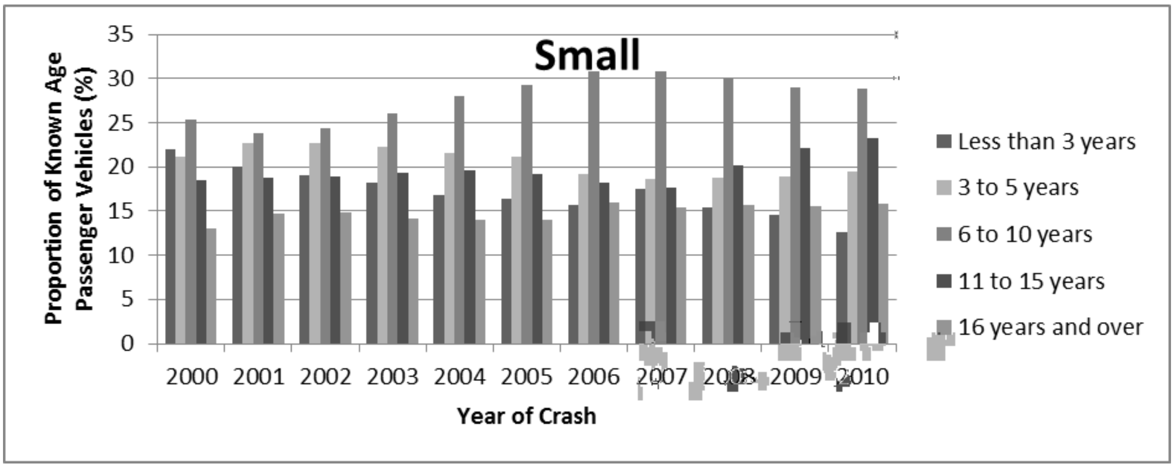

Figure J33: ***Proportion of crashed Small passenger vehicles involved in injury crashes, with a year of manufacture, by vehicle age and crash year.***

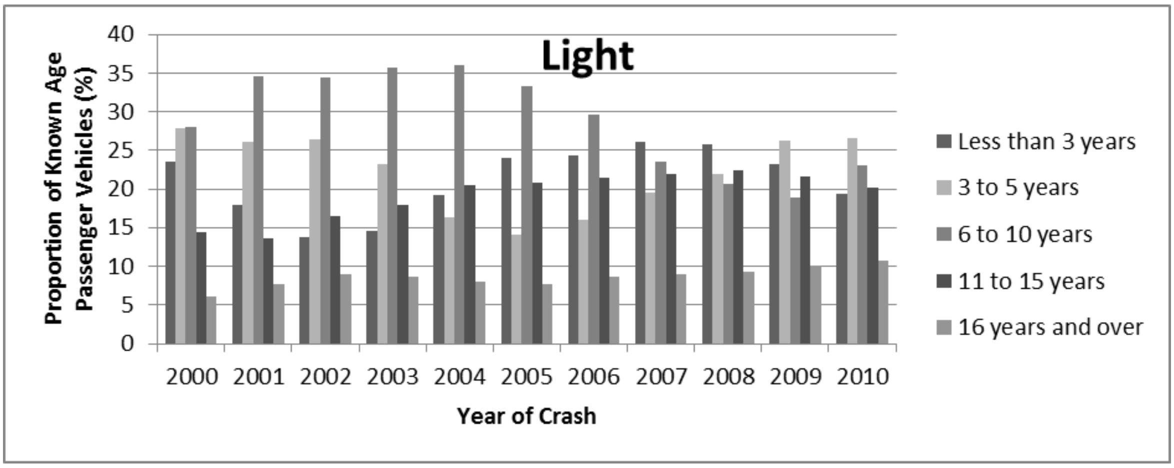

Figure J34: ***Proportion of crashed Light passenger vehicles involved in injury crashes, with a year of manufacture, by vehicle age and crash year.***

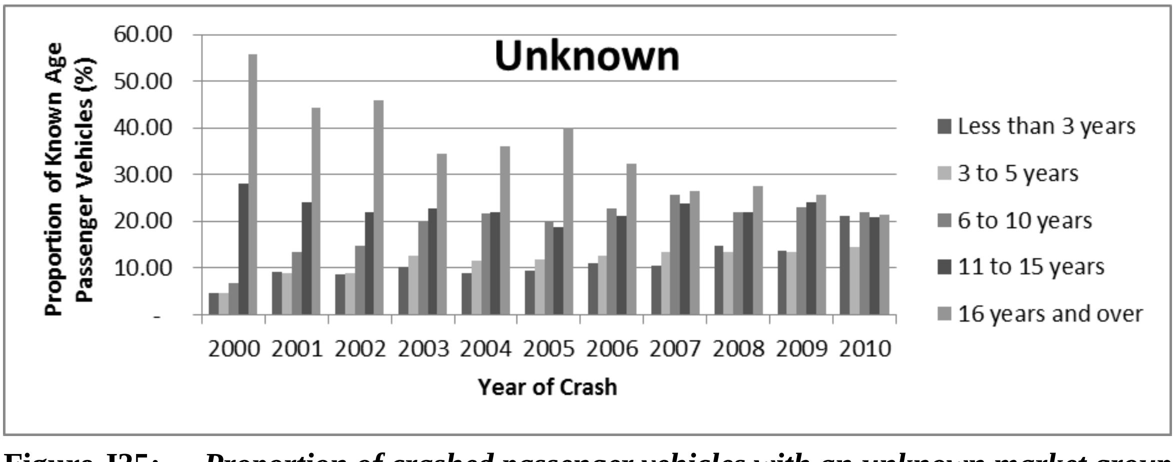

Figure J35: ***Proportion of crashed passenger vehicles with an unknown market group involved in injury crashes, with a year of manufacture, by vehicle age and crash year.***

Figures J36 to J51 give actual (2000 and 2009 or 2010) and projected (2016 and 2020) age profiles of injury crash involved passenger vehicles in Australia (with a year of manufacture) by crash year.

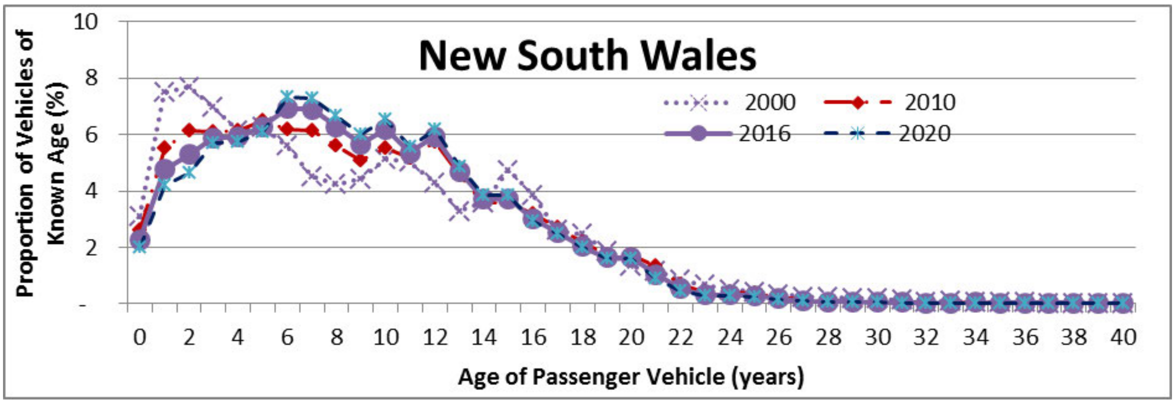

Figure J36: ***Actual (2000,2010) and Projected (2016, 2020) Age Profiles of injury crash involved passenger vehicles in New South Wales (with a year of manufacture) by crash year.***

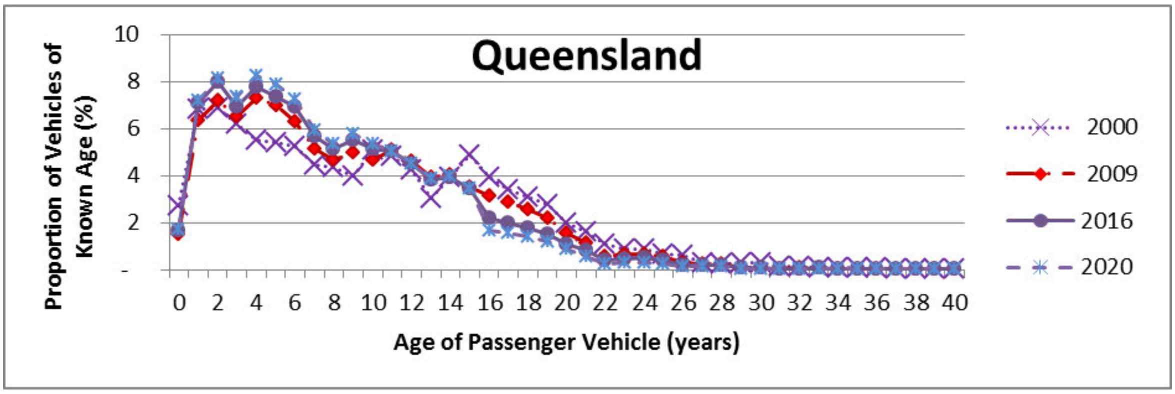

Figure J37: Actual (2000,2009) and Projected (2016, 2020) Age Profiles of injury crash involved passenger vehicles in Queensland (with a year of manufacture) by crash year.

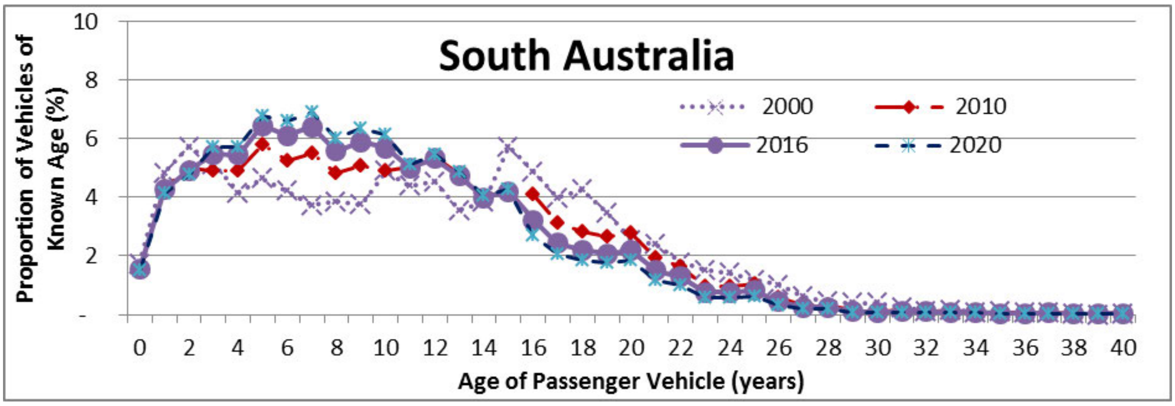

Figure J38: ***Actual (2000,2010) and Projected (2016, 2020) Age Profiles of injury crash involved passenger vehicles in South Australia (with a year of manufacture) by crash year.***

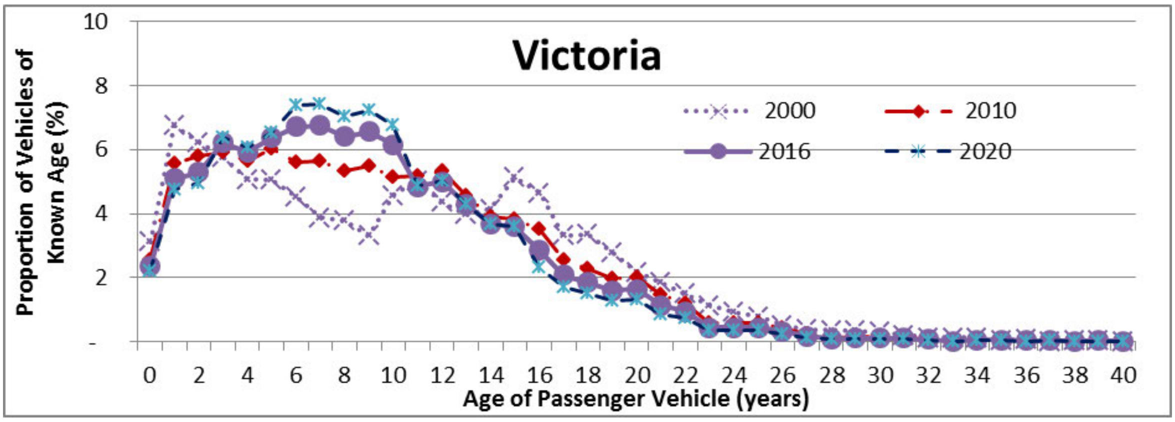

Figure J39: ***Actual (2000,2010) and Projected (2016, 2020) Age Profiles of injury crash involved passenger vehicles in Victoria (with a year of manufacture) by crash year.***

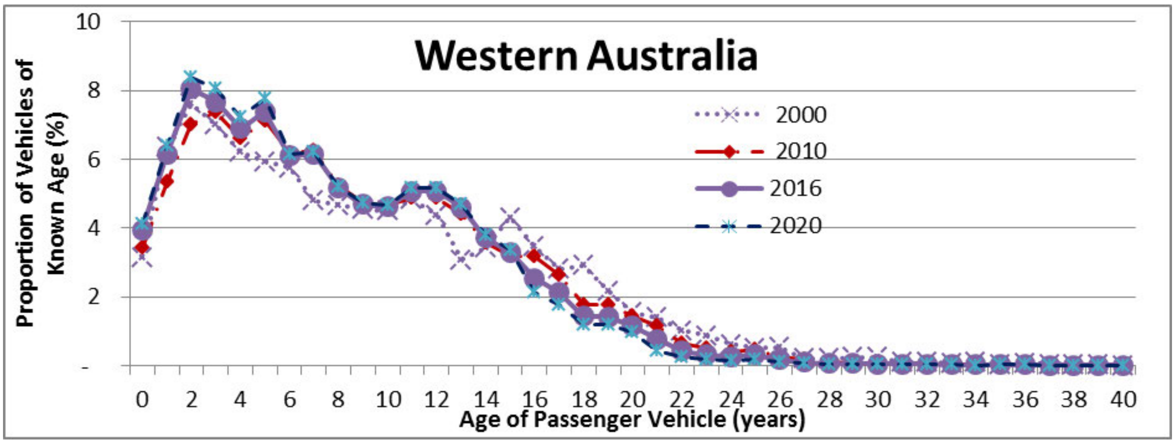

Figure J40: ***Actual (2000,2010) and Projected (2016, 2020) Age Profiles of injury crash involved passenger vehicles in Western Australia (with a year of manufacture) by crash year.***

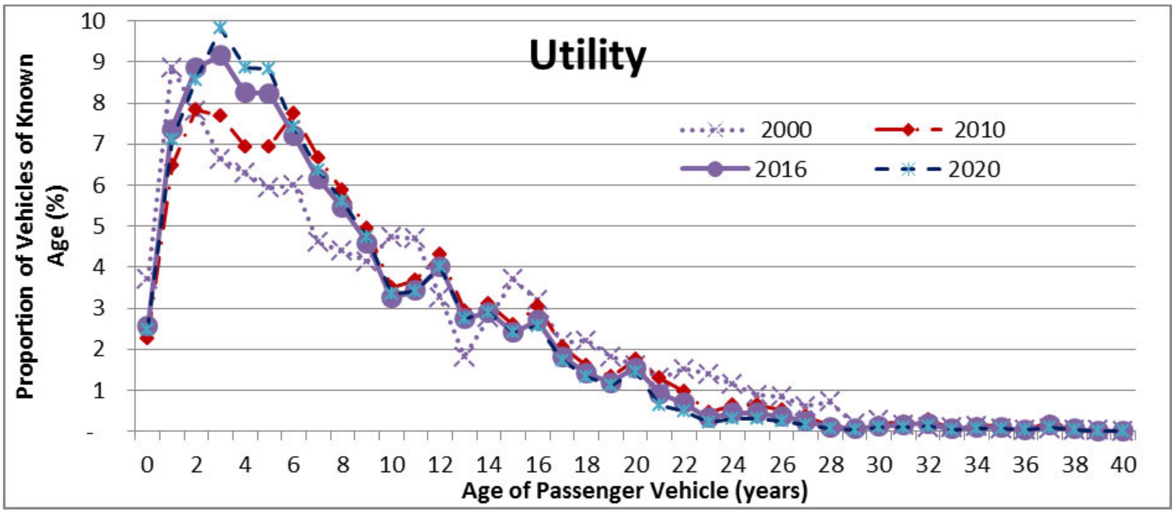

Figure J41: ***Actual (2000,2010) and Projected (2016, 2020) Age Profiles of injury crash involved Light Commercial Utilities (with a year of manufacture) by crash year.***

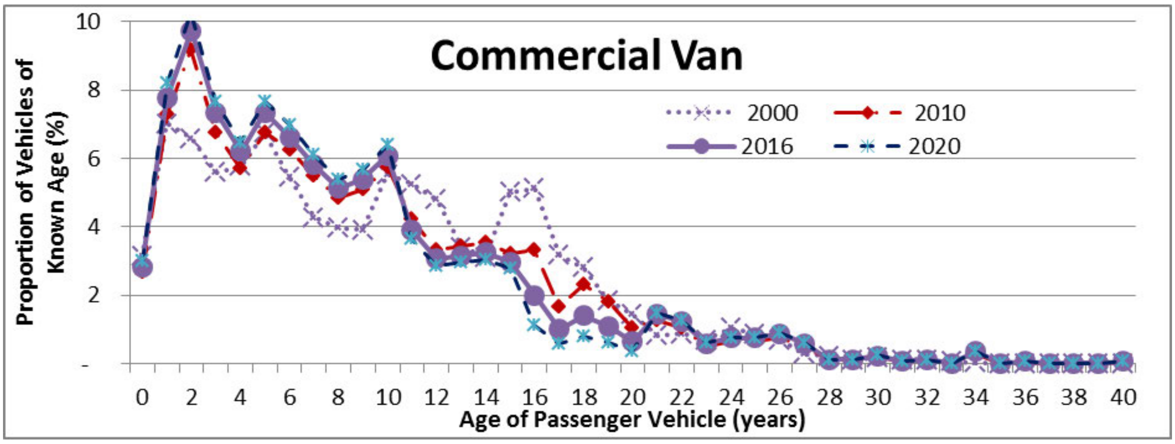

Figure J42: *Actual (2000,2010) and Projected (2016, 2020) Age Profiles of injury crash involved Light Commercial Vans (with a year of manufacture) by crash year.*

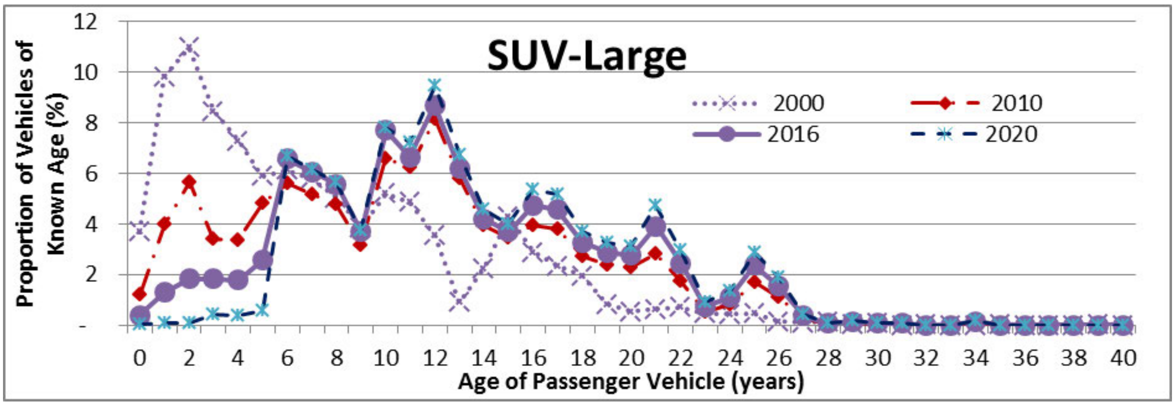

Figure J43: *Actual (2000,2010) and Projected (2016, 2020) Age Profiles of injury crash involved Large SUVs (with a year of manufacture) by crash year.*

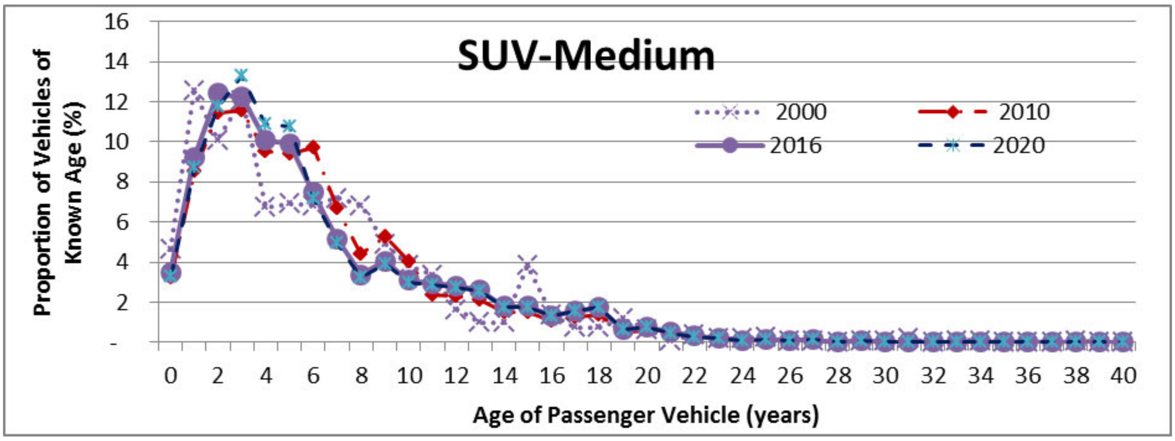

Figure J44: *Actual (2000,2010) and Projected (2016, 2020) Age Profiles of injury crash involved Medium SUVs (with a year of manufacture) by crash year.*

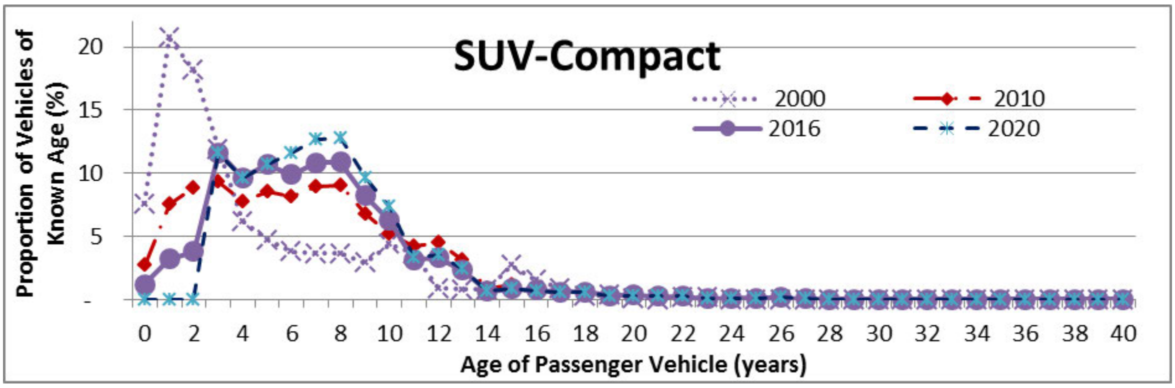

Figure J45: ***Actual (2000,2010) and Projected (2016, 2020) Age Profiles of injury crash involved Compact SUVs (with a year of manufacture) by crash year.***

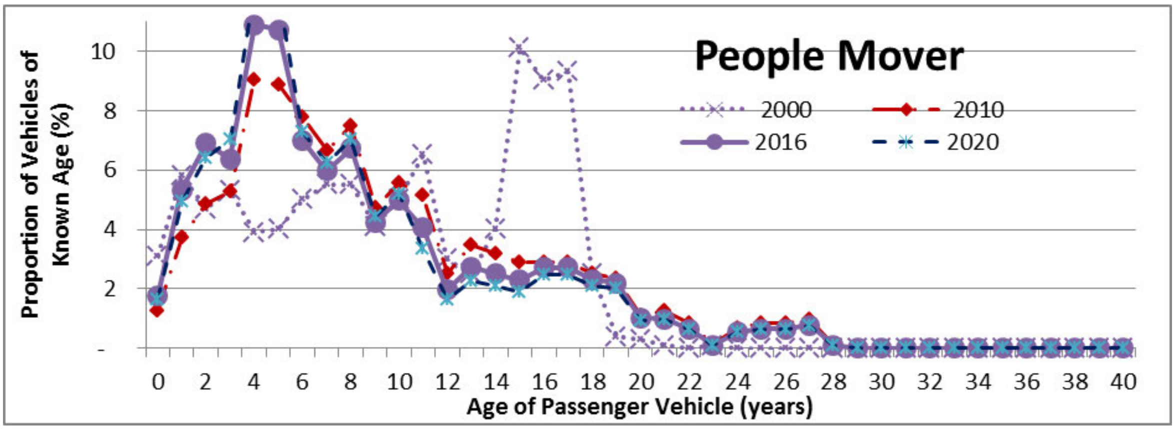

Figure J46: ***Actual (2000,2010) and Projected (2016, 2020) Age Profiles of injury crash involved People Movers (with a year of manufacture) by crash year.***

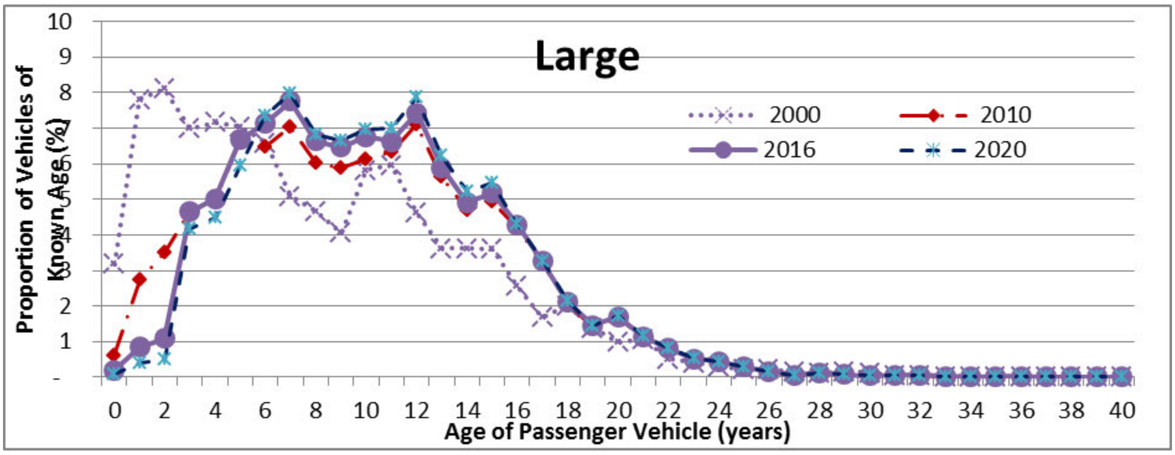

Figure J47: ***Actual (2000,2010) and Projected (2016, 2020) Age Profiles of injury crash involved Large passenger vehicles (with a year of manufacture) by crash year.***

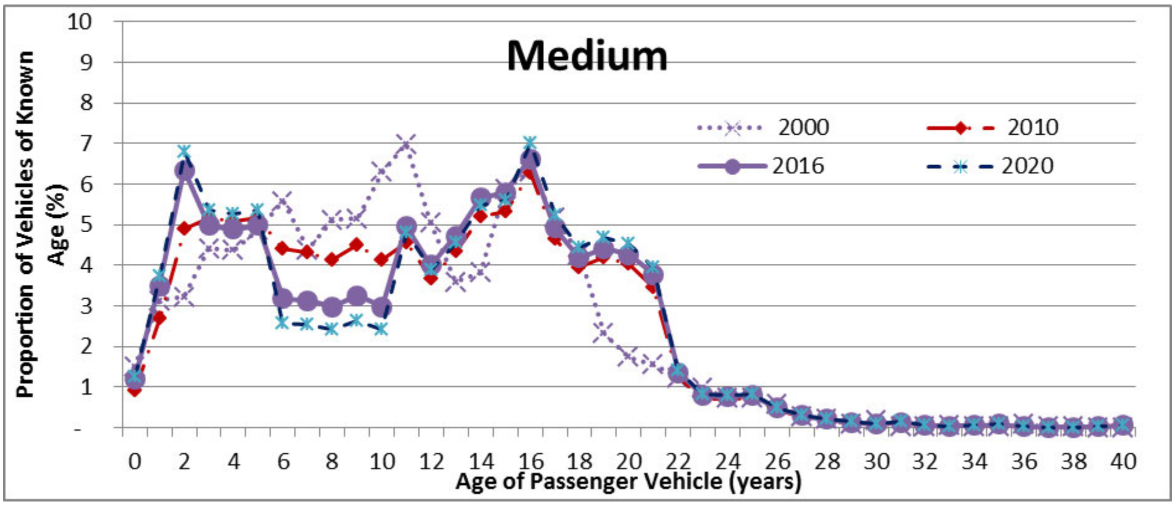

Figure J48: ***Actual (2000,2010) and Projected (2016, 2020) Age Profiles of injury crash involved Medium passenger vehicles (with a year of manufacture) by crash year.***

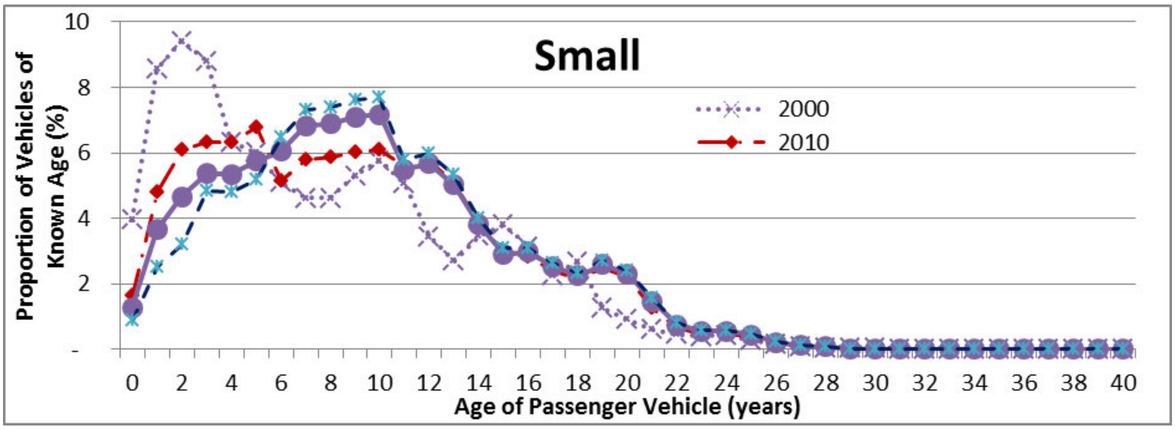

Figure J49: ***Actual (2000,2010) and Projected (2016, 2020) Age Profiles of injury crash involved Small passenger vehicles (with a year of manufacture) by crash year.***

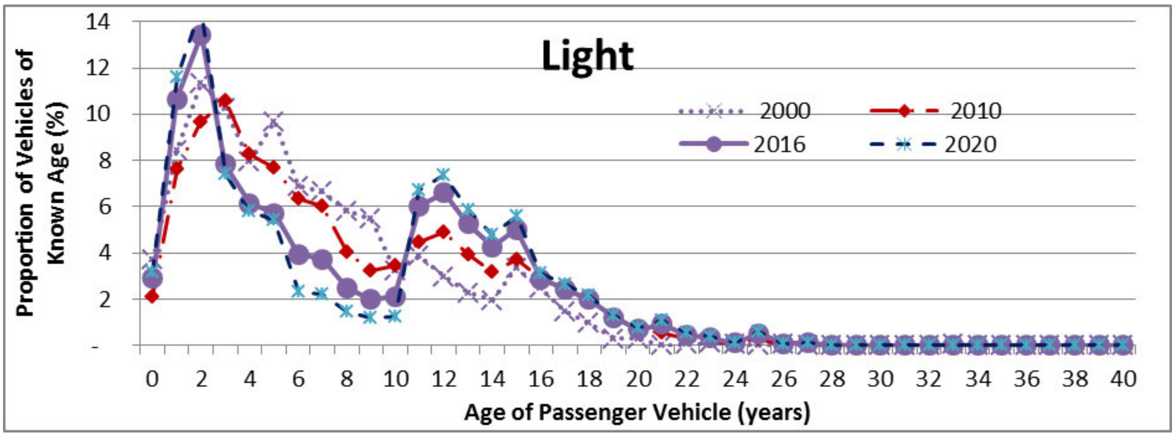

Figure J50: ***Actual (2000,2010) and Projected (2016, 2020) Age Profiles of injury crash involved Light passenger vehicles (with a year of manufacture) by crash year.***

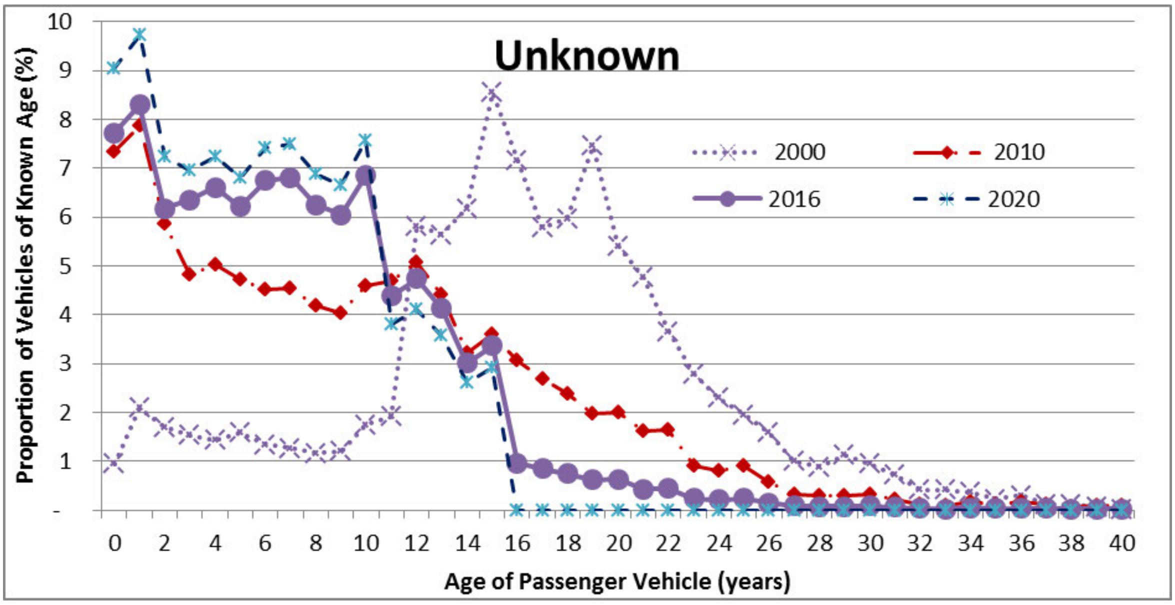

Figure J51: ***Actual (2000,2010) and Projected (2016, 2020) Age Profiles of injury crash involved passenger vehicles with an unknown market group (with a year of manufacture) by crash year.***

Figures J52 to J67 give trends over time, modelled with linear regression, for age group proportion distributions and crash year for injury crash involved passenger vehicles with a year of manufacture: 2000-2010.

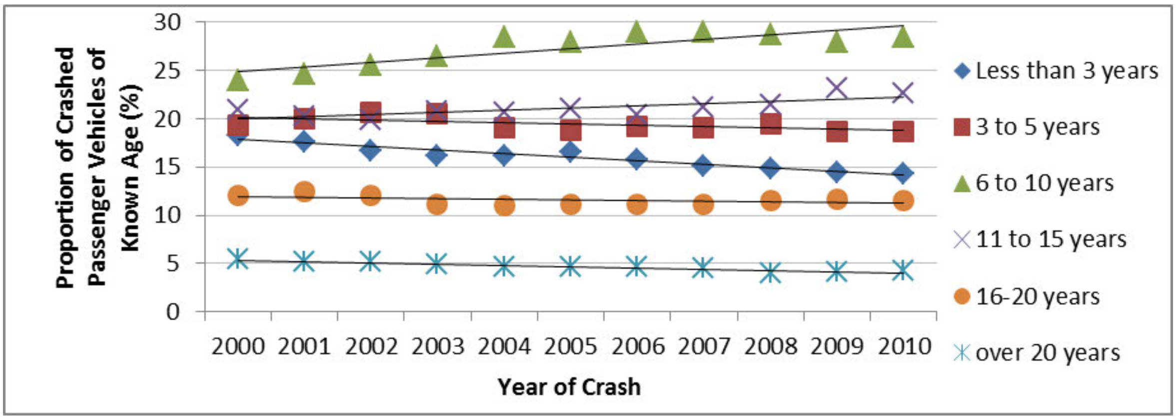

Figure J52: ***Trends in age group proportion over crash years: New South Wales.***

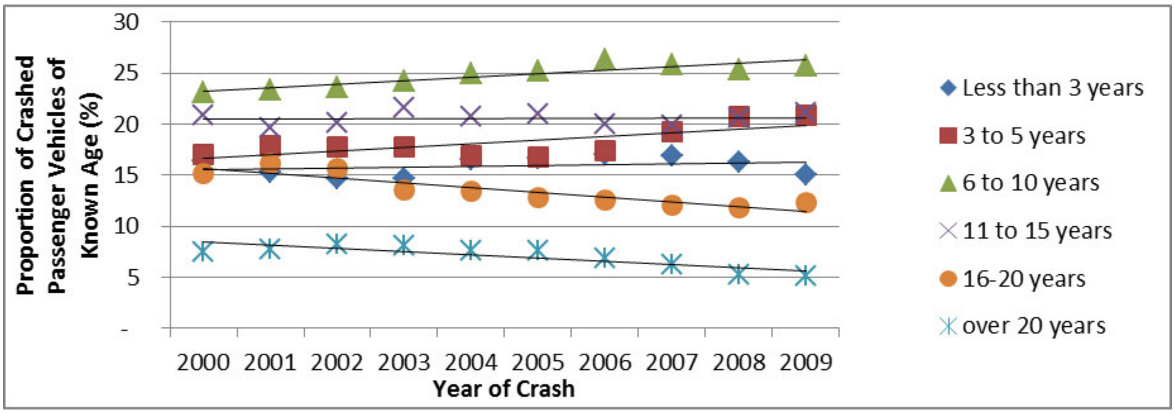

Figure J53: ***Trends in age group proportion over crash years: Queensland.***

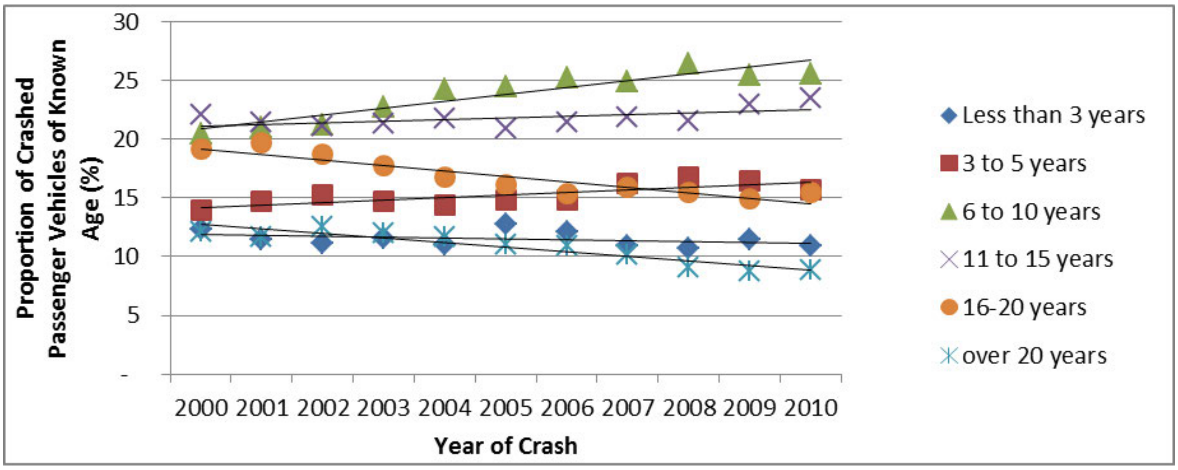

Figure J54: Trends in age group proportion over crash years: South Australia.

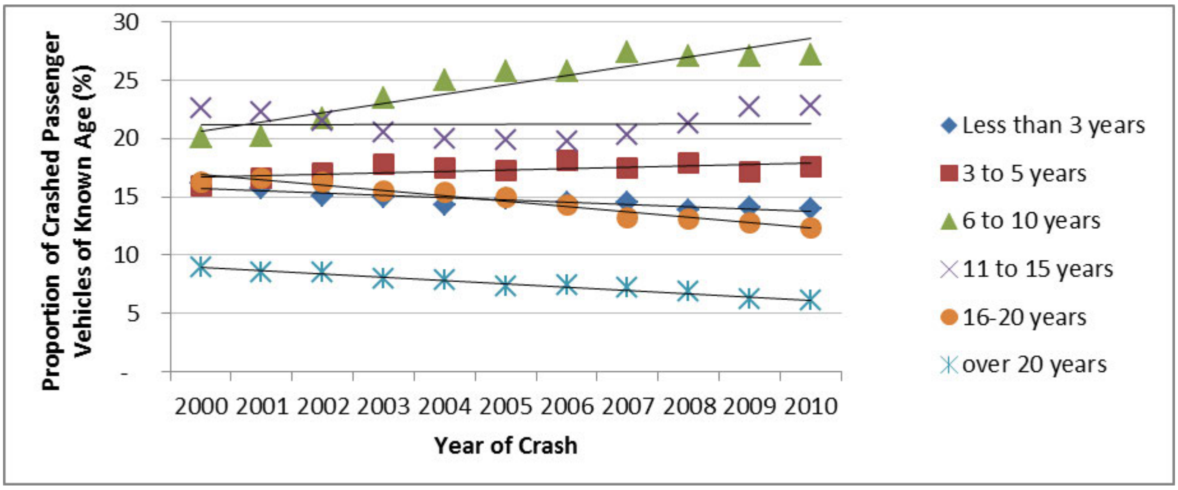

Figure J55: ***Trends in age group proportion over crash years: Victoria.***

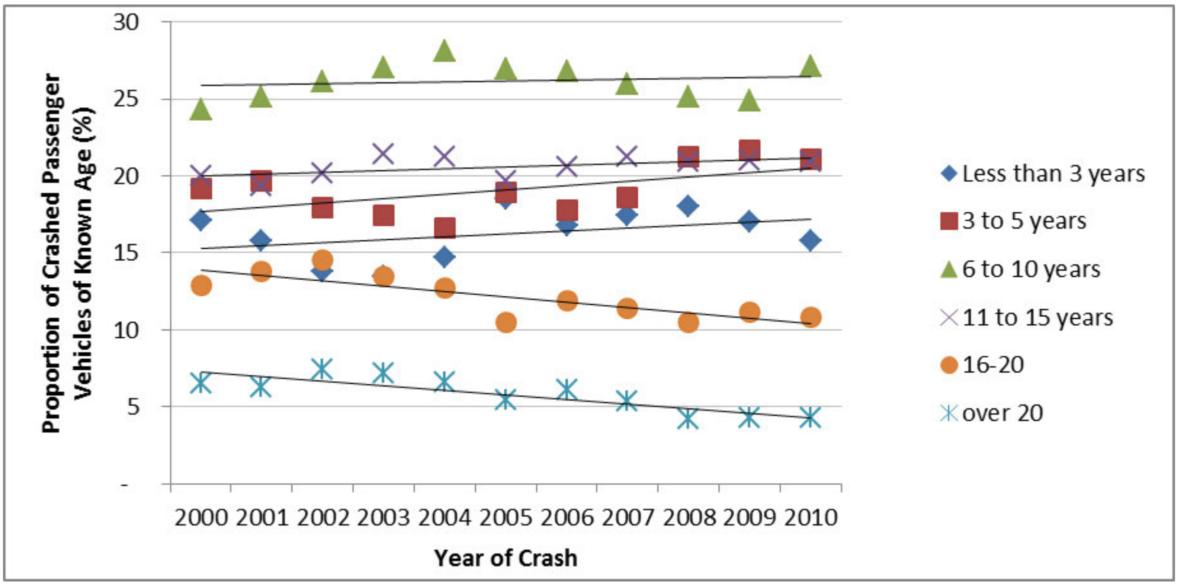

Figure J56: ***Trends in age group proportion over crash years: Western Australia.***

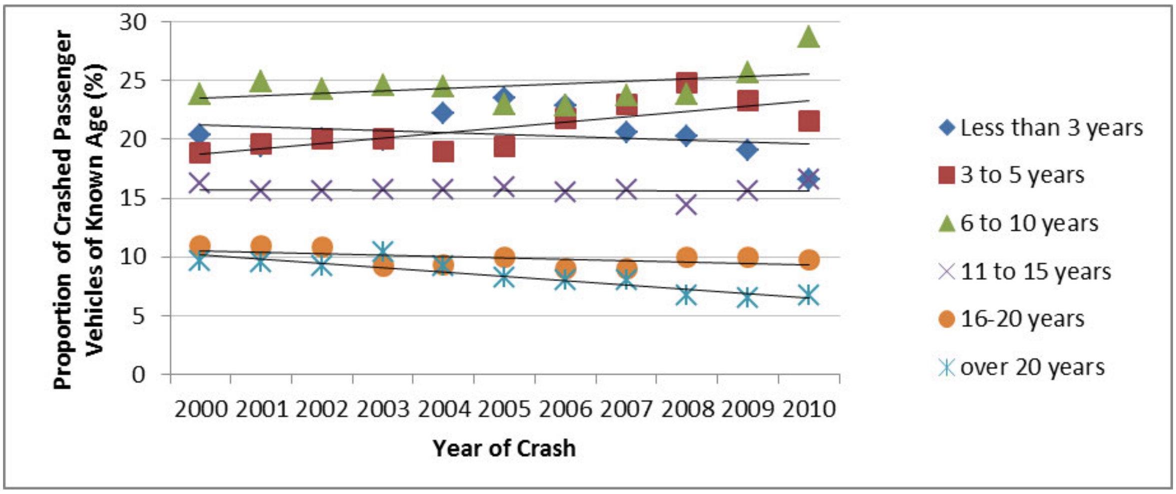

Figure J57: ***Trends in age group proportion over crash years: Utilities.***

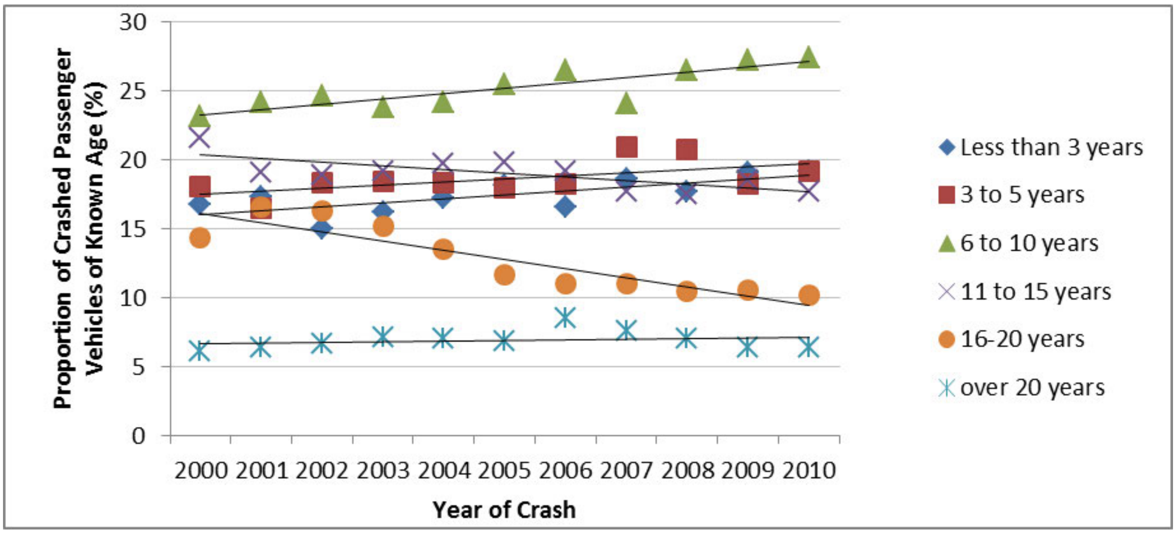

Figure J58: ***Trends in age group proportion over crash years: Light Commercial Vans.***

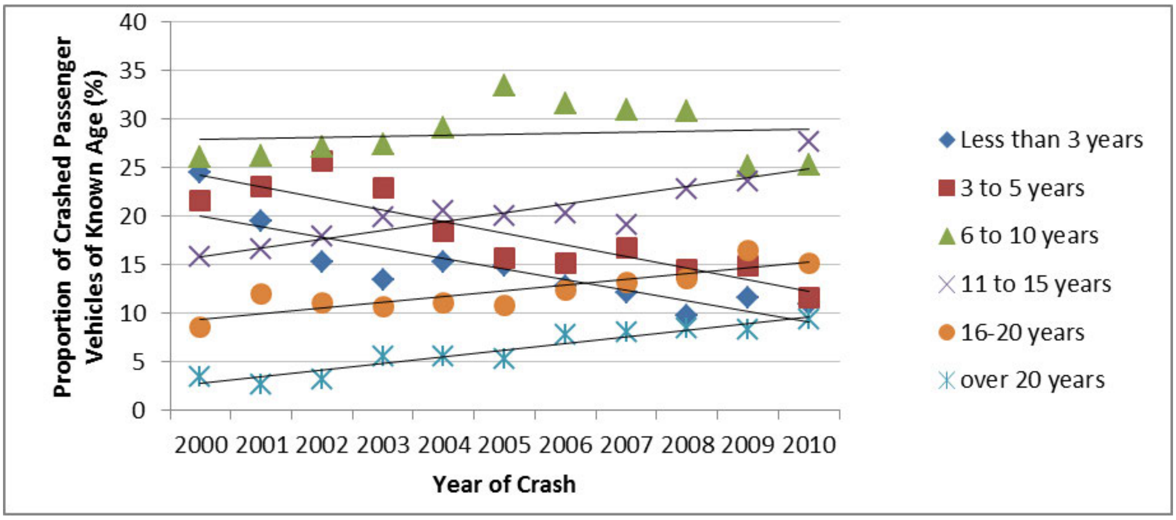

Figure J59: ***Trends in age group proportion over crash years: Large SUVs.***

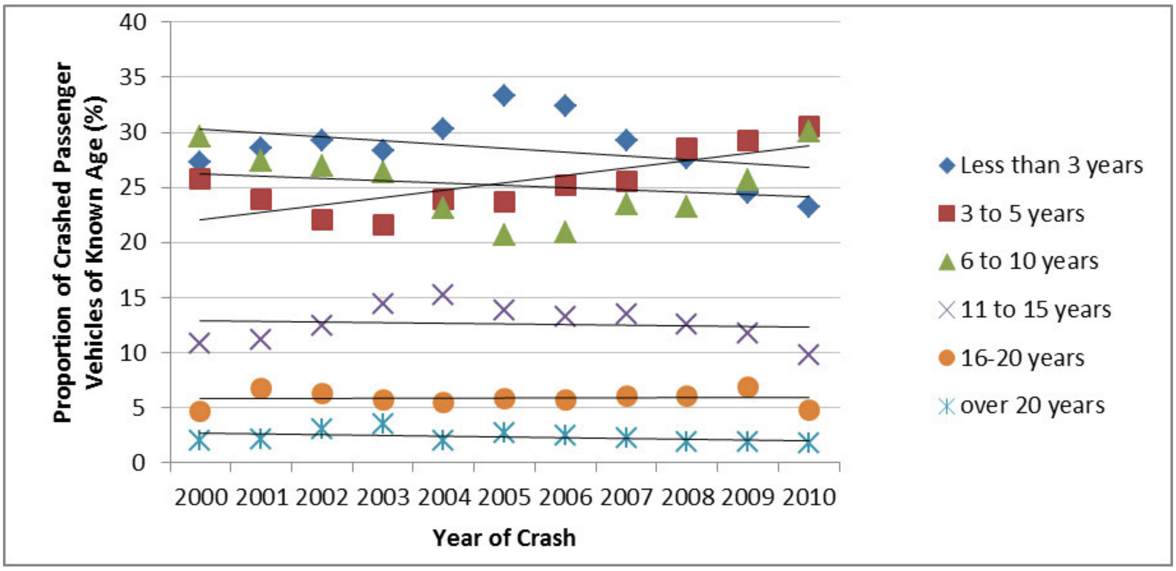

Figure J60: ***Trends in age group proportion over crash years: Medium SUVs.***

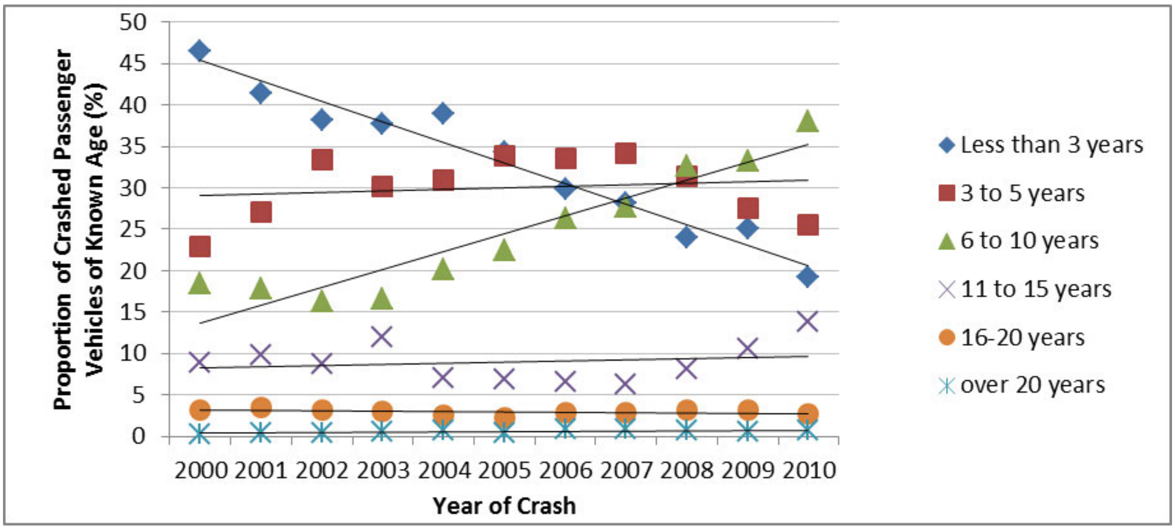

Figure J61: ***Trends in age group proportion over crash years: Compact SUVs.***

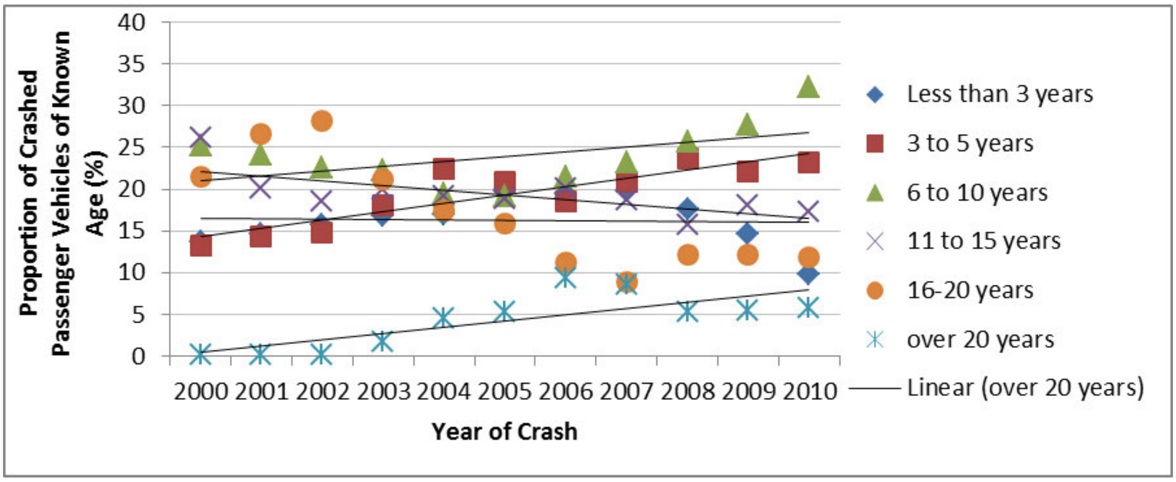

Figure J62: ***Trends in age group proportion over crash years: People Movers.***

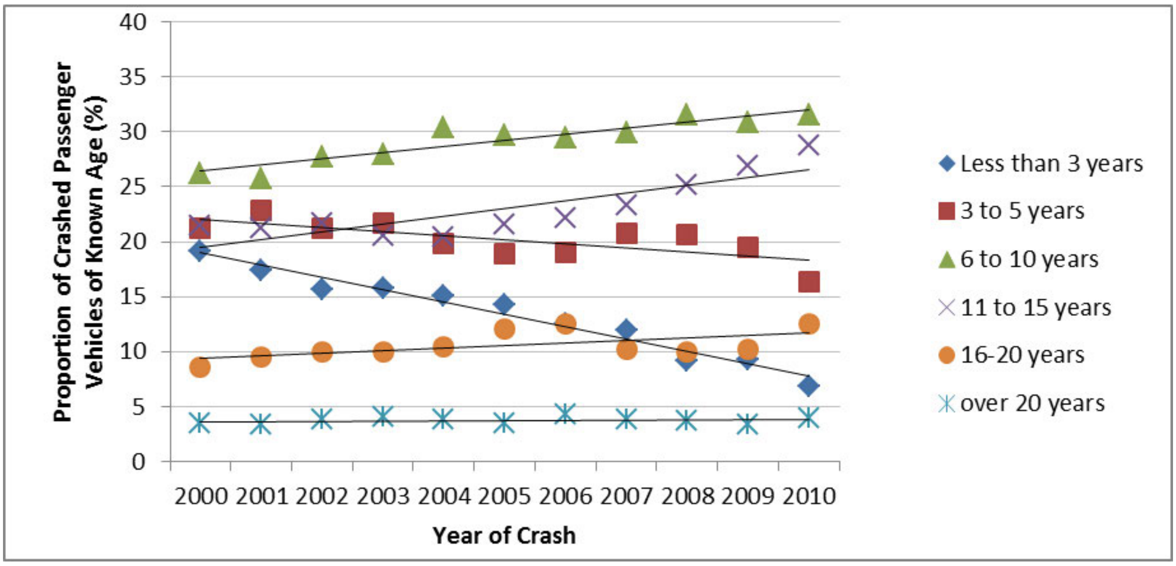

Figure J63: ***Trends in age group proportion over crash years: Large passenger vehicles.***

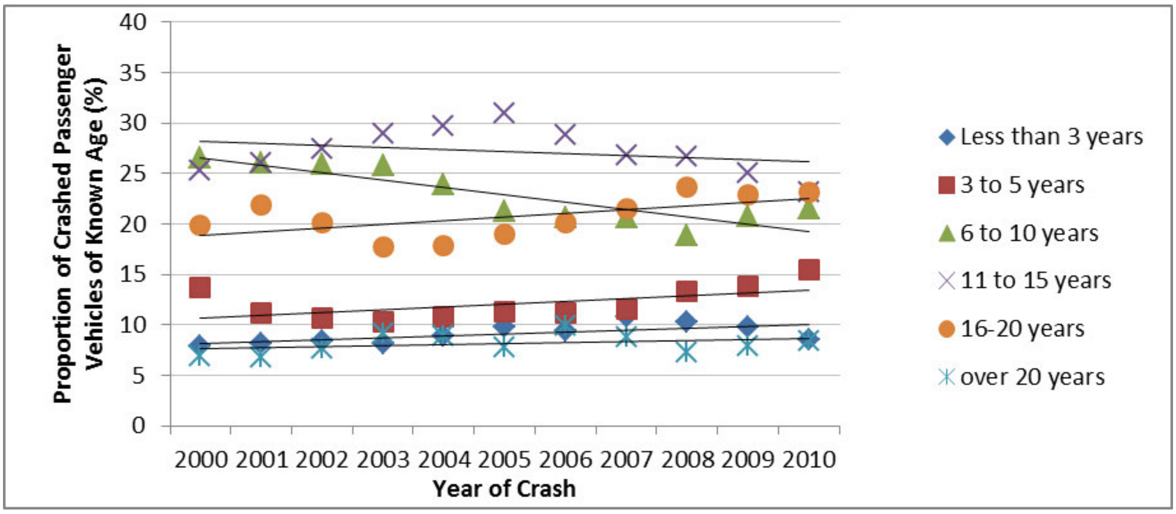

Figure J64: ***Trends in age group proportion over crash years: Medium passenger vehicles.***

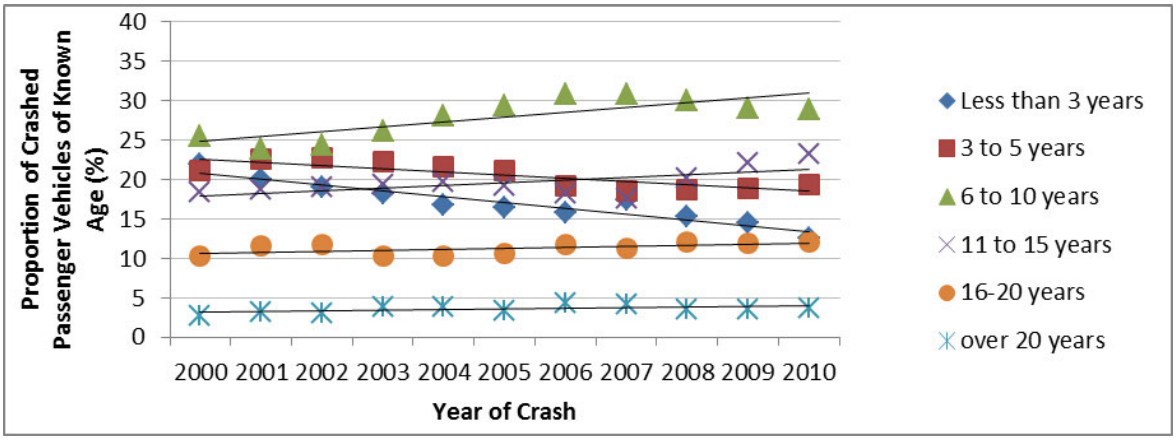

Figure J65: ***Trends in age group proportion over crash years: Small passenger vehicles.***

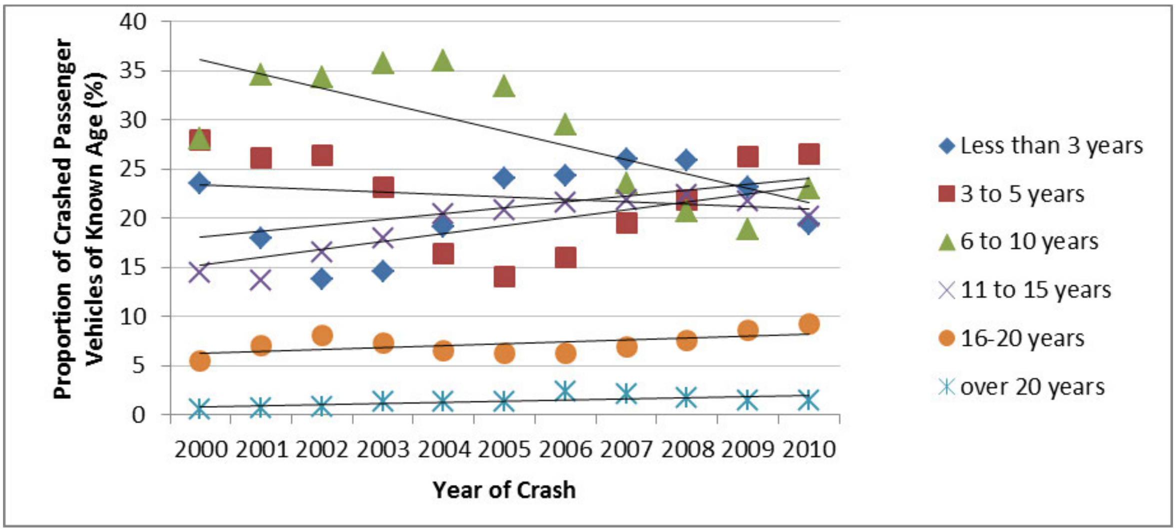

Figure J66: ***Trends in age group proportion over crash years: Light passenger vehicles.***

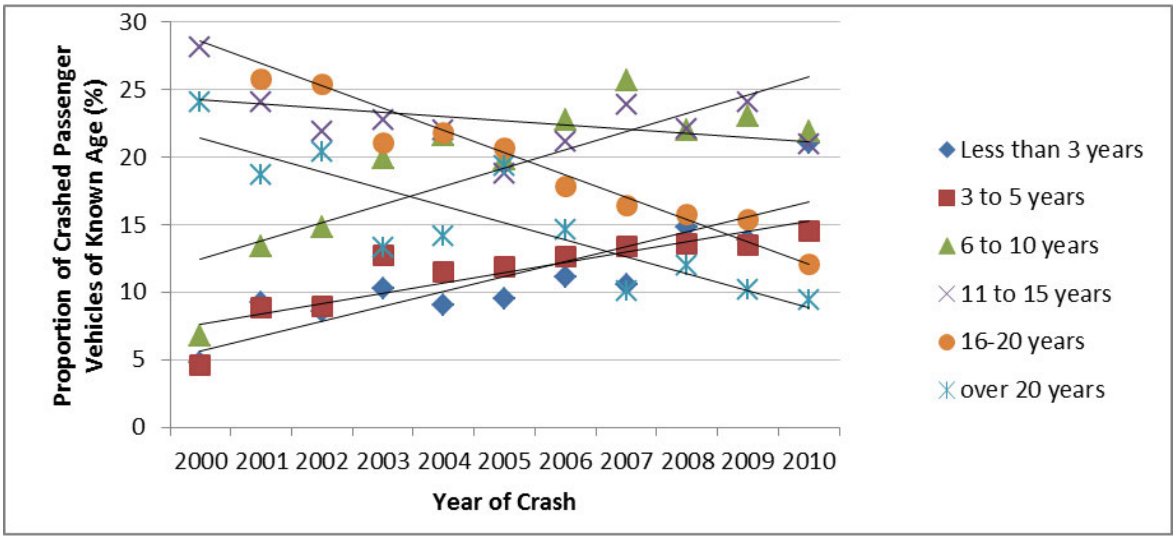

Figure J67: Trends in age group proportion over crash years: passenger vehicles with an unknown market group.

21 APPENDIX K – NET GAIN IN CRASHED VEHICLES

A vehicle which remains in the fleet in 2010 will be one year older in 2011, two years older in 2012 and three years older in 2013. The net gain of zero year old vehicles in 2011 is the number of 2011 new vehicle registration. The net gain in one year old fleet vehicles in 2011 will be the current number less those that were new (zero years old) in 2010. The net gain of vehicles two years old in 2011 will be the current less those that were one year old in 2010. And so forth. In this study, the crashed passenger fleet is modelled the same way. Table K1 displays the actual 2010 and projected crashed vehicles for aggregated Australian injury crash, passenger vehicle data (purple) and the net crashed passenger vehicle gain at each vehicle age within a crash year for this data (blue). Following the example above, the net gain for vehicles of the 2011 crash year is: 2,488 aged zero years, 5,045-2,406 aged one year and 5,743-4,879 aged two years. Projections are not whole numbers so differences calculated in the table may differ from subtraction of the integer versions. The final column of the table is the sum of the net gains over the ten year period. Net losses are not shown.

Table K1: ***Estimated Net Gain in crashed passenger vehicles (with YOM) involved in injury crashes (2011-2020) for aggregated data by age of vehicles age (0 to 46 years) and crash year.***

Age= Vehicle Age at time of crash in years   Projections of crashed vehicle fleet allowed for fleet decline

2,406	2,488	2,450	2,414	2,379	2,344	2,311	2,279	2,247	2,216	2,186	
4,879	2,638	4,968	4,894	4,822	4,753	4,686	4,620	4,556	4,494	4,432	44,863
5,554	864	3,249	5,571	5,490	5,411	5,334	5,259	5,187	5,115	5,046	46,526
5,633	163	839	3,316	5,728	5,735	5,744	5,754	5,766	5,778	5,791	44,615
5,430	-	-	637	3,115	5,529	5,537	5,547	5,558	5,570	5,583	37,075
5,874	532	330	413	1,094	3,574	5,990	6,001	6,013	6,025	6,039	36,012
5,394	-	111	-	106	843	3,378	5,848	5,911	5,976	6,041	28,214
5,442	138	-	220	78	219	957	3,493	5,964	6,029	6,095	23,194
4,897	-	-	-	-	-	-	429	2,960	5,425	5,484	14,298
4,667	-	-	-	-	-	-	-	236	2,764	5,226	8,226
4,716	127	-	-	-	-	-	-	-	346	2,876	3,349
4,661	-	-	-	-	-	-	-	-	-	-	-
4,941	87	26	73	-	-	-	-	-	-	-	186

Table K1 continued: ***Estimated Net Gain in crashed passenger vehicles (with YOM) involved in injury crashes (2011-2020) for aggregated data***

by age of vehicles age (0 to 46 years) and crash year.

4,171			
3,409			
3,341			
3,110			
2,480			
2,018			
1,765			
1,726			
1,290			
863			
496			
478			
489			
306			
173			
123			
98			
89			
81			
62			
33			
58	23		
46		9	
41			2

Table K1 continued: ***Estimated Net Gain in crashed passenger vehicles (with YOM) involved in injury crashes (2011-2020) for aggregated data by age of vehicles age (0 to 46 years) and crash year.***

41	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-
23	0	-	-	-	-	-	-	-	-	-	0
27	3	3	-	-	-	-	-	-	-	-	6
20	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-
15	3	1	-	-	-	-	-	-	-	-	4
5	-	-	-	-	-	-	-	-	-	-	-
8	2	-	-	-	-	-	-	-	-	-	2

The net gain was totalled not only by age of vehicle but also by year of manufacture. Table K2 displays the results of this. Net gain vehicles manufactured in 2020 equal 2,186; those aged zero in the 2020 crash year. The sum of crashed vehicles with a 2019 year of manufacture equal the sum of those aged one in 2020 and those aged zero in 2019: 4,432 + 2,216. The sum of crashed vehicles with a 2018 year of manufacture equal the sum of those aged two in 2020, those aged one in 2019 and those aged zero in 2018: 5,046 + 4,494 + 2,247. And so forth for each year of manufacture. When approaching the tail end years of manufacture care was taken to ensure that vehicles older than 46 years were excluded. For example vehicles with a year of manufacture 1971 are 40 years old in 2011, 41 in 2012, 42 in 2013, 43 in 2014, 44 in 2014, 45 in 2015, 46 in 2015 and older than 46 in years 2016 to 2020. Thus the sum of net gain vehicles manufactured in 1971 includes only data from the crash years 2011 to 2015.

Table K2: ***Estimated Net Gain in crashed passenger vehicles (with YOM) involved in injury crashes (2011-2020) for aggregated data by vehicle year of manufacture for vehicles aged 0 to 46 years.***

	Net Gain at vehicle age and crash year											Net Gain by year of manufacture			
Age	2011	2012	2013	2014	2015	2016	2017	**2018**	**2019**	**2020**	**Ten year sum by age**	**yom**	**veh age 2020**	**veh age 2010**	**ten year Sum by yom**
0	2,488	2,450	2,414	2,379	2,344	2,311	2,279	2,247	2,216	2,186		2020	-		2,186
1	2,638	4,968	4,894	4,822	4,753	4,686	4,620	4,556	4,494	4,432	44,863	2019	1		6,649
2	864	3,249	5,571	5,490	5,411	5,334	5,259	5,187	5,115	5,046	46,526	2018	2		11,786
3	163	839	3,316	5,728	5,735	5,744	5,754	5,766	5,778	5,791	44,615	2017	3		17,742
4	-	-	637	3,115	5,529	5,537	5,547	5,558	5,570	5,583	37,075	2016	4		23,478
5	532	330	413	1,094	3,574	5,990	6,001	6,013	6,025	6,039	36,012	2015	5		29,664
6	-	111	-	106	843	3,378	5,848	5,911	5,976	6,041	28,214	2014	6		35,844
7	138	-	220	78	219	957	3,493	5,964	6,029	6,095	23,194	2013	7		42,022
8	-	-	-	-	-	-	429	2,960	5,425	5,484	14,298	2012	8		47,532
9	-	-	-	-	-	-	-	236	2,764	5,226	8,226	2011	9		52,737
10	127	-	-	-	-	-	-	-	346	2,876	3,349	2010	10	-	31,363
11	-	-	-	-	-	-	-	-	-	-	-	2009	11	1	6,246
12	87	26	73	-	-	-	-	-	-	-	186	2008	12	2	901
13	-	-	-	-	-	-	-	-	-	-	-	2007	13	3	408
14	-	-	-	-	-	-	-	-	-	-	-	2006	14	4	863
15	-	-	-	-	-	-	-	-	-	-	-	2005	15	5	-
16	-	-	-	-	-	-	-	-	-	-	-	2004	16	6	138
17	-	-	-	-	-	-	-	-	-	-	-	2003	17	7	-
18	-	-	-	-	-	-	-	-	-	-	-	2002	18	8	-

Table K2 continued: ***Estimated Net Gain in crashed passenger vehicles (with YOM) involved in injury crashes (2011-2020) for aggregated data by vehicle year of manufacture for vehicles aged 0 to 46 years.***

	Net Gain at vehicle age and crash year											Net Gain by year of manufacture			
Age	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Ten year sum by age	yom	veh age 2020	veh age 2010	ten year Sum by yom
19	-	-	-	-	-	-	-	-	-	-	-	2001	19	9	200
20	-	-	-	-	-	-	-	-	-	-	-	2000	20	10	26
21	-	-	-	-	-	-	-	-	-	-	-	1999	21	11	87
22	-	-	-	-	-	-	-	-	-	-	-	1998	22	12	-
23	-	-	-	-	-	-	-	-	-	-	-	1997	23	13	-
24	-	-	-	-	-	-	-	-	-	-	-	1996	24	14	-
25	-	-	-	-	-	-	-	-	-	-	-	1995	25	15	-
26	-	-	-	-	-	-	-	-	-	-	-	1994	26	16	-
27	-	-	-	-	-	-	-	-	-	-	-	1993	27	17	-
28	-	-	-	-	-	-	-	-	-	-	-	1992	28	18	-
29	-	-	-	-	-	-	-	-	-	-	-	1991	29	19	-
30	-	-	-	-	-	-	-	-	-	-	-	1990	30	20	-
31	-	-	-	-	-	-	-	-	-	-	-	1989	31	21	-
32	-	-	-	-	-	-	-	-	-	-	-	1988	32	22	-
33	-	-	-	-	-	-	-	-	-	-	-	1987	33	23	-
34	23											1986	34	24	-
35		9										1985	35	25	-
36			2									1984	36	26	-
37	-	-	-	-	-	-	-	-	-	-	-	1983	37	27	-
38	-	-	-	-	-	-	-	-	-	-	-	1982	38	28	-
39	0	-	-	-	-	-	-	-	-	-	0	1981	39	29	-
40	3	3	-	-	-	-	-	-	-	-	6	1980	40	30	-
41	-	-	-	-	-	-	-	-	-	-	-	1979	41	31	-
42	-	-	-	-	-	-	-	-	-	-	-	1978	42	32	-
43	-	-	-	-	-	-	-	-	-	-	-	1977	43	33	34
44	3	1	-	-	-	-	-	-	-	-	4	1976	44	34	-
45	-	-	-	-	-	-	-	-	-	-	-	1975	45	35	-
46	2	-	-	-	-	-	-	-	-	-	2	1974	46	36	-

Table K2 continued: ***Estimated Net Gain in crashed passenger vehicles (with YOM) involved in injury crashes (2011-2020) for aggregated data by vehicle year of manufacture for vehicles aged 0 to 46 years.***

	Net Gain at vehicle age and crash year											Net Gain by year of manufacture			
Age	2011	2012	2013	2014	2015	2016	2017	**2018**	**2019**	**2020**	**Ten year sum by age**	**yom**	**veh age 2020**	**veh age 2010**	**ten year Sum by yom**
47												1973		37	-
48												1972		38	3
49												1971		39	3
50												1970		40	-
51												1969		41	-
52												1968		42	1
53												1967		43	3
54												1966		44	-
55												1965		45	2
56												1964		46	-

22 APPENDIX L – SUMMARY OF EXPECTED OCCUPANT INJURIES WITH PROJECTED CHANGES TO CRASHED VEHICLE FLEET SIZE

Australian Crash Data, with projected decreased crashed vehicle fleet and projected changes in crashworthiness ratings

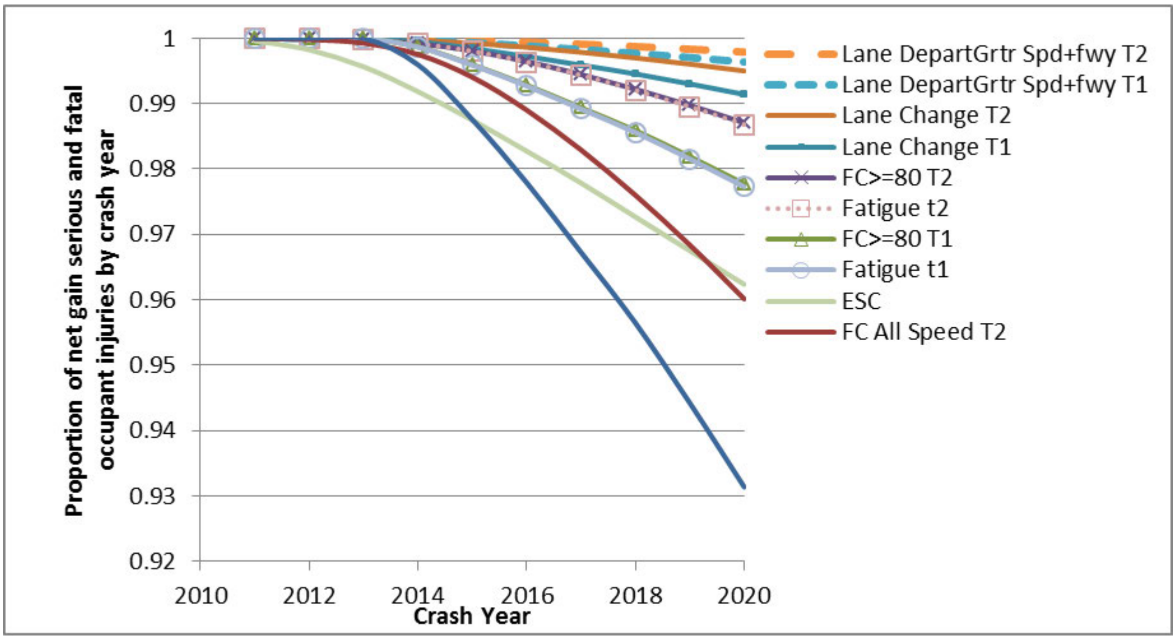

Figure L.1: ***Proportion of net gain occupant injuries expected each crash year due only to technology fitment, Australia.***

23 APPENDIX M – DEFINITIONS

Crash Definitions

- A ***fatal crash*** was a crash that resulted in a road user dying within 30 days of the crash occurring;
- A ***serious injury crash*** was a crash that did not result in the death of a road user within 30 days but that did result in a road user being transported to hospital or admitted to hospital;
- An ***'other injury' crash*** was a crash that resulted in a road user being injured but no road users being fatally injured or seriously injured.

From these definitions of crash severity, the following further categorisations of crash severity were made:

- A ***serious casualty crash*** was a crash in which the most seriously injured road user was killed within 30 days as a result of the crash or transported to hospital or admitted to hospital as a result of the crash (i.e. a fatal crash or a serious injury crash);
- A ***casualty crash*** was defined as a crash in which a road user received an injury of any severity (i.e. a fatal crash, serious injury crash or an 'other injury' crash).

Market Group Definitions

Table M1: ***Market Groups.***

Market Group	Description[†]	Body Types
Traditional Passenger Vehicles		
SL Light	3 or 4 cylinder engine, up to 1500cc, tare mass <1150kg	Hatch, Sedan, coupe, convertible
S Small	4-6 cylinder engine, 1501cc-2000cc, tare mass 1150-1350kg	Hatch, Sedan, coupe, convertible, station wagon, station sedan
M Medium	4+ cylinder engine, 2001cc upward, tare mass 1350-1550kg	Hatch, Sedan, coupe, convertible, station wagon, station sedan
L Large	6-8+ cylinder engine, tare mass >1550kg	Sedan, coupe, convertible, station wagon, station sedan
PM People Mover	Passenger seating capacity >5 people.4-8 cylinders.	Vans, station sedans
Sports Utility Vehicles (Four Wheel Drive Vehicles with high ground clearance and generally a wagon with off road potential.)		
SUVC-Compact	Index rating <550, typically 1700kg tare mass	Station sedans
SUVM-Medium	Index rating 550-700, typically 1700-2000kg tare mass	Station sedans
SUVL- Large	Index rating >700, typically >2000kg tare mass	Station sedans
Light Commercial Vehicles (≤3.5t)		
CU -Utility	2 and 4 wheel drive, normal control (bonnet), utility, cab chassis and crew cabs.	Utilities
CV -Van	Blind and window vans.	Vans, station wagon

24 APPENDIX N – TECHNOLOGY BREAK EVEN CALCULATIONS BY VEHICLE TYPE AND JURISDICTION: AUSTRALIA

Table N1: ***Estimated Break-even Costs (2010 $AUS) for new 2011-2020 crashed passenger vehicles, for all of Australia and for groups disaggregated by jurisdiction or market group, achieved through fitment of Forward Collision Warning Systems with AEB.***

		Forward Collision At All Speed				Forward Collision At Speeds ≥80			
		Fitment model 1		Fitment model 2		Fitment model 1		Fitment model 2	
	Cost per Vehicle	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
ALL	Per fitted registered vehicle	$59	$86	$97	$131	$19	$28	$32	$43
NSW	Per fitted registered vehicle	$54	$79	$89	$120	$12	$18	$21	$28
QLD	Per fitted registered vehicle	$55	$80	$91	$122	$15	$21	$24	$32
SA	Per fitted registered vehicle	$71	$102	$116	$156	$15	$22	$25	$33
VIC	Per fitted registered vehicle	$42	$62	$70	$94	$14	$20	$23	$30
WA	Per fitted registered vehicle	$109	$160	$179	$243	$23	$34	$38	$52
Light	Per fitted registered vehicle	$429	$471	$659	$715	$111	$121	$170	$184
Small	Per fitted registered vehicle	$480	$530	$735	$806	$124	$137	$191	$209
Medium	Per fitted registered vehicle	$221	$229	$339	$348	$57	$59	$88	$90
Large	Per fitted registered vehicle	$814	$842	$1,246	$1,279	$271	$280	$414	$425
People Mover	Per fitted registered vehicle	$352	$413	$558	$628	$78	$91	$123	$139
SUV-Large	Per fitted registered vehicle	$44	$49	$69	$74	$19	$21	$30	$33
SUV-Medium	Per fitted registered vehicle	$152	$177	$241	$269	$51	$59	$80	$90
SUV-Compact	Per fitted registered vehicle	$345	$408	$549	$620	$94	$111	$149	$168
Utility	Per fitted registered vehicle	$217	$218	$338	$332	$92	$93	$144	$141
Van	Per fitted registered vehicle	$923	$977	$1,423	$1,486	$297	$315	$458	$479
Unknown	Per fitted registered vehicle	$55	$82	$91	$125	$19	$29	$32	$43

Table N2: ***Estimated Break-even Costs (2010 $AUS) for new 2011-2020 crashed passenger vehicles, for all of Australia and for groups disaggregated by jurisdiction or market group, achieved through fitment of LCWS OR FWS.***

		Lane Change				Fatigue			
		Fitment model 1		Fitment model 2		Fitment model 1		Fitment model 2	
Cost of ten year reduction		A	B	A	B	A	B	A	B
ALL	Per fitted registered vehicle	$7	$11	$12	$16	$20	$29	$32	$43
NSW	Per fitted registered vehicle	$7	$10	$11	$15	$21	$31	$35	$47
QLD	Per fitted registered vehicle	$8	$11	$13	$17	$17	$24	$27	$37
SA	Per fitted registered vehicle	$6	$9	$10	$14	$23	$34	$38	$51
VIC	Per fitted registered vehicle	$5	$8	$9	$12	$12	$18	$20	$27
WA	Per fitted registered vehicle	$10	$14	$16	$21	$36	$53	$59	$80
Light	Per fitted registered vehicle	$55	$61	$85	$92	$104	$114	$159	$173
Small	Per fitted registered vehicle	$61	$68	$94	$103	$111	$123	$170	$186
Medium	Per fitted registered vehicle	$29	$30	$45	$46	$56	$59	$86	$89
Large	Per fitted registered vehicle	$106	$110	$163	$167	$270	$279	$412	$424
People Mover	Per fitted registered vehicle	$44	$51	$69	$78	$103	$121	$163	$184
SUV-Large	Per fitted registered vehicle	$5	$6	$8	$9	$18	$20	$28	$30
SUV-Medium	Per fitted registered vehicle	$22	$25	$34	$38	$57	$66	$89	$100
SUV-Compact	Per fitted registered vehicle	$43	$51	$68	$77	$103	$121	$163	$184
Utility	Per fitted registered vehicle	$26	$26	$40	$40	$80	$81	$126	$123
Van	Per fitted registered vehicle	$125	$133	$193	$202	$223	$236	$344	$359
Unknown	Per fitted registered vehicle	$6	$9	$10	$14	$21	$32	$35	$48

Table N3: ***Estimated Break-even Costs (2010 $AUS), for the new 2011-2020 crashed passenger vehicles, for all of Australia and for groups disaggregated by jurisdiction or market group, achieved through fitment of LDWS.***

		LD-2 +80km/hr or greater zones +no illegal alcohol/speeding				LD- + major highway expressway			
		Fitment model 1		Fitment model 2		Fitment model 1		Fitment model 2	
Cost per Vehicle		A	B	A	B	A	B	A	B
ALL	Per fitted registered vehicle	$12	$17	$19	$26	$3	$5	$5	$7
NSW	Per fitted registered vehicle	$13	$19	$21	$28	$2	$3	$3	$5
QLD	Per fitted registered vehicle	$10	$15	$17	$23	$2	$3	$3	$4
SA	Per fitted registered vehicle	$9	$14	$15	$21	$5	$7	$8	$11
VIC	Per fitted registered vehicle	$7	$11	$12	$16	$3	$5	$5	$7
WA	Per fitted registered vehicle	$14	$21	$24	$32	$8	$11	$12	$17
Light	Per fitted registered vehicle	$59	$65	$90	$98	$15	$17	$24	$26
Small	Per fitted registered vehicle	$62	$69	$95	$105	$16	$18	$25	$28
Medium	Per fitted registered vehicle	$29	$30	$45	$46	$7	$7	$11	$11
Large	Per fitted registered vehicle	$151	$156	$231	$237	$40	$42	$62	$63
People Mover	Per fitted registered vehicle	$65	$76	$103	$116	$15	$17	$23	$26
SUV-Large	Per fitted registered vehicle	$12	$13	$19	$20	$2	$3	$4	$4
SUV-Medium	Per fitted registered vehicle	$39	$45	$62	$69	$9	$10	$14	$15
SUV-Compact	Per fitted registered vehicle	$69	$82	$110	$124	$15	$18	$24	$28
Utility	Per fitted registered vehicle	$55	$55	$86	$84	$12	$12	$18	$18
Van	Per fitted registered vehicle	$153	$162	$236	$246	$43	$45	$66	$69
Unknown	Per fitted registered vehicle	$38	$57	$63	$87	$16	$25	$27	$37

Table 22 : ***Estimated Break-even Costs (2010 $AUS), for the new 2011-2020 crashed passenger vehicles, for all of Australia and for groups disaggregated by jurisdiction or market group, achieved through fitment of ESC.***

		Electronic Stability Control	
		Fitment model 1	
	Cost per Vehicle	**A**	**B**
ALL	Per fitted registered vehicle	$259	$254
NSW	Per fitted registered vehicle	$249	$243
QLD	Per fitted registered vehicle	$227	$222
SA	Per fitted registered vehicle	$307	$301
VIC	Per fitted registered vehicle	$181	$177
WA	Per fitted registered vehicle	$487	$479
Utilities	Per fitted registered vehicle	$155	$150
Vans	Per fitted registered vehicle	$412	$428