Centre for
Automotive Safety Research

The safety attributes of registered passenger vehicles and vehicles involved in serious crashes in South Australia

RWG Anderson

CASR REPORT SERIES
CASR081
February 2012

THE UNIVERSITY OF ADELAIDE AUSTRALIA

Report documentation

REPORT NO.	DATE	PAGES	ISBN	ISSN
CASR081	February 2012	48	978 1 921645 18 1	1449-2237

TITLE

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AUTHOR

RWG Anderson

PERFORMING ORGANISATION

Centre for Automotive Safety Research
The University of Adelaide
South Australia 5005
AUSTRALIA

SPONSORED BY

Department of Planning, Transport and Infrastructure
GPO Box 1533
Adelaide SA 5001
AUSTRALIA

AVAILABLE FROM

Centre for Automotive Safety Research
http://casr.adelaide.edu.au/reports

ABSTRACT

This report characterises the South Australian passenger vehicle fleet according to attributes related to safety, vehicle classification and mass, and the type of original buyer. Vehicles were disaggregated by year of sale. Examination of a sample of registered vehicles allowed the uptake of technology, and the change in other attributes of the general registered fleet, to be examined. Crashed vehicles were also characterised. The linkage of vehicle attributes to individual vehicles allowed us to examine safety attributes by year of sale in the two groups of vehicles.

Observations are made in relation to the origin of vehicles, with the new vehicle purchaser in mind. Improvement in the average safety of the stock of vehicles partly relies on new vehicle purchasers choosing vehicles with safety in mind. Other observations are made about trends in vehicle size, and the availability of safety systems over time. In general, the availability of technology is similar among crashed vehicles and registered vehicles for a given year of vehicle, although there is evidence in the data of the protective effect of ESC. However, given that crashed vehicles are older on average than in the general registered fleet, availability of safety equipment in crashed vehicles is lower than average.

Finally, some attention is paid the potential of effecting improvements in vehicle safety through fleet purchasing policies.

KEYWORDS

Vehicle fleets, active safety, passive safety, vehicle mass, new car assessment program, crash data analysis, vehicle specifications

Summary

This report characterises the South Australian passenger vehicle fleet according to attributes related to safety, vehicle classification and mass, and the type of original buyer. By disaggregating vehicles by year of sale, it has been possible to estimate the rate at which these attributes have changed in new vehicle sales.

Two populations of vehicles were studied: a random sample of 2000 passenger vehicles was extracted from South Australian registration records in April 2010 to represent the fleet as it was at that time; the second sample involved all passenger vehicles involved in serious and fatal crashes in 2008 and 2009 in South Australia. A feature of the analysis method was that vehicles were linked to data supplied by the Federal Chamber of Automotive Industries (FCAI) and managed by RL Polk Australia, to provide information on the initial purchase of the vehicles and on the vehicles' specifications.

Examination of the registered vehicle sample allowed the uptake of technology, and the change in other attributes of the general registered fleet, to be examined. The crashed vehicle population was of particular interest as it is for such vehicles that safety (in particular, secondary safety) is of most relevance. The linkage of vehicle attributes to individual vehicles allowed us to examine those attributes by year of sale in the two groups of vehicles.

The analysis also showed that, with respect to the origin of the vehicle:

- 71% of vehicles registered in South Australia were originally sold new in the state, with the other 29% originating interstate (mainly NSW and Victoria).
- The importance of non-private buyers with respect to the makeup of the registered fleet is plainly evident with more than half of all vehicles on the road originally bought for use in either a private fleet, government fleet or for some other type of non-private use.
- Vehicles originally bought by the South Australian government make up about 7% of registered fleet, but the presence of vehicles originating in South Australian private fleets is much greater - 25% of all registered vehicles.

With respect to the classification of vehicles:

- The prevalence of new vehicles weighing more than 1900 kg in 2009 appears to be over 20%, more than twice the number amongst vehicles first bought 10 years before. Meanwhile, the sales of vehicles between 1600 and 1800 kg appear to have declined over the last decade, partly compensated for by sales of lighter vehicles as well as very heavy vehicles. There is a polarisation of vehicle mass emerging in the fleet, which may present increasing crash compatibility problems in the future.
- The meaning of nominal vehicle segments has changed over the last decade with the average mass of vehicles increasing such that the average mass of each segment (light, small, medium and large) is now greater than the mass of the proceeding segment that was average two decades (or even one decade) ago. For example, the average 'medium' passenger vehicle is now about as heavy as the average 'large' car sold in 2000.

With respect to the safety specification of vehicles:

- In general, crashed vehicles and registered vehicles were the same in respect of the prevalence of safety attributes aggregated over crash type. While crashed vehicles and registered vehicles had about the same rate of installation of many features within a year of

sale cohort, given the older age of crashed vehicles, the overall rate of installation was lower in crashed vehicles compared to the registered fleet sample.

- The one feature that seemed to be clearly underrepresented in crashed vehicles was electronic stability control (ESC) – while the numbers were small, it was clear that the prevalence of ESC systems in crashes was smaller than in the general registered fleet, indicating that ESC systems are preventing crashes from occurring in South Australia. An additional analysis of single and multiple vehicle crashes revealed that, indeed, ESC equipped vehicles are substantially under-represented in single vehicle crashes.
- The introduction of a safety technology into new vehicles has generally taken between 10 and 20 years to reach saturation (for those technologies that have achieved an almost 100% fitment rate). ESC was present in 50% of the registered vehicle sample bought new in 2008 and 2009, but is in only 13% of the fleet overall.
- Occupant safety ratings of vehicles are rapidly improving such that South Australia should soon see more than half of its new vehicle sales rated at five stars in the ANCAP program. However, the average star rating of all registered vehicles that have a rating is 3.78 stars, and given that ratings exist for only 42% of registered vehicles, the average of all registered vehicles is likely to be much lower than this (possibly under 3 stars), demonstrating that even the improved passive safety of vehicles in the general registered fleet is a work in progress.
- Unfortunately, the pedestrian safety ratings of vehicles have not kept pace with occupant ratings and the average star ratings of the newest vehicles remains under 2 stars (of a possible 4) and has remained almost unchanged over the last 10 years.

The use of fleet purchasing as a method of increasing the uptake of technology was examined in more detail and the analysis showed that aggressive uptake of new safety technologies by government and private fleets can be effective in increasing the prevalence of those technologies in the overall fleet. For example, earlier adoption of ESC amongst fleets in Australia might have meant that South Australia would have had more than double the number of installations in the registered fleet than it does today. The effect of early adoption in fleets is highest for technologies that are relatively recent, and by the time a technology has saturated new vehicle sales, further effects are obviously nil, and any overall effect will have disappeared 20 years or so after the introduction of the technology. But given that further technological advances are emerging in primary safety areas, there will still be opportunities to maximise the uptake of new safety technologies in new vehicles in the coming decade. Strategies to target fleets to encourage early adoption of these technologies should therefore be encouraged.

It would be useful for forecasting if it were possible to model the future prevalence of safety technologies in vehicles that are at risk of crashing, based on the pattern of deployment in new vehicles. Such a model might allow us to predict the prevalence of, for example, ESC into the future, in vehicles likely to be at risk of single vehicle crashes. Predicting future effects of technologies that are only establishing themselves would allow for a nuanced approach to investment in activities aimed at encouraging uptake, and in the coordination of associated road infrastructure investment.

Contents

1 Introduction

It almost goes without saying that the safer vehicles are considered to be an essential component of reducing the road toll. Vehicle manufacturers now commonly promote the safety of their product in marketing material and authorities actively promote safer vehicles through consumer rating programs such as the Australasian New Car Assessment Program and through regulation. “Safer vehicles” are one pillar of the safe system approach to road safety, common to jurisdictions across Australia.

But the way in which new vehicle safety affects road safety is not immediately clear – vehicles on the road are a mixture of old and new, and the latest safety technologies are often in only the most up-market vehicles. Many technologies are of uncertain efficacy. Most drivers and their passengers benefit from new safety developments only when effective safety technologies become commonplace; even then, with a median vehicle age of about 10 years, most South Australians effectively wait for more than a decade before they begin to benefit from the latest technologies.

This characteristic of vehicle technologies – the inevitable lag between development and benefit – places vehicle technologies in a separate category from other road safety measures. A speed limit can be changed and a benefit is realised immediately, whereas improvements to vehicle technology, while often extremely important, must be considered as part of a much longer-term strategy to improve road safety.

The vehicles that are used by the community for business and private use are a component of the whole safety system, but the dynamics of how this system is changing, and ways in which it is possible to mould the future fleet are poorly understood. The characteristics of new vehicles – their size, primary safety and secondary safety features – are largely determined by a free market, in which safety must compete with other ideas of what constitutes value and satisfies the desires of customers. Yet, it is the new vehicle purchaser that determines the restocking of vehicles in the fleet. A new vehicle owner may drive a vehicle for a relatively short time (for as short as two years in some commercial and government fleets), but the legacy of that purchase will persist for almost two decades. New vehicles are the second hand vehicles of tomorrow, and the safety features of some vehicles may be tested in a crash only after 15 years (if at all).

In a previous report we analysed the age of the registered fleet in South Australia and also that subset of vehicles involved in crashes (Anderson et al., 2008). Other studies by Newstead et al. (e.g. Newstead et al, 2008) have shown that vehicle crashworthiness is improving by around 2.5% per annum; that is, the rate of serious injury and fatal crashes per tow away crash increases by 2.5% per year of vehicle age and that the improvement comes about through improving vehicle design.

While South Australia has, on average, an older fleet of vehicles than the national average, the straightforward estimate that was made in Anderson et al (2009) of the over-representation of serious and fatal crashes in South Australia, associated with the lag in the age of vehicles, was around 3%. It was by no means clear that efforts to modernise the South Australian passenger vehicle fleet would deliver much road safety benefit – a conclusion of that report was that it was probably more important to focus on fleet mix, rather than fleet age, and that a better objective would be to influence the standard of safety of vehicle entering the fleet and then encouraging diffusion of those vehicles to those most at risk of crashing.

So with this motivation in mind, this report has been structured to examine the evolving nature of vehicles, generally and in crashes, in South Australia.

2 Methodology

This section outlines the methods used to examine the safety attributes of South Australian passenger vehicles. Two samples of vehicles were examined. The first is a random sample of all passenger vehicles on register in April 2010 and the second is all passenger vehicles involved in any kind of casualty crash in 2008-2009. Detailed information about the vehicles in these samples was sourced from RL Polk Australia via the vehicle identification number (VIN) of each vehicle in the sample. The specifications returned from Polk cover a range of vehicle attributes that are relevant to primary safety (crash prevention) and secondary safety (crash protection). Similar methods are outlined by Scully and Newstead (2007), but in that case, several datasets and some hand matching was employed to identify the prevalence of a single feature (ESC). In the present report, matching vehicles to specifications using the Polk database allowed rapid matching and the determination of the many vehicle attributes simultaneously.

The two groups of vehicles, the sample registered vehicles and population of crashed vehicles, are obviously separated temporally and so methods were used to allow comparisons to be made. The method is described below, but in essence, the samples were compared by first disaggregating each sample into 'year-of-sale' cohorts. The characteristics of each year-of-sale cohort are then compared within and across the two samples.

2.1 Registered vehicle sample

In mid-April 2010, the known VINs of all passenger type vehicles were extracted from South Australian vehicle registration records (TRUMPS). VINs from all vehicles classified as "sedans", "station wagons" and "utilities" were combined, resulting in 1,070,923 records. Less than 1% of fields were either repeated or appeared invalid. Note that VINs are only consistently recorded for vehicles sold new after about 1990, and so the extract represents that proportion of the vehicle population that are under 20 years of age.

The results file was cleaned of duplicates and invalid data and randomised. A sample of 2000 was taken from the randomised list for further analysis. The distribution of vehicle ages in South Australia is rather flat for vehicles under 20 years of age (Anderson and Doecke, 2008), and so a sample of 2000 VINs was expected to give approximately 100 vehicles in each year-of-sale cohort.

The file of VINs was then sent to RL Polk Australia who attached Price and Specification data and a limited number of fields from the VFACTS database. (VFACTS data are used to report on new vehicle sales and so the data has details about the original sale of the vehicle.) More detail about the VIN matching process is given in Section 2.3.

2.2 Crashed vehicles

The second sample of vehicles analysed was one of vehicles involved in serious injury crashes. For the purposes of this initial analysis, a decision was made to examine vehicles involved in serious injury or fatal crashes aggregated over crash type. The primary objective was to look at whether vehicles involved in crashes that cause significant injury to any person in the crash differ in respect of known vehicles features. In analyses to be reported in later sections, some specific sub-groups of vehicles are examined based on crash type, but a more comprehensive analysis of specific crash types and driver profiles will be left for a future study, in which a larger set of crashed vehicles would need to be used to support finer levels of disaggregation.

Part of the reason for keeping the present analysis simple was that the methods being employed for this project were potentially costly (due to licensing fees for VFACTS, Price and Specification data from Polk). Additionally, early testing with Polk revealed errors in some of the returned data and these were not properly resolved until late 2009.

Hence stable data on every vehicle involved in a serious or fatal crash from two recent crash years were used (2008-09 being the closest such years to the time of the data extraction: April 2010).

The Traffic Accident Report System (TARS) records the details of reported and processed crashes in South Australia. TARS was queried to return vehicle information on any crash involving a sedan, station wagon, utility, taxi, or four wheel drive (indicated for some fatal crashes only) where the vehicle movement field value was not “parked”. Some 2,210 vehicles were returned with the number of active units and the crash type of the associated crash. Through matching via the SA Police Vehicle Crash Report system, the VIN of each vehicle (where present or ascertainable) was retrieved. Of these vehicles, a VIN was returned for 1,853 vehicles (84%).

Figure 2.1 shows the retrieval of VINs for crashed vehicles according to year of manufacture (as recorded in the TARS database.) For vehicles sold in 1989 and 1990, no additional information was available from RL Polk Australia.

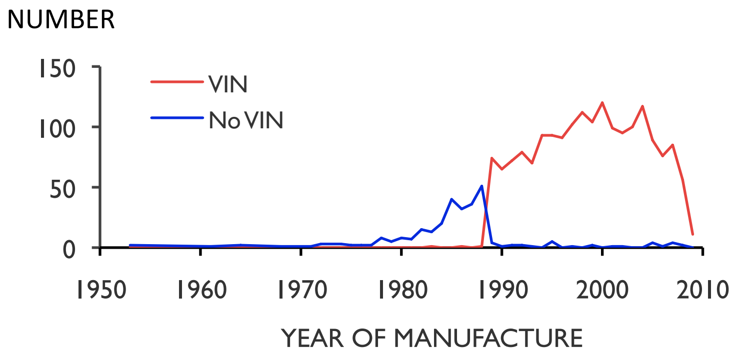

Figure 2.1
Availability of vehicle identification numbers of crashed vehicles

2.3 VIN matching

The VINs found for each sample were transferred to RL Polk Australia. A customised report was generated indicating certain de-identified sales information and specifications related to the safety of the vehicle. The full list of fields returned is contained in the Appendix of this report, but those that were analysed and are presented in this report are described below.

The data itself is managed by RL Polk Australia on behalf of the Federal Chamber of Automotive Industries. The price and specification data are of a general nature – for example the presence of a certain feature may be described as “standard” or “optional”. Where the feature is listed as optional, it is not possible to determine from the data whether or not the feature was included in the specific vehicle identified by the VIN.

Data is available for vehicles sold after 1990. VINs submitted that come from vehicles sold before then are not matched by RL Polk. In general this presents almost no limitation on the results reported herein as most features described were not available prior to 1990. The main method of analysis involves disaggregation into year-of-sale cohorts, and given the date limit, no results are provided for vehicles sold before 1990 except for overall installation rates where it has been assumed that the fitment rate for older vehicles is zero or negligible.

2.4 Disaggregation

As alluded to above, the analysis of the composition of the fleet relies on the disaggregation of the sample according to the feature or attribute of interest. The result is a cross-tabulation of the presence of the feature (usually being along the lines of “standard”, “optional” or “not present”) or the average value of an attribute (e.g average mass) against the year in which the vehicle was sold. It is then possible to work out what proportion of each cohort of vehicles has the feature installed as standard etc. It is also then possible to filter the data to examine the cross tabulation along specific lines: vehicle sales segment or, in the case of the crashed vehicle population, crash type.

Cross-tabulating features and attributes against the year of sale serves two purposes. For the sample of registered vehicles, the cross-tabulation estimates how fitment rates are evolving over time. It might be observed that a certain feature was not available in 1991 and that in later years it is installed in all vehicles. Overall fitment rates can also be compared with the nature of this evolution. For several features, most new vehicles may have the feature, but the overall prevalence may still be low, due to the age of the fleet and the recentness of the feature (for example, electronic stability control).

The second purpose for cross-tabulating the features and attributes against year of sale is to allow a direct comparison between the crashed vehicle sample and the registered fleet sample. As mentioned above, these samples are removed in time, making any differences in the overall sample slightly difficult to interpret, being partly explained by the temporal difference in the two samples. But examining the composition of discrete year-of-sale cohorts, and comparing cohorts across the two samples provide a method for observing differences and similarities between crashed and registered vehicles.

2.4.1 Vehicle safety attributes examined in the study

The price and specification data contain data on many vehicle attributes. Not all attributes available are listed in the Appendix, but only those part of the query set up for this project. Of those attributes, those selected for analysis for the purposes of this report are given in Table 2.1. Examination of these two lists will show that only a small set of attributes has been examined. The focus is on those attributes most associated with vehicle safety advances within the broader categories of ‘braking and stability control’, ‘passive safety’, ‘ANCAP performance’, and ‘vehicle performance’.

The results flowing from the examination of these vehicle attributes across the two samples and across vehicle years is presented in the following sections.

Table 2.1
Vehicle attributes examined or used in this report

General	Year of sale Buyer type state of origin Vehicle class Sales segment Mass
Braking and stability control	Electronic stability control Brake assist systems Electronic brake force distribution Anti-lock braking systems Traction control systems
ANCAP performance	Occupant rating Pedestrian rating
Passive safety	Advanced seat belt technology Airbag systems
Vehicle performance	Power to weight ratio

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3 Vehicle origin

The origin of vehicles is of interest for two main reasons. First, one method of improving the safety performance of the general registered fleet is through the provision of information to consumers. The most effective means of improving vehicle safety through information is by informing purchasers of new vehicles, as these buyers determine the stock of vehicles available to second-hand purchasers. It is therefore useful to understand who these purchasers are, so that there is an opportunity to target information effectively. Second, South Australia is a net importer of second-hand vehicles. Any policy or program designed to affect the safety of the vehicle stock by targeting vehicles originating in South Australia will be effective only to the extent that the stock was originally bought in South Australia. It is therefore useful to know from where vehicles originated.

Figure 3.1 shows the buyer type recorded by FCAI for the vehicles in the sample of the April 2010 registered passenger vehicle fleet in South Australia. Forty-six per cent of vehicles originated with private buyers. Figure 3.2 shows the state of origin of the vehicles in the sample. Slightly fewer than 30% of vehicles registered in South Australia originated in a state other than South Australia with the majority originating in New South Wales or Victoria. The likelihood that a significant number of vehicles have been imported into South Australia was suggested in an earlier paper (Anderson and Doecke, 2009) where it was noted that the number of vehicles built in a given year tends to increase for up to a decade after the build year.

The future composition of the fleet with respect to the state of the vehicles' origin is not certain. Disaggregation of the fleet by state of origin and year of manufacture shows that 36% of vehicles older than about 6 years of age originated interstate. This figure appears very stable for each individual year of sale between 1991 and 2004 (Figure 3.3). It might be concluded that the decline in the proportion of

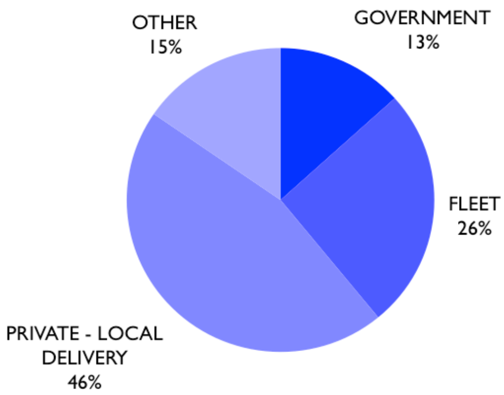

Figure 3.1
The original buyer type of the vehicles in the sample of registered vehicles in South Australia in April 2010

later vehicles originating interstate is, in the absence of other evidence, a function of the rate of the importation of vehicles, and the age of those vehicles. However, such a pattern may also be partly due to a decline in the demand for second-hand vehicles from interstate in more recent years, although we have no evidence for this.

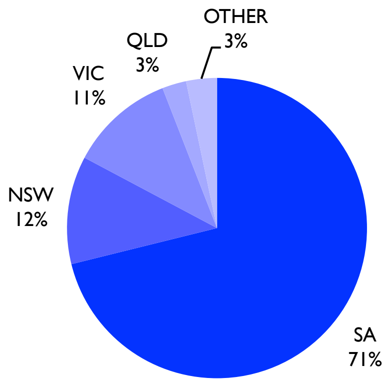

Figure 3.2
The state of origin of the vehicles in the sample of registered vehicles in South Australia in April 2010

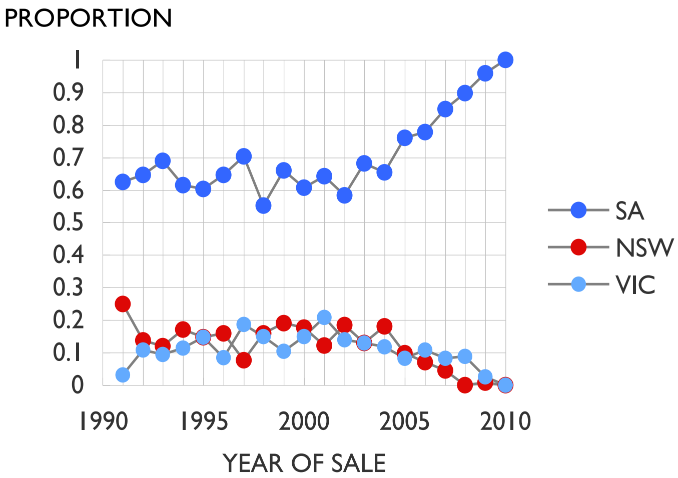

Figure 3.3
The state of origin of the vehicles in the sample of registered vehicles in South Australia in April 2010 by year of sale

Similar disaggregations performed on those vehicles involved in serious casualty or fatal crashes in 2008 and 2009 show an insignificant bias toward an interstate origins (69% were from SA rather than 71%) and a slightly larger bias toward vehicle originally bought by government (18% were originally bought by government rather than 13%, and 40% were originally private purchases rather than 46%).

3.1 Affecting safety through targeting large fleet purchases in South Australia

It is sometimes mentioned that having a policy to affect the safety standards of government vehicles and large fleet vehicles may be an effective way of accelerating the introduction of new safety features into the general registered fleet. In the sample of registered vehicles in South Australia, around 40% were originally bought by government or private fleets; a further 10% were purchased by rental businesses. Of the government vehicles, around 30% were bought by government agencies interstate.

One quarter of fleet vehicles and 65% of rental vehicles also were originally bought interstate. Of the total number of vehicles originating from government, fleet or rental buyers, 32% were originally bought interstate. Thus, a policy targeting the safety of these fleets in South Australia has the potential to affect the safety performance of about one third of the vehicles in the whole passenger vehicle fleet in the long term. A national strategy targeting these fleets would be more effective for states such as South Australia who are net importer of second hand vehicles from interstate.

Of vehicles purchased in SA, government purchased about 13% and fleet buyers 25%. A similar breakdown of vehicles originating in other states of Australia that were subsequently imported into South Australia shows similar levels of government and private sector fleet vehicles, but more “other” and fewer privately purchased vehicles.

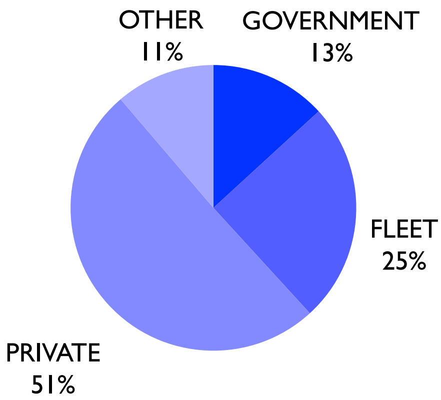

Figure 3.4
The original buyer type of the vehicles first bought in South Australia
in the sample of registered vehicles in South Australia in April 2010

Of government purchases made in South Australia, 74% were state government purchases. Thus the overall representation of South Australian state government purchased vehicles in the fleet is 0.74 x 0.13 x 0.71 = 0.067.

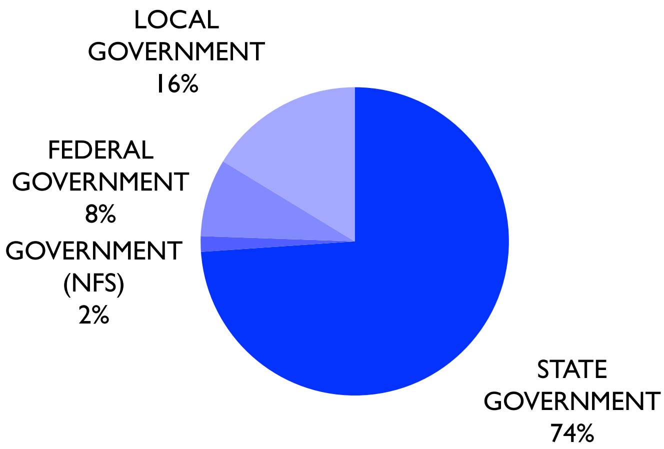

Figure 3.5
The original type of government buyer of the vehicles first bought by government in South Australia in the sample of registered vehicles in South Australia (April 2010)

The prevalence of South Australian government vehicles (all kinds of government, present and ex) is greater amongst older vehicles. This might be evidence of reduced levels of government vehicle purchases in recent years. The representation of interstate government vehicles (all kinds of government) is fairly steady; note here that the numbers are expected to be lower in recent years because such vehicles up to 10 years of age tend to continue to be imported into SA.

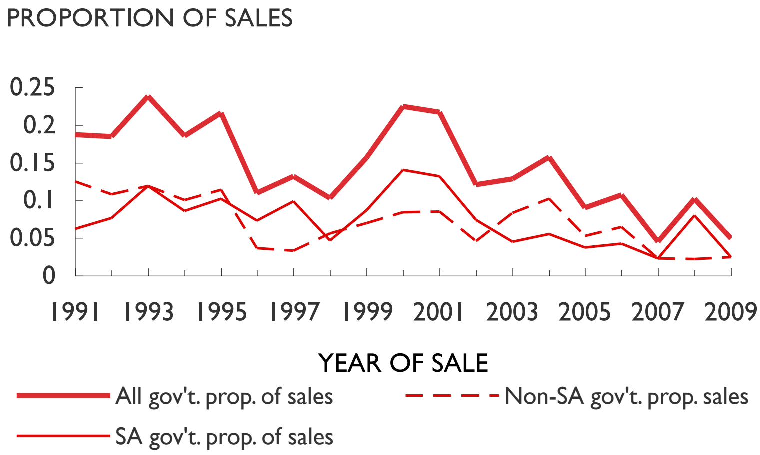

Figure 3.6
The proportion of vehicles bought by government buyers in South Australia
by year of sale in the sample of registered vehicles in South Australia (April 2010)

Fleet vehicles (present and ex) on the other hand are most prevalent amongst newer vehicles. This might be evidence of increased numbers of fleet purchased vehicles in recent years. The representation of interstate ex-fleet vehicles is fairly steady.

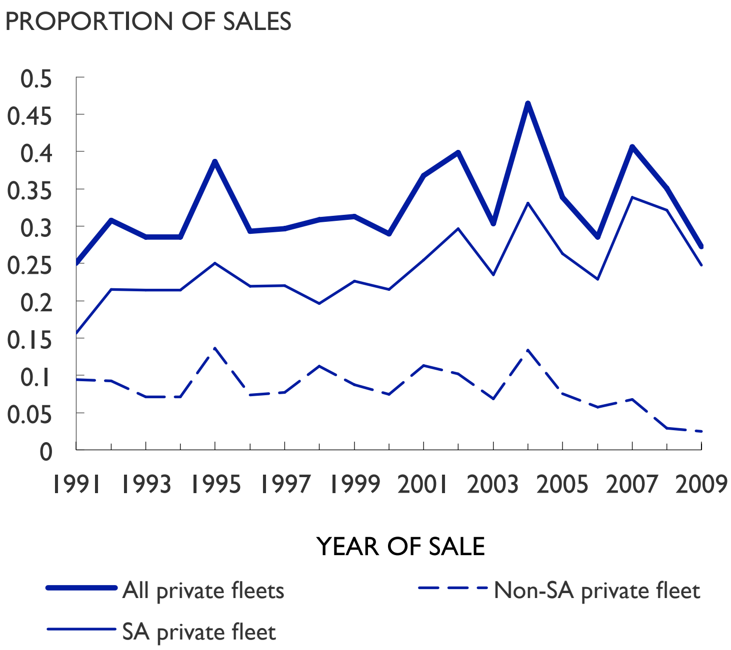

Figure 3.7
The proportion of vehicles bought by South Australian private sector fleet buyers
by year of sale in the sample of registered vehicles in South Australia (April 2010)

The relative contribution of vehicles purchased by South Australian government and private sector fleets is shown in Figure 3.8. Private sector fleets appear to have contributed at least double the number of government vehicles to the overall fleet. The number of private sector fleet vehicles appears to have grown substantially over the past 10 years, while South Australian government fleet vehicle numbers appears to have declined, such that private sector fleet vehicles appear to outnumber government vehicles by 3:1 for vehicles bought from 2003 onward.

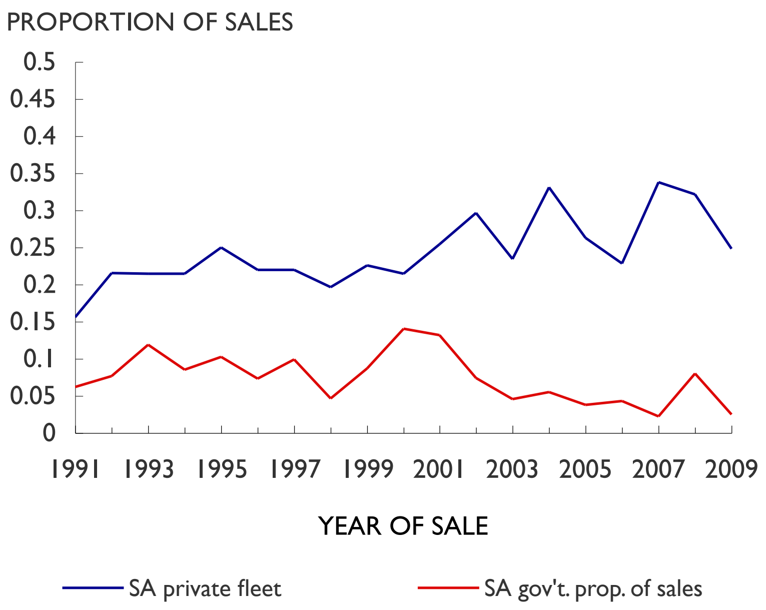

Figure 3.8
Relative contributions to the present South Australian fleet by government and private sector fleets, by year of sale. Based on a sample of registered vehicles in South Australia (April 2010)

In summary, the safety standard of vehicles bought by government and private sector fleet buyers is an important factor in the average safety standard of the general fleet. Around 40% of vehicles in the present date South Australian vehicle fleet were bought originally by government or private sector fleet buyers, with a quarter of these originating interstate.

South Australian state government vehicles have contributed around 7% of vehicles in the present day fleet. If current trends continue, private sector fleet vehicles originating in South Australia will become slightly more prevalent in the future, and will account for 25-30% of vehicles in the general registered fleet.

Further analysis on the potential of fleet purchases to effect increases in the average safety of vehicles in the general registered fleet is given in Section 9.

4 Vehicle segment and mass

Vehicle mass is considered in this report as it plays an important role in crashworthiness. Mass ratio is influential on crash outcome in vehicle-to-vehicle crashes, as it determines the relative change of velocity in the two vehicles. More controversially, it has also been claimed that mass has an effect in single vehicle crashes and in crashes between vehicles of similar mass, because mass may be related weakly to vehicle crush distances, but the evidence for the importance of this is disputable.

4.1 Vehicle segment

The vehicle segment (according to the definitions of the Federal Chamber of Automotive Industries – FCAI - and as used in their VFACTS reports) is often used to characterise the size and mass of vehicles. For example, Newstead (2009) concluded that Australia is experiencing a trend toward fewer 'large; vehicles, with an increase in both smaller and much larger vehicles based on an analysis of sales in FCAI segments.

Figure 4.1 shows the South Australian 2009 registered fleet broken down by FCAI segments and by the vehicle purchase year. A reading of this Figure suggests that sales of vehicles falling into the segment 'large' have diminished, particularly in recent years, while sales of SUV-type vehicles and

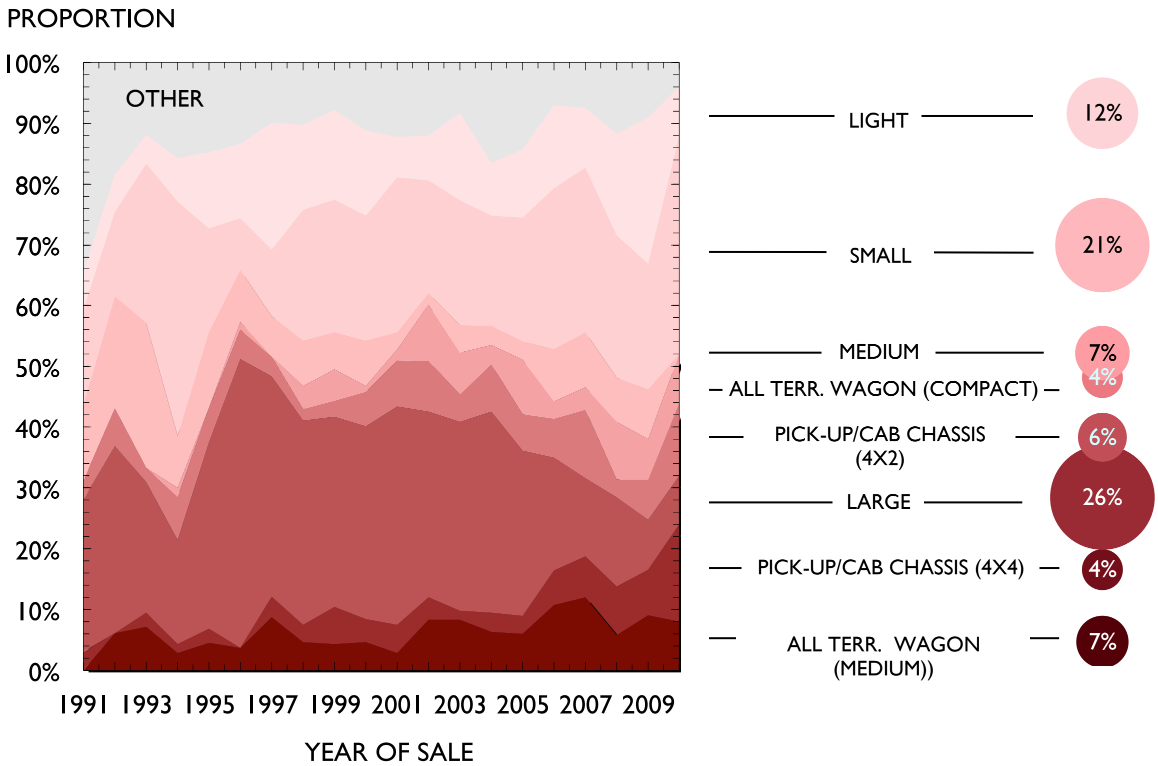

Figure 4.1
Proportions of the 2009 South Australian passenger fleet falling into segments as defined by the Federal Chamber of Automotive Industries, disaggregated by year of purchase on the left, and overall on the right. Individual segments comprising less than 5% of the fleet are grouped under OTHER. Segments are ordered from the smallest average mass to the heaviest (based on each vehicle in the registered fleet sample)

small vehicle have increased. This is consistent with the trends documented by Newstead (2009). Nevertheless, vehicles falling into the LARGE category remain the dominant segment in the registered fleet for the time being.

Trends in vehicle segments do not necessarily portray accurate trends in vehicle mass. Models within segments change through facelifts, and other models are subject to major upgrades, and so it is not necessarily true that vehicles comprising any given segment are homogeneous with respect to mass across different year-of-sale groups.

4.2 Mass

The vehicle specification data from Polk were used to characterise vehicle mass directly. The Polk data are imperfect here: three mass fields are provided – tare, kerb and gross vehicle mass – but the fields are not always consistently populated, particularly for vehicles sold in recent years. For the majority of vehicles, both tare and kerb mass were provided, but in many cases, one but not the other were present in the database. For some models, weight ranges were provided.

Kerb and tare mass are related as kerb mass is the sum of the tare mass plus operating fluids. A highly linear relationship exists for the vehicles in the sample where both tare mass and kerb mass were provided, with the kerb mass being 2.5% higher than the tare mass. This relationship was used

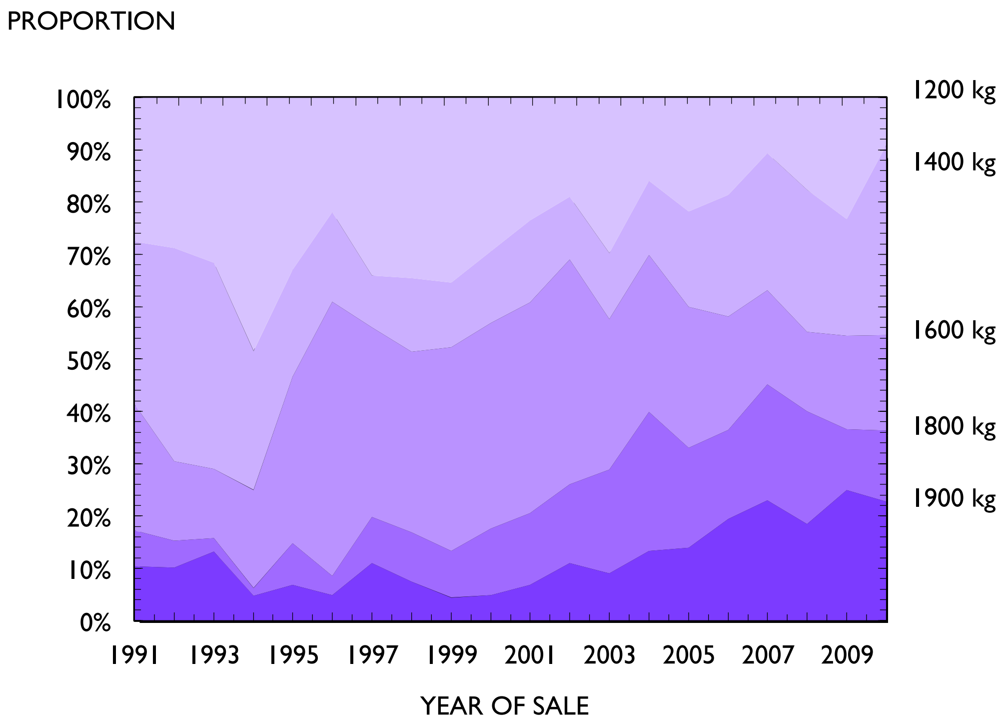

Figure 4.2
Proportions of the 2009 South Australian passenger fleet falling into kerb mass categories
< 1200 kg, 1200 – 1400 kg, 1400 – 1600 kg, 1600 – 1800 kg, > 1800 kg, by year of sale

to populate missing kerb mass values where tare mass was provided alone. Where a range was given, the average of the two values was used. After this process, 84% of kerb mass values were either known directly or estimated via the tare mass value or averaging procedure.

Figure 4.2 shows the distribution of known vehicle kerb mass values categorised into mass ranges and disaggregated by the vehicle sale year. The trend toward heavier vehicles in recent years is apparent, with an indication that some subtle polarisation of the fleet with respect to mass may be under way: in the last few years, sales of the heaviest vehicles have been increasing as have vehicles falling into the sub-1600 kg category.

In this report, the term passenger vehicle is used to encompass regular passenger vehicles, but also four-wheel-drive vehicles under 2500 kg kerb mass, and hence include the FCAI category LIGHT TRUCK. Figure 4.3 shows the trend in mass with year of sale of vehicles in the South Australian registered fleet, also disaggregated by FCAI vehicle class. Notable is the 130 kg difference in the average mass of vehicles sold in 1991 and in 2008. This difference is largely a product of the increase in both the mass and market share of LIGHT TRUCKS over the time interval 1991-2008. There is also

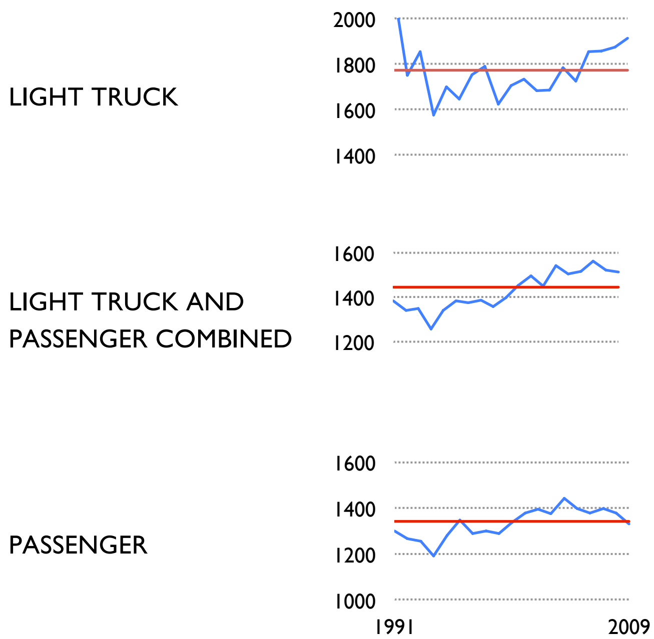

Figure 4.3
The average kerb mass (kg) of registered passenger vehicles in the 2009 South Australian registered fleet (April 2010), by year of sale (1991 – 2010) and overall. Very few light trucks from 1991 were included in the sample and so the average weight of these vehicles in 1991 should be treated with caution

a more modest difference in the mass of PASSENGER vehicles sold in 1991 and 2008. The average mass of all vehicles in South Australia falling into either of category is about 1445 kg.

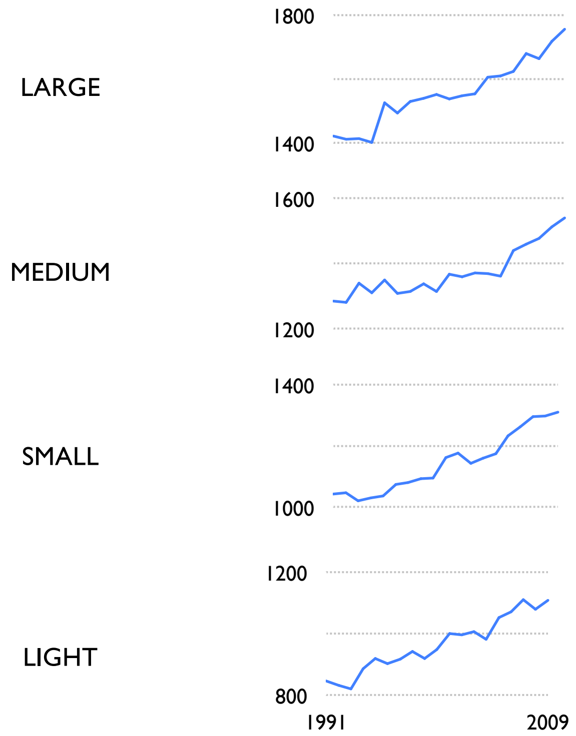

Figure 4.4
Estimates of the changes in average mass (kg) of vehicles sold in South Australia, for four FCAI segments, between 1991 and 2008

Notable is the inflation of mass of vehicles within FCAI market segments. Trends in market segments have been increasing at a rate of over 12-17 kg per year (Figure 4.4).

The trend in average kerb mass of individual models with year of sale is also positive. The average mass of three popular models shown in Figure 4.5 show steady positive correlations with year of sale. The average mass of the Toyota Corolla is steady with respect to year of sale until an increase corresponding with a major upgrade of the model in 2006. It is interesting to note that the new Toyota Corolla is heavier than the Toyota Camry sold in 1991, and similar to the weight of a Holden Commodore sold in 1991 (for those vehicles that are still in the fleet).

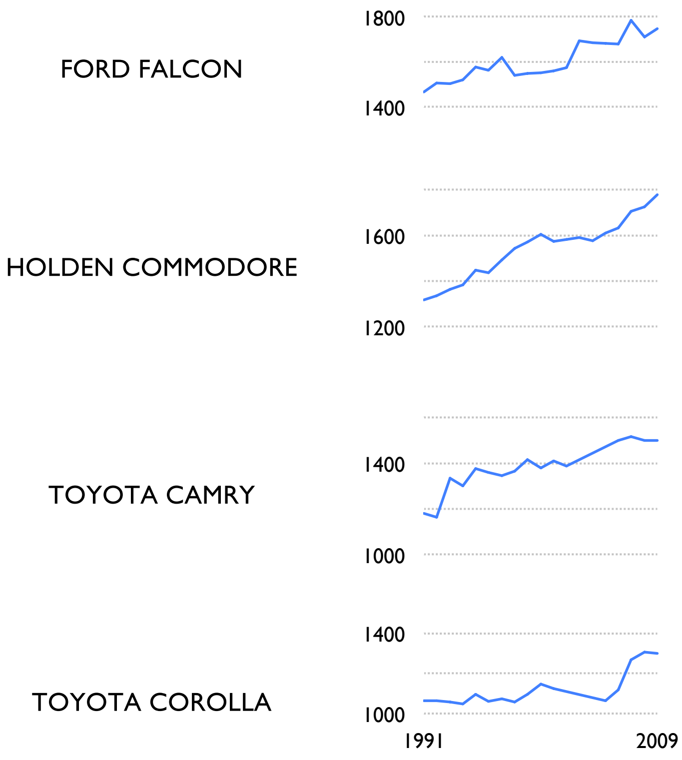

Figure 4.5
Estimates of the changes in average mass (kg) of vehicles - four specific models (all variants) - sold in South Australia between 1991 and 2009

5 Braking and stability control systems

Systems to improve vehicle handling in emergency situations are promoted as being beneficial for crash prevention. Historically, the effectiveness of such systems has been highly variable. Anti-lock brake systems (ABS) maintain brake forces without inducing skidding and hence allow steering control through emergency brake manoeuvres. Many studies, including one of the most recent, have been unable to associate any reduction in injury crashes with the fitment of ABS (Cummings and Grossman, 2007). Other evidence suggests that ABS may be useful for only sub-groups of drivers and crashes (Nishida, 2009). Electronic stability control (ESC) on the other hand has been shown to markedly reduce crash risk for some common crash types. ESC systems detect excessive yaw angles and wheel slip, and intervene to create stabilising moments on the vehicle through selective application of brakes to individual wheels. While effectiveness estimates have varied, large reductions in fatal single vehicle crashes have been noted (a summary of estimates is given in Ferguson, 2007). Scully and Newstead (2008) found that ESC was associated with a 30% reduction in single vehicle injury crashes in Australia.

Two other systems are considered here: electronic brake force distribution, and brake assist. Often braking and stability control systems are integrated in vehicles. ESC uses systems that are common to ABS and traction control systems. And so for newer cars, such devices are packaged together.

Figure 5.1 shows the fitment rate of these systems in the two samples of vehicles analysed in this report: the sample of the April 2010 registered fleet and all vehicles involved in casualty crashes in 2008 and 2009. Aggregate fitment rates are reported in the right hand column of Figure 5.1.

The vehicles in each sample were disaggregated by the year in which the vehicle was first sold new. For each year group, the proportion of vehicles with each system is plotted. In other words, the plots are an estimate of the fitment rate of each system in new vehicles over time. For the registered fleet sample, standard installations (dark blue) and standard plus optional systems (light blue) are shown. It is not possible to know from this data what the take up of optional systems are, but anecdotally take up rates of optional safety equipment is not high. The difference between the light blue and darker blue lines (and the associated light and dark blue numbers) probably indicates the potential shortfall in deployment of each system due to the non-fitment of optional systems.

An example may serve to explain how Figure 5.1 might be read: the top-right cell of the figure shows that 53% of the sample of registered vehicles in April 2010 had ABS installed as standard. The adjoining plot shows that very few vehicles in the sample that were new in 1991 had ABS as a standard feature, and that around 82% of vehicles in the sample sold in 2009 had ABS installed as a standard feature. The red line shows that, in respect of ABS fitment, and for a given vehicle year, those vehicles involved in serious/fatal crashes look much like the sample of registered vehicles – there is little difference between the plot for the registered and crashed vehicle samples, and so the rate of crash involvement of vehicles with ABS is similar to such vehicles' representation in the fleet as a whole. Were the red line to lie above the dark blue line, it might indicate an over-involvement of such vehicles in crashes (per registered vehicle in each year-of-sale cohort). Were the red line to lie beneath the dark blue line, it might indicate that such vehicles were under-represented in crashes, hence preventing crashes to a measurable extent.

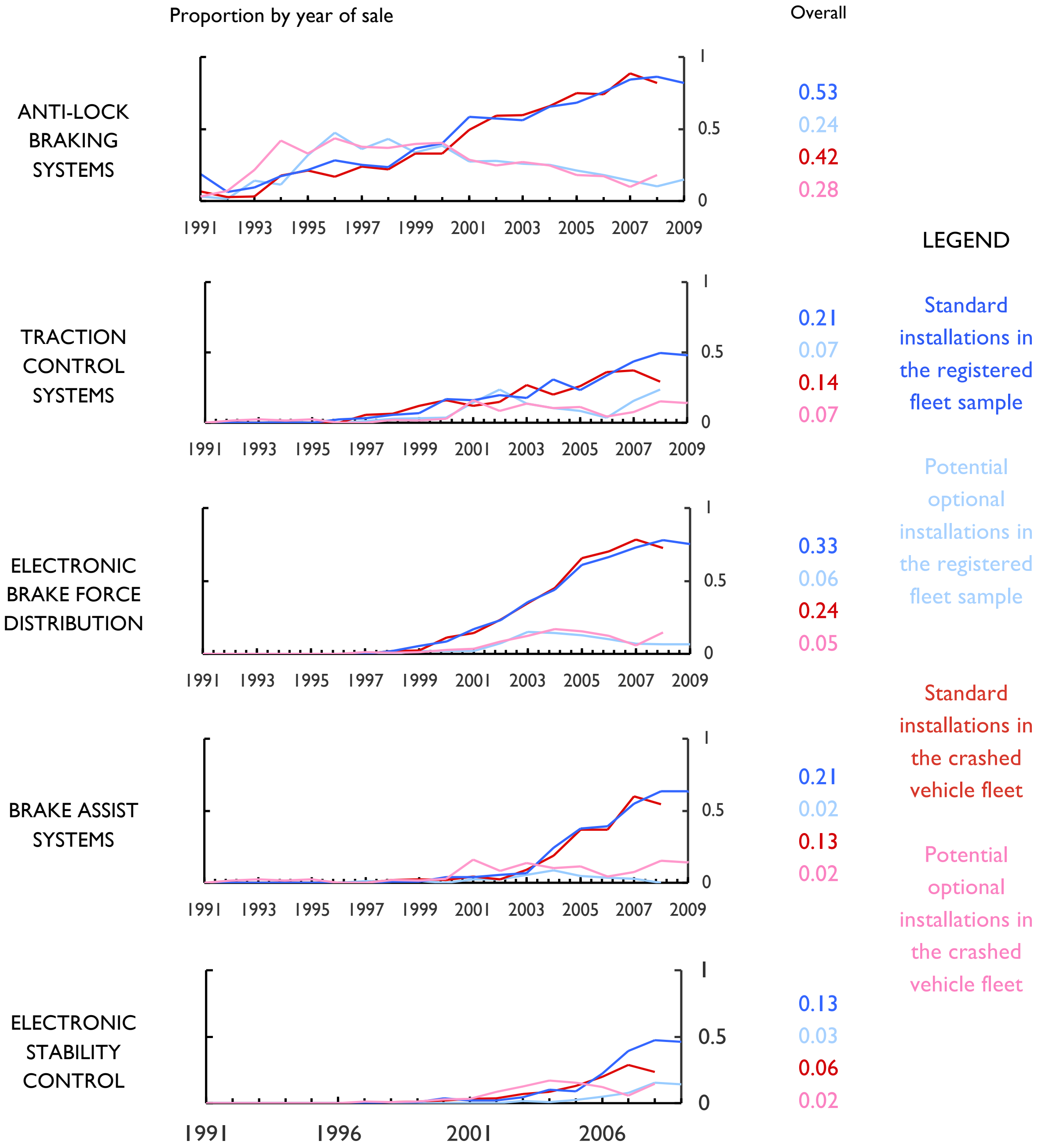

Figure 5.1
Proportions of vehicles in the registered fleet (April 2010) and in passenger vehicles involved in serious and fatal crashes (2008-2009) with braking and stability control systems by year of first sale (plots), and overall (figures to the right). Note that differences in overall fitment rates between vehicles involved in crashes and the registered fleet will arise due to differences in the age profile of vehicle in the two groups, and do not represent changes in crash risk due to the fitment of the feature

It might be noted that some technologies in Figure 5.1 appear underrepresented in crashes given the figures in the right hand column. This is due to the differences in the age profile of the crashed vehicles and the registered fleet in general, and partly due to the temporal separation of the two samples, and not necessarily due to a reduced crash risk. As older vehicles are over-represented in crashes due to non-vehicle reasons, and these vehicles are less likely to have any given technology in Figure 5.1, the prevalence of the technology in crashes is lower than in the registered fleet generally.

The progressive introduction of various features into new vehicles can be seen with the earliest system (ABS) at the top of Figure 5.1 and the most recent (ESC) at the bottom. While ESC was fitted to around 50% of vehicles in the registered fleet sample that were sold in 2009, in April 2010, ESC equipped vehicles constituted only about 13% of all registered vehicles.

There is a noticeable downtick in the representation of vehicles with ESC and other systems in crashes involving vehicles sold in 2006 onward. It is likely that this due to the effectiveness of ESC in preventing crashes. Table 5.1 shows that, for vehicles first sold from 2004 onward, ESC installation was associated with a large under-involvement in single vehicle crashes in 2008 and 2009. About ten serious casualty single vehicle crashes appear to have been prevented within this sub-population of vehicles in 2008 and 2009 (50% reduction). While it is not possible to exclude confounding effects to do with vehicle type and driver type from this observation, the effect is large and consistent with benefits found in other studies.

Table 5.1
Cross-tabulation of vehicles involved in serious/fatal crashes in 2008 and 2009 by ESC status and crash type – for vehicles sold between 2004 and 2009 only

ESC fitment	Single vehicle crashes	Multi-vehicle crashes
None / optional	95	236
Standard	9	68

Chi-square = 8.64, p = 0.0033

Similar treatments of crashes involving vehicles according to the installation of the other technologies in Figure 5.1 are unable to detect an influence of any of the other technologies – an influence is found when ESC equipped vehicles are included, but when ESC vehicles are removed from the analyses, effects due to the other systems are no longer detectable.

6 Passive (secondary) safety features

Passive safety systems are designed to protect occupants or vulnerable road users in a crash. Passive safety systems encompass vehicles structural design (energy absorption, intrusion mitigation) and restraint design (advanced seatbelts, airbags, head restraints). The 1990s were a decade that saw large-scale deployments of many such systems into new vehicles.

Specification data from RL Polk include some detail, but not all, of the passive safety features built into vehicles. Certain aspects of restraint design are explicitly coded, but details of the structural crash design are not. However, the specifications do include the performance of vehicles in crash tests performed by the Australasian New Car Assessment Program. ANCAP ratings are described in Section 7.

The procedure of disaggregation by year of sale that was used in the previous section is employed below to compare the crashed vehicle and registered vehicle samples with respect to passive safety systems. Braking and stability control systems are designed to prevent crashes, whereas passive safety systems mitigate and manage the energy of a crash; so the comparison of the two samples is less likely to show any under-representation of vehicles in injury crashes with respect to the fitment of passive safety systems. This is because the police coding of crashes does not allow a reduction in severity where injuries are reduced, but remain serious, to be detected.

6.1 Seatbelt technology

Seatbelts are highly effective passive safety devices. Drivers are 3.5 to 4 times less likely to die in a crash if they are properly restrained (Crandall et al., 2001). Seatbelts are effective because they allow an occupant to ride down a crash that has a large frontal component – by which it is meant that they are slowed over a longer distance by being tied to the vehicle structure. Unrestrained, an occupant will fly forward relative to the vehicle interior and, depending on the relative geometry of the interior and the crush caused to the front of the vehicle, strike the interior surface at close to the speed of the crash. In the unrestrained case, the occupant's energy is dissipated over a much smaller distance, which produces much larger and hence more injurious forces. The other important function of a seat belt is to keep the occupant from being ejected from the vehicle and to lessen the chances of being thrown around the interior of the vehicle in rollover crashes in particular.

Certain technologies are designed to improve the performance of seatbelts in crashes. The ability of an occupant to ride the crash down with the vehicle is impeded if there is any slack in the system – the slack may cause an increase in forces on the body of the occupant. Pretensioners are systems designed to eliminate any slack in the belt system at the onset of a crash. Systems may vary in the means that they employ to perform this function, but often a pyrotechnic charge is used to drive a piston in such a way as to pull the belt tight around the occupant.

While eliminating slack improves the efficiency of the belt system, large forces on the occupant may still arise in more severe crashes. Force limiters allow the belt system to give when restraint forces approach injurious levels. Often these systems allow the belt to spool out in a controlled manner so that in a frontal crash, the free space between the occupant and the vehicle interior can be utilized to absorb energy at force levels below the tolerance of the occupant to injury.

Figure 6.1 shows the prevalence of these two types of seatbelt systems in the two samples of vehicles considered in this report. Almost all vehicles in the registered vehicle sample sold new in the latter half of the 2000s have pretensioners in the front seating positions – almost no vehicles sold new in the early 1990s were equipped with pretensioners. Overall, almost half of all vehicles in the sample of the registered fleet were equipped with pretensioners in the front seating positions. A similar pattern is observable in the pattern of fitment of force limiting seat belts, although installation appears to have plateaued at around 75% of new vehicles from 2003 onwards.

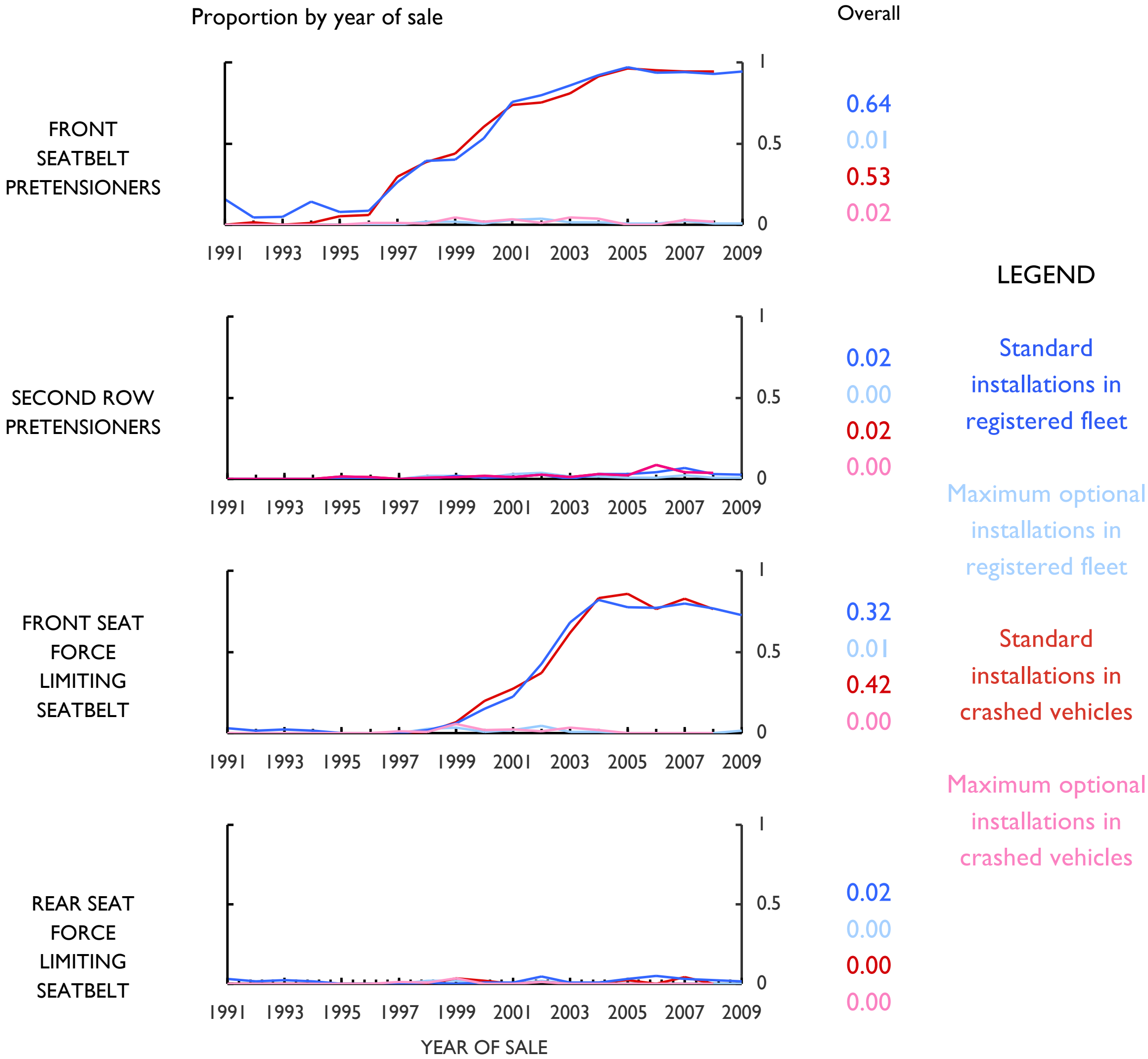

Figure 6.1
Proportions of vehicles in the registered fleet (Mar 2009) and in passenger vehicles involved in serious and fatal crashes (2007) with systems to improve seatbelt performance, by year of first sale (plots), and overall (figures to the right). Overall fitment rates for vehicles involved in crashes are omitted, as the two samples are not directly comparable at this level of aggregation

Vehicles involved in serious injury crashes in 2008-2009, when disaggregated by year of first sale, look much like the registered fleet sample in respect of the fitment of seatbelt pretensioners and force limiting seatbelts. Filtering on crash type to examine only those vehicles that were involved in the type of crashes likely to benefit from improved seatbelt performance did not change the pattern. Any effect these technologies are having in crashes is therefore not detectable in these samples according to the methods used in this report.

Recently there has been some concern that the specifications of restraint systems in rear seating positions are inferior to those in the front (Beck et al., 2009; Kent et al., 2009; Tylko and Dalmotas, 2005). Figure 6.1 shows that almost no vehicles in the 2009 registered fleet sample had either pretensioners or force limiting belts in rear seating positions. Rear seat occupants accounted for 8.7% of serious and fatal car occupant casualties in 2007, with the great majority of those being adults and the majority wearing their restraint at the time of the crash (according to police records) (TARS, 2010).

6.2 Airbags

Figure 6.2 shows the deployment of front, side and curtain airbags in the two samples of vehicles. Front passenger frontal airbags are now almost ubiquitous in new passenger vehicles and 77% of the registered vehicle sample has a driver's airbag. Installation of side and curtain airbags appears to be currently increasing with around 50% of vehicles in the sample sold new in 2009 having such airbags as standard.

As with the seatbelt technology, vehicles fitted with airbags are neither particularly underrepresented nor overrepresented in serious casualty crashes. In Figure 6.2, the prevalence of frontal airbags in vehicles involved in all serious and fatal crashes is shown. For side airbags, only vehicles involved in serious and fatal 'right angle' and 'right turn' crashes are shown. Similarly, the prevalence of side curtain airbags in crashed vehicles is restricted to those serious and fatal crashes that are more likely to benefit from their installation and deployment.

Having said that, there is some indication that side curtain airbags are reducing the incidence of serious and fatal injury crashes in the subset of all crash types indicated in Figure 6.2. However, the differences are small enough to be overwhelmed by statistical uncertainty.

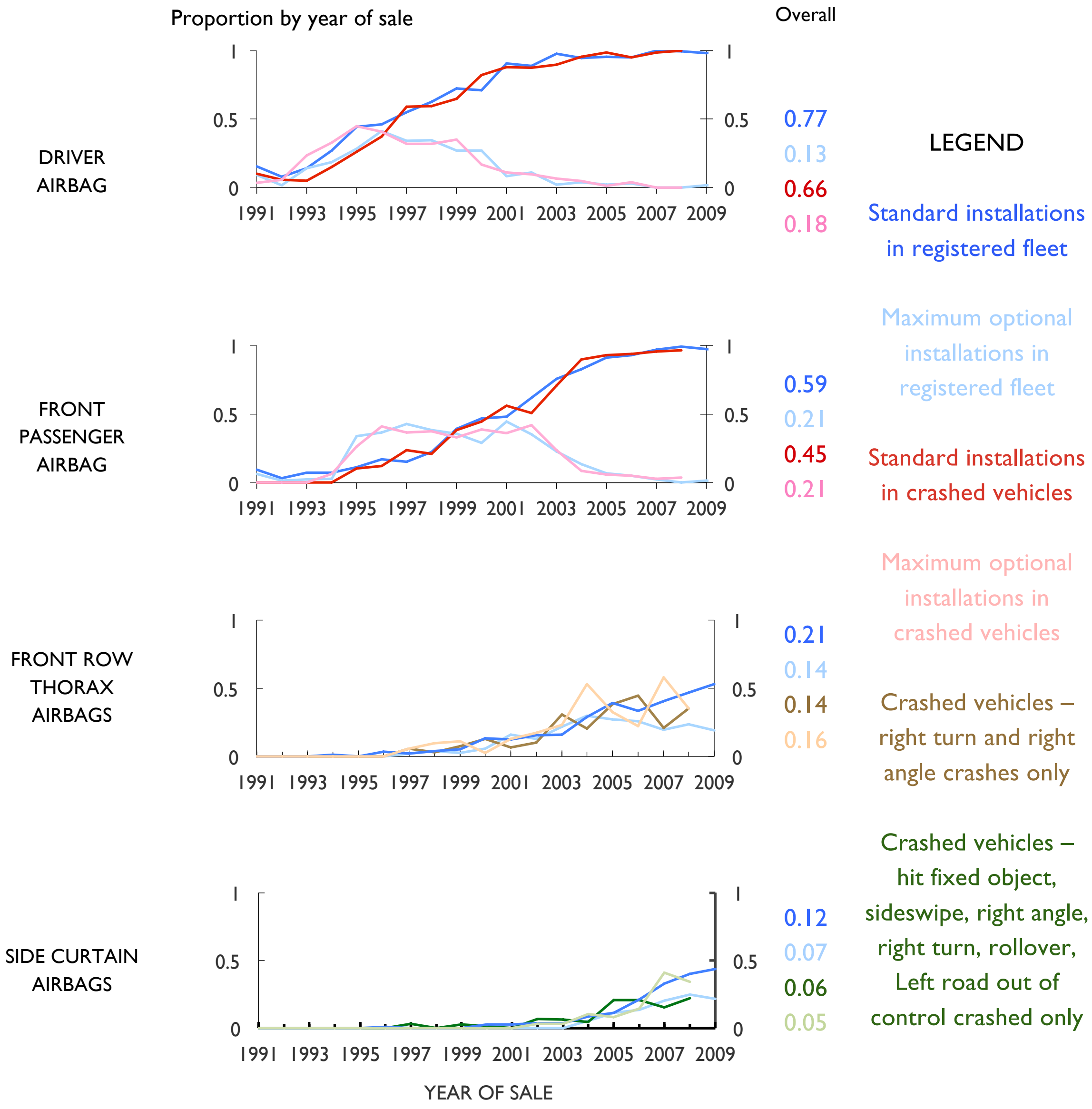

Figure 6.2
Proportions of vehicles in the registered fleet (Mar 2009) and in passenger vehicles involved in serious and fatal crashes (2007) with airbag systems, by year of first sale (plots), and overall (figures to the right). Overall fitment rates for vehicles involved in crashes are omitted, as the two samples are not directly comparable at this level of aggregation

7 Crash test performance

The Australasian New Car Assessment Program (ANCAP) publishes the results of crash tests to inform the public of the safety of vehicles. Up to four crash tests are performed: an offset frontal crash test, side impact crash test, a pole impact test (used only where there is a side curtain airbag), and a pedestrian safety assessment made through subsystem impact testing. The results of the offset frontal and side impact tests are used to generate an occupant rating, which is modified according to the presence of other safety features such as seat belt reminders and electronic stability control. The result of the pedestrian assessment is currently separate from the occupant assessment, but both will soon be integrated into an overall assessment.

Vehicles are assigned points based on aspects of the crash test results and these are then converted to a star rating with 5 stars being the highest level of performance in the occupant assessment and 4 stars the highest in the pedestrian assessment. On a model-by-model basis, ANCAP ratings have been improving over time: 62% of models tested by ANCAP in 2009-10 achieved a 5-star ANCAP occupant rating. This compares with 14% in the years 2000-2004 (Michael Paine, personal communication). More information on the program and details on the assessment procedure can be found at http://www.ancap.com.au.

In the following sections, fleet-weighted ANCAP results are presented, to examine how the model-by-model performance is being translated through sales into the performance of the registered fleet.

7.1 Occupant rating

The ANCAP program began in 1993. In 1999 ANCAP aligned its crash testing procedures with Euro NCAP and hence began republishing Euro NCAP results in Australia. Results based on the aligned test program are available in the Polk data from about this date onwards. Figure 7.1 shows the variation in the proportion of the sample of registered vehicles that have a known occupant rating, according to year of sale. More than 81% of vehicles sold new in 2009 have an ANCAP rating, but 58% of all vehicles in the registered fleet are without a rating, with composition of the unrated vehicles biased toward older vehicles.

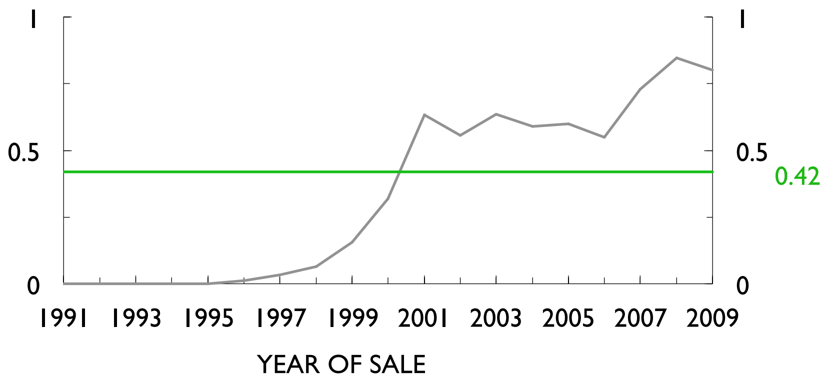

Figure 7.1
Proportions of vehicles in the registered fleet (Mar 2009) with an ANCAP rating disaggregated by year of sale (grey) and the overall proportion (green)

There is a positive association between the occupant rating of vehicles (those that have a rating) and the year of sale (Figure 7.2). Those vehicles in the registered vehicle sample with a star rating that were sold new in 2009 had an average rating of over 4 stars. The equivalent portion of the sample sold new in 2001 had an average star rating of just over 3 stars. The average rating of all vehicles (that have a rating - 32% of the sample) is over 3.5 stars. It is not possible to determine how those vehicles that have no rating compare with those that do in each year of sale cohort.

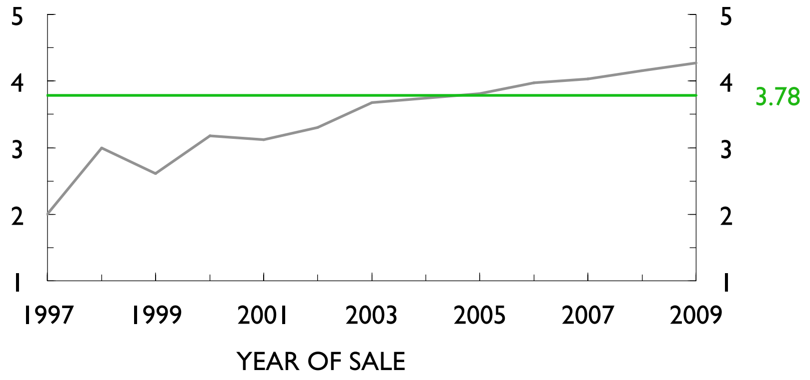

Figure 7.2
The average star rating of vehicles in the registered fleet (Mar 2009) disaggregated by year of sale (grey) and the overall average (green)

Figure 7.3 shows the makeup of vehicles in each year-of-sale cohort according to the occupant protection star rating of the vehicles in each cohort. The majority of vehicles with a rating sold new in 2000-2003 had a star rating of three whereas from 2003 onward, a large majority have a star rating of four. The number of five-star vehicles has accelerated in recent years, but it is clear that improving the occupant rating of the registered fleet is still a work in progress after more than 10 years of the current ANCAP program.

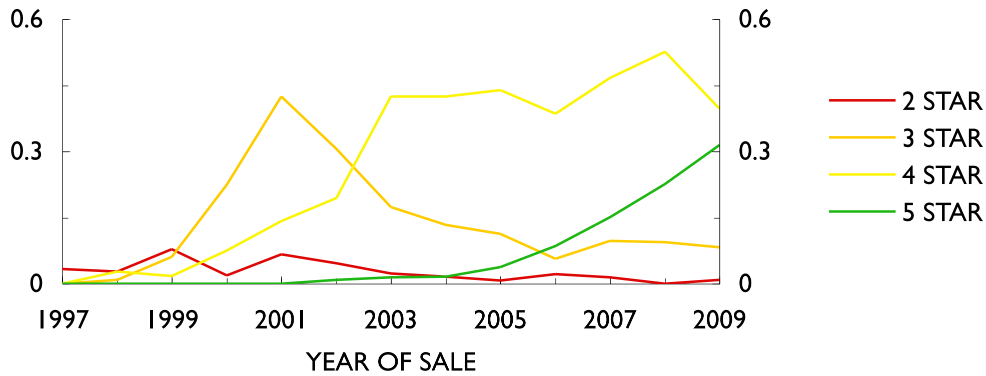

Figure 7.3
The proportion of vehicles in the registered fleet (Mar 2009) in each year of sale cohort with star ratings of two to five. Almost no vehicles had a star rating of one

7.2 Pedestrian rating

In the history of the ANCAP program, the pedestrian rating has received less attention than the occupant rating portion of the program. Nevertheless, the proportion of the fleet with a pedestrian rating mirrors the proportion of the fleet with an occupant rating (Figure 7.4).

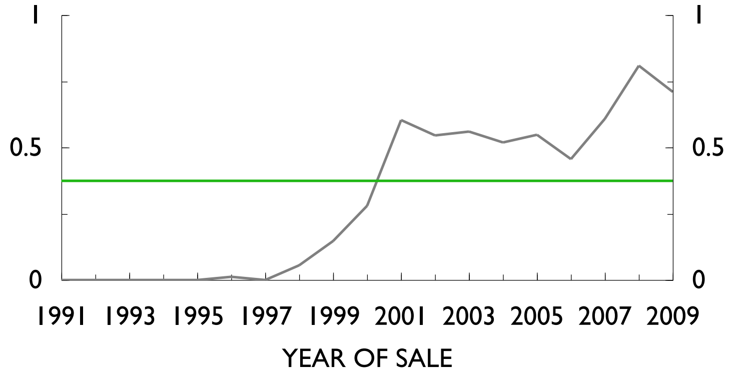

Figure 7.4
Proportions of vehicles in the registered fleet (Mar 2009) with an ANCAP pedestrian rating disaggregated by year of sale (grey) and the overall proportion (green)

However, in contrast to the occupant rating, there is no positive association between the average pedestrian rating of vehicles and the year of sale in that portion of the sample of registered vehicles with a rating (Figure 7.5).

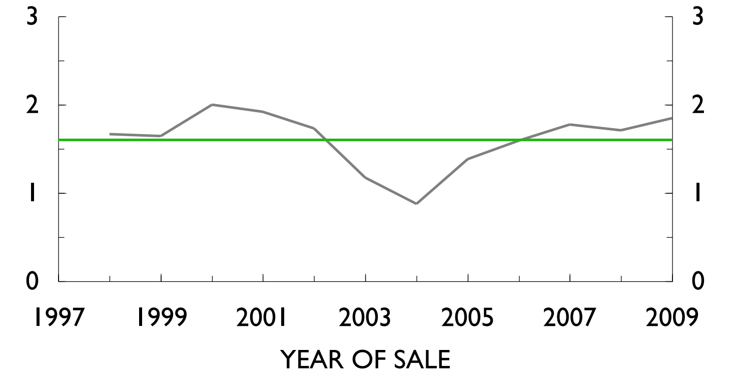

Figure 7.5
The average star rating of vehicles in the registered fleet (Mar 2009) disaggregated by year of sale (grey) and the overall average (green)

In a previous study we examined the trend in pedestrian ratings of new vehicles sold in Australia. In that report, those vehicles that were released more recently performed better on average than those released in preceding years (Anderson et al., 2008). However, Figure 7.5 would suggest that such trends are not yet manifesting themselves when the entire registered fleet in South Australia is considered.

Figure 7.6 shows that the pattern in the prevalence of vehicles with a given pedestrian protection star rating has not been stable. In contrast to the vehicles with occupant protection, vehicles with zero or one star have become more common at certain times rather than less common. Only for vehicles sold in 2007 to 2009 does there appear to be a modest shift toward higher levels of pedestrian protection as assessed by the ANCAP procedures

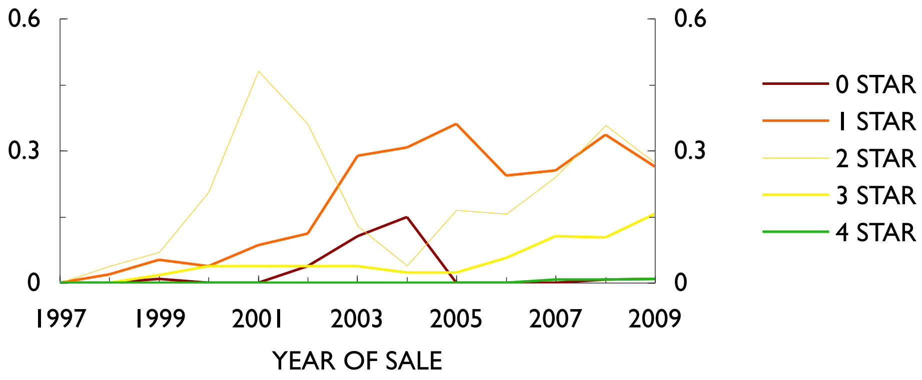

Figure 7.6
The proportion of vehicles in the registered fleet (Mar 2009)
in each year of sale cohort with pedestrian star ratings of zero to four

8 Vehicle performance

Vehicle performance is often thought to be negatively associated with safety: vehicles with high power to weight ratio may tend to be driven faster and hence be over-involved in serious casualty crashes. The topic is deserving of a thorough analysis, but here data is provided to show trends in the performance of vehicles, as measured by power-to-weight ratio.

In Figure 8.1, the power-to-weight ratios of the April 2010 sample of vehicles, and those vehicles involved in serious casualty crashes in 2008 and 2009 are disaggregated according to the year of first sale, averaged, and plotted. Each market class shows a positive trend in power to weight ratio. On average, vehicles have increased power by about 10 kW/1000 kg over the first 19 years represented in the sample. The light truck class has shown the largest average increase in power to weight ratio over the period, with an increase of 30%. This reflects the changing nature of this market class from vehicles that were deserving of the label “light truck” (including Toyota Landcruisers, and many with diesel engines) to increasingly popular sports utility vehicles designed for mainly urban use.

Vehicles in the serious injury crash sample show similar trends with respect to power to weight ratio as the general fleet. There is some indication that older vehicles with higher power to weight ratios are over-represented in crashes, but this observation is tentative, and a more thorough analysis is required to examine the role of higher performance vehicles in crashes. (Such a study is currently underway in Western Australia, with the involvement of the authors of this report, with results due in 2011).

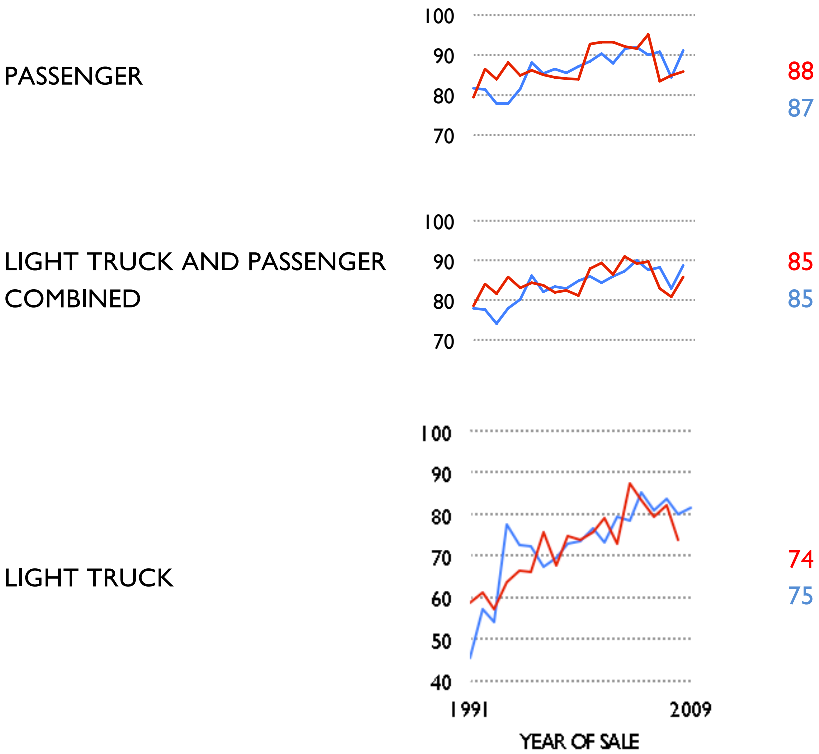

Figure 8.1
Power to weight ratios (kW/1000 kg) of vehicles in the South Australian fleet (April 2010) and in vehicles involved in serious injury crashes in 2008-2009

9 Using fleet purchasing as a method of increasing technology uptake

In Anderson et al (2009) we investigated the relative age of the registered passenger vehicle fleet in South Australia. We reported that the state has a relatively old passenger vehicle fleet, and lagged the national average by 1.3 years. Based on a crashworthiness improvement of 2.5% per year in the rate of serious injury crashes per tow-away crash, we calculated that this might mean that serious crashes were over-represented in South Australia by about 3%.

Another effect of an older fleet might be that the prevalence of primary safety features in passenger vehicles might be lower in this state compared to vehicles in other jurisdictions.

To examine how the prevalence of new technology might be affected by accelerated fleet renewal, we have compared the prevalence of several technologies in the registered fleets of South Australia and New South Wales. New South Wales has the most modern fleet of any state (noting that the Northern Territory's fleet is slightly newer) and is slightly newer than the national average. It therefore represents a registered fleet against which SA can be compared to answer the question 'what if' the SA registered fleet was at least similar in age profile to the Australian average.

9.1 Comparing the prevalence of safety technology between the fleets of SA and NSW

The December 2009 quarterly extract of the registered light passenger vehicle fleet (<2500 kg) in New South Wales was sampled. A sample of 1880 vehicles with decoded VINs (and therefore safety specifications) was obtained. Some 11.5 per cent of vehicles were lost at this stage: the great majority of these were pre-1991 vehicles. The sample was analysed to estimate the prevalence of a selection of the technologies presented in sections 5 and 6 in the NSW fleet.

The sample is slightly older than the sample taken in SA (sampled 4 months later). As the prevalence of technologies increases with time, this difference may introduce a small error in the comparison such that the prevalence of technologies in NSW may have been slightly lower in December 2009 than it would have been in April 2010.

For seven technologies at different maturity of deployment, there is a consistently lower representation of each in the April 2010 sample of the South Australian fleet. The difference is small however, averaging less than two per cent.

It should be noted however that the four months separation in the two samples may mean that the comparison slightly under-represents the true differences in the prevalence of technologies, particularly for newer technologies: if it is generously assumed that vehicles added to the NSW fleet in those four months are 4% of the fleet (given slightly less than 10% of the fleet are less than a year old), and half those vehicles have a technology for which the overall prevalence is 10%, then the prevalence may have increased by slightly less than 2% (noting that the fleets in all states are growing).

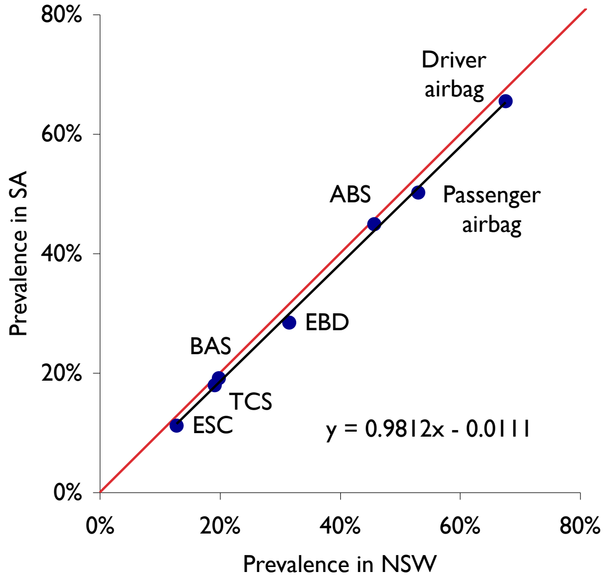

Figure 9.1
A comparison of the prevalence of a selection of vehicle safety technology
in samples of the South Australian fleet (April 2010) and New South Wales (December 2009)

9.2 The use of fleet purchasing to affect the prevalence of new-vehicle safety technology in South Australia

9.2.1 Introduction of a new technology into vehicles

The introduction of a new technology into new vehicles tends to follow a predictable pattern. Typically, only higher priced ‘prestige’ vehicles may contain a certain technology to begin with. Thereafter, the technology tends to trickle down to lower priced models of vehicle. If the technology becomes successful, the final installation rate in new vehicles will be close to 100%. Whether a technology achieves a 100% installation rate will depend on a host of factors including vehicle regulation and the nature of the market, and may take 10 or 20 years to achieve.

9.2.2 The general pattern of technology uptake in new vehicles

Vehicle fleet buyers will inevitably take up a new vehicle technology, at least passively. If a fleet buyer selects vehicles in a representative manner from across the range of available vehicles, a particular technology will start to infiltrate that fleet of vehicles over time in a way that reflects the overall introduction of the technology into new vehicles. A schematic representation of this is given in Figure 9.2, for a technology that is introduced in year I, and is present in 100% of vehicles by Year N.

In this figure, the solid blue line represents the introduction of the technology into new vehicles. Here, for illustrative purposes, a constant proportion of new vehicles are being bought by fleets (The yellow/green area). The representation of the technology in this segment of new vehicle sales reflects the proportion in new vehicles more generally.

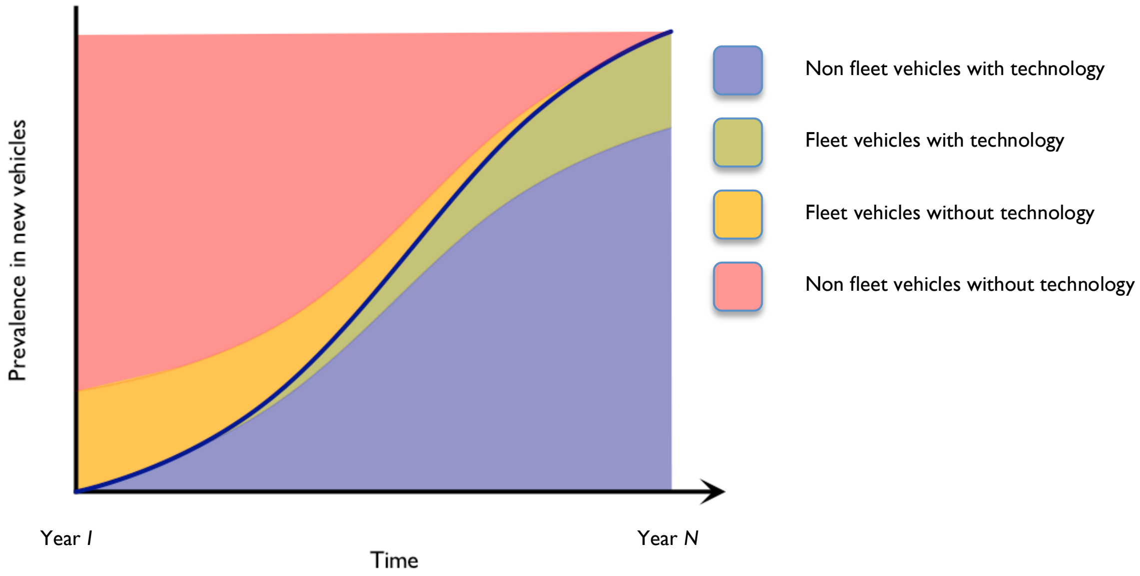

Figure 9.2
Schematic representation of increasing prevalence of technology
in new vehicle over time, and the fleet/non-fleet components of the prevalence

It should be immediately clear what the effect would be of a decision to adopt the technology early in fleet vehicles: the introduction curve would be bumped up to the boundary between the red and yellow areas. Conversely, if the fleet buyer actively rejects the technology in fleet vehicle purchases, the introduction cure would be bumped down to the boundary between the green and blue areas.

9.2.3 The general effect of technology uptake in fleet vehicles, on the prevalence of new technology

The discussion above considers technology uptake in new vehicles. But of course, the rate of uptake also has effects on the uptake in the registered fleet more generally.

Consider the age profile of all registered vehicles. Generally, the most frequent vehicle is a new vehicle, and the numbers of vehicles in subsequent age bands tend to decay (slowly at first) as vehicles are removed from the fleet through scrappage. In South Australia, there is a particular effect on the age profile that is due to significant importation of used vehicles less than 10 years old from other Australian states. The effect means that vehicles of older ages actually become more frequent, rather than less, the most frequent age being 10 years. The number of vehicles older than 10 years begins to decay.

Figure 9.3 schematically represents the age profile of the fleet. It has been schematically split according to whether vehicles in each age band are fitted with our example technology. The figure represents the situation at Year N, the time at which all new vehicles (those aged ‘0’) are fitted with the technology, the technology having been initially introduced N-I years previously.

Here the colours have the same meaning as before, but refer not to the current owner of the vehicle, but to the original buyer of that vehicle. Vehicles may change ownership several times before they are scrapped, but the configuration of the vehicle, and the stock of vehicles, is determined to a large extent by the choices made by the original buyer.

The total area and the sub-areas in the figure represent the total number of registered vehicles and the number bought originally by fleet and non-fleet buyers. In this illustrative example, the number of additional registered vehicles that would have the technology, if the fleet buyer had actively purchased the technology from its introduction, is represented by the yellow area, but only that portion which is newer than N-I.

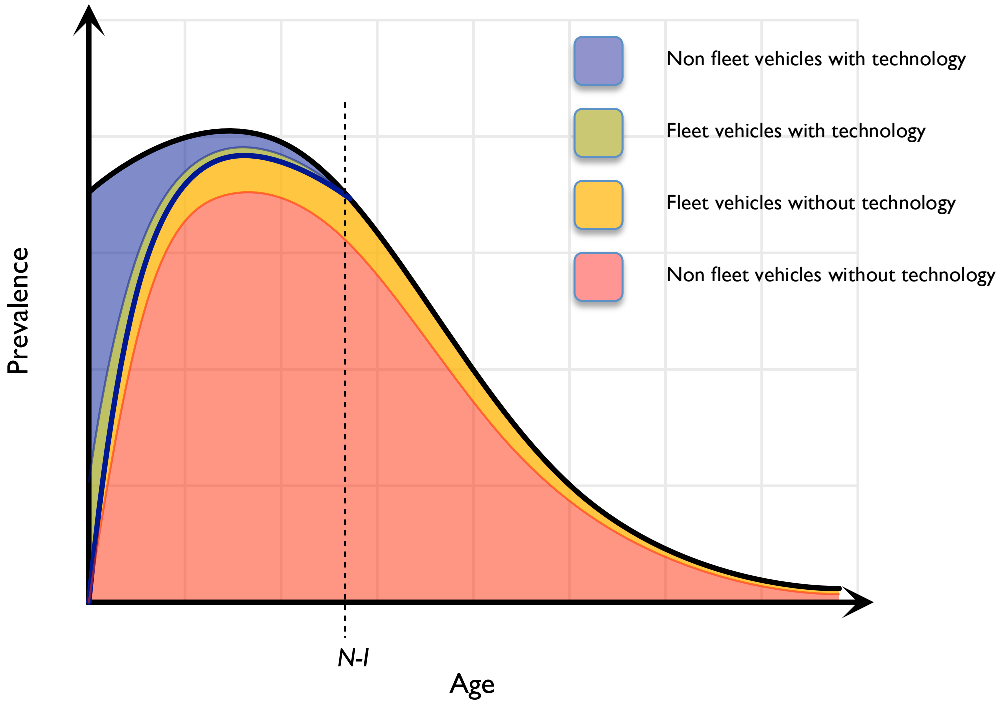

Figure 9.3
Schematic representation of the age profile of the registered fleet in South Australia, and the prevalence of new technology in the fleet, and the fleet/non-fleet components of the prevalence

9.2.4 The transient effect of the installation of the technology in fleet vehicles

The effect of fleet purchasing preferences is illustrated above at a particular time: that is at the time at which the technology is fully deployed in all new vehicles. But clearly effects on the general registered fleet are present before and after this particular time.

Consider the sequence in Figure 9.4: (A) a time before the technology was introduced, (B) a time part way toward full uptake in new vehicles, (C) the time at full uptake in new vehicles, and (D) a time some period after full uptake in new vehicles. In a fleet with a stable vehicle age distribution, the effect of fleet take up is illustrated in the following sequence of figures.

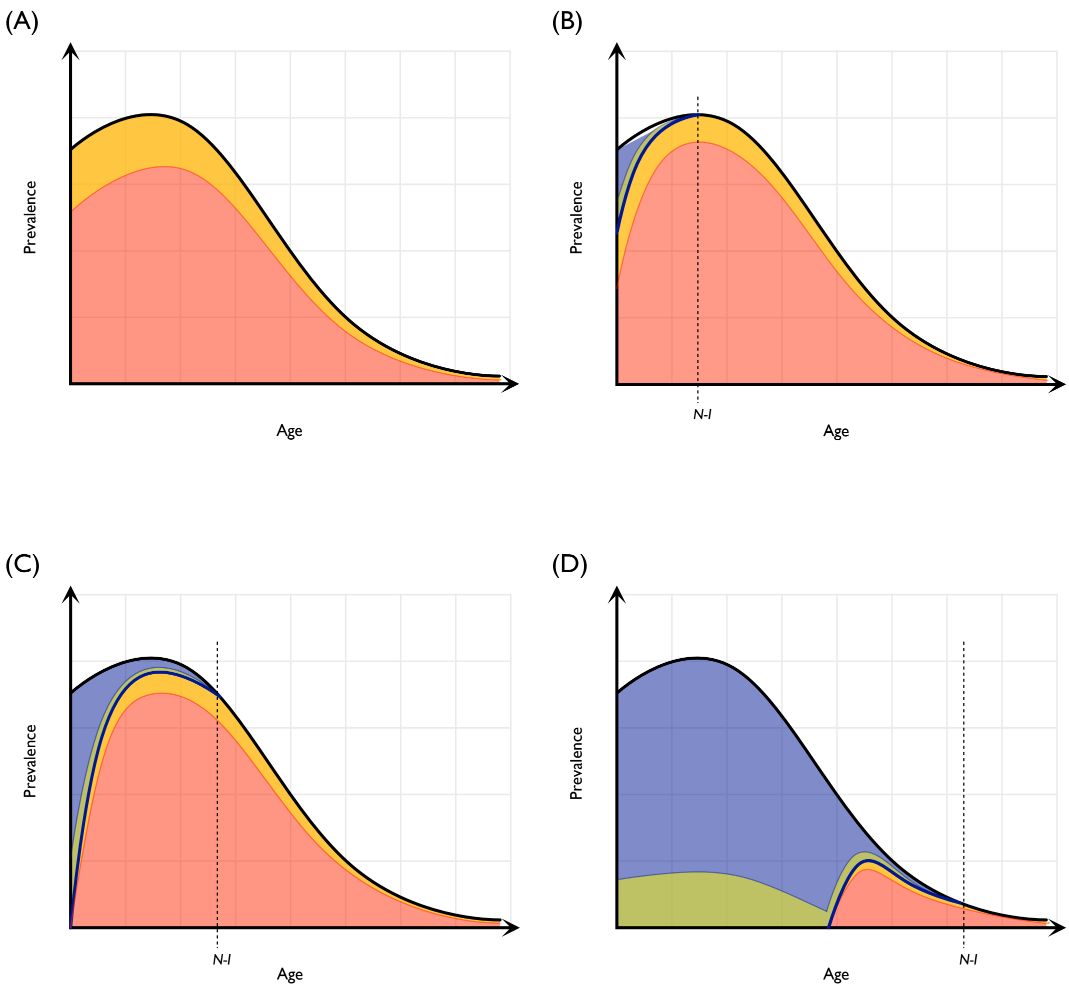

Figure 9.4
Schematic representation of increasing prevalence of technology in new vehicle over time, and the fleet/non-fleet components of the prevalence

The potential for the fleet buyer to affect the general fleet is non-existent at (A), increases through (B) and (C) before declining as the technology has become universally available for an extended period, and those vehicles without the technology 'wash out' of the registered vehicle fleet. Schematically, this effect is represented in Figure 9.5.

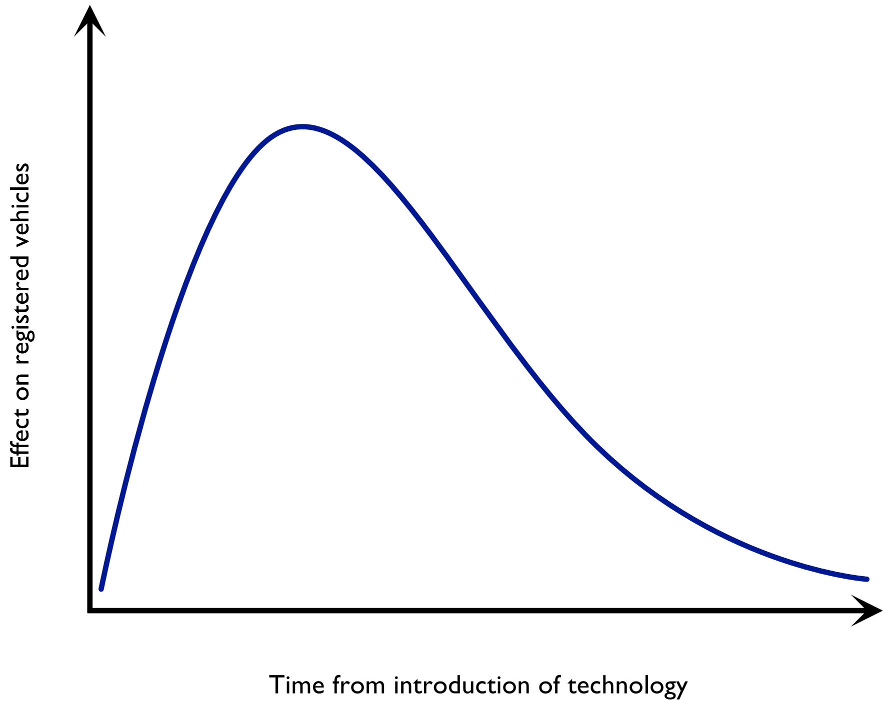

Figure 9.5
Schematic representation of the transient effect on the prevalence of new technology from fleet purchases. As a technology becomes widely available, and becomes standard on most vehicles, the influence of fleet purchasing policy diminishes

Looked at in this way, we can see that the effects of fleet purchasing decisions are transient. But in an area that has seen the continuous introduction of new technologies into vehicles, a fleet purchasing policy of early adoption would have an ongoing general effect of maximising fleet purchasing effects on the prevalence of new technology in registered vehicles.

9.2.5 Some historical examples of the potential effectiveness of purchasing decisions on the prevalence of technology in the present day fleet.

By examining the safety features of vehicles bought by fleets in the past, and making an assessment about whether it is feasible that certain features would have been available to purchasers at the time, it is possible to estimate how different the present day fleet might have looked if government and fleet buyers had aggressively required such features as soon as a benefit was apparent, and the feature was available.

Figure 9.6 shows the current prevalence of range of vehicle safety attributes on the horizontal scale. The vertical scale shows a potential prevalence over the actual prevalence – the potential being the effect of government and corporate fleets in Australia would have had, if they had mandated the attribute in their purchasing policies in the past.

It is clear that the effect is most pronounced early in cycle of technology take-up: ESC would now be in about 30% of vehicles rather than in 14%, but the effect for frontal airbags would be now minimal given the high rates of installation that have existed for 10 years.

The effects described above do not include any additional 'halo' effect that such purchasing polices would have. For certain vehicle models, a consistent policy of purchasing optional equipment would increase the likelihood of that technology becoming standard on the model for all purchases.

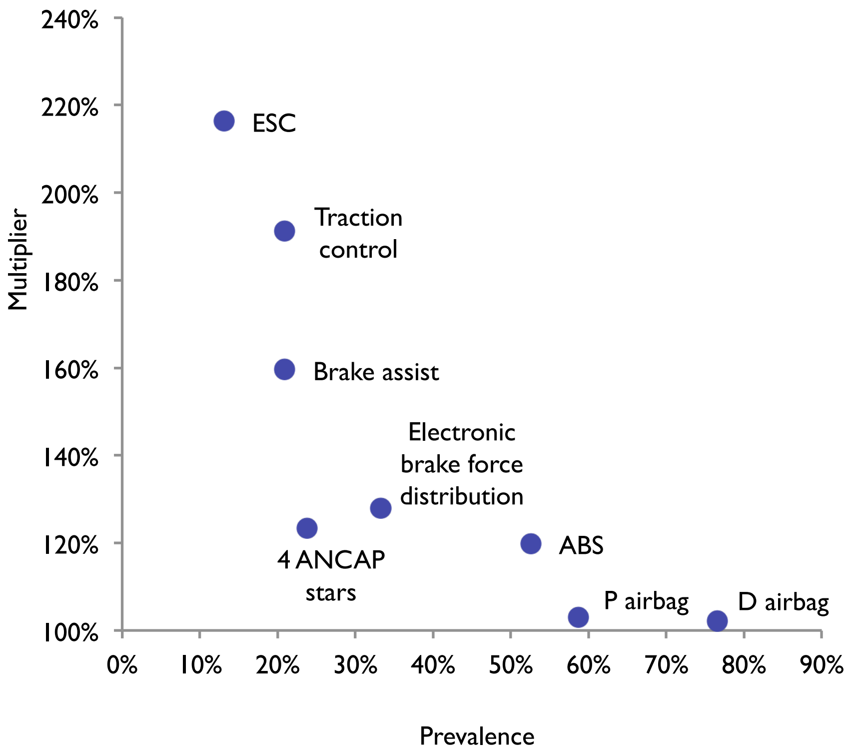

Figure 9.6
The potential factor by which the prevalence of certain technologies would be higher, if all South Australian fleet buyers (government and private sector) had been early adopters of new vehicle technology. The effect on prevalence is greatest for newer technologies that have not yet saturated the newer vehicle fleet

10 Summary

This report has characterised the South Australian passenger vehicle fleet according to attributes related to safety, vehicle mass, and the type of original buyer. By disaggregating vehicles by year of sale, it has been possible to estimate the rate at which these attributes have changed in new vehicle sales.

Two populations of vehicles were studied: a random sample of 2000 passenger vehicles was extracted from registration records in April 2010 to represent the fleet as it was at that time; the second sample involved all passenger vehicles involved in serious and fatal crashes in 2008 and 2009 in South Australia.

Examination of the registered vehicle sample allowed the uptake of technology, and the change in other attributes of the general registered fleet, to be examined. The crashed vehicle population was of particular interest as it is for these vehicles that safety (in particular, secondary safety) is of most relevance. Furthermore, we have previously seen that crashed vehicles are a biased sub-population of the entire registered fleet – they are older on average and vehicles up to 20 years of age are approximately equally represented (Anderson et al., 2009).

The origin of vehicles in the registered vehicle fleet was examined in the two samples, and showed that an estimated 71% of vehicles registered in South Australia were originally sold new in the state, with the other 29% originating interstate (mainly NSW and Victoria). For vehicles older than 6 years, the number of vehicles of interstate origin is higher still, as vehicles appear to be imported into South Australia up until about this age.

Another observation regarding the origin of vehicles was the type of original buyer – this is of interest as it is these buyers who, in part, determine the level of safety of new vehicles entering the registered fleet in South Australia. The importance of non-private buyers in this respect is plainly evident with more than half of all vehicles on the road originally bought for use in either a private fleet, a government fleet or for some other type of non-private use. Vehicles originally bought by the South Australian government make up about 7% of registered fleet, but the presence of vehicles originating in South Australian private fleets is much greater (25% of all registered vehicles), emphasising the importance of these buyers in determining the average level of safety of the registered stock of vehicles in the state.

The changing composition of the fleet has meant that the state is seeing an increasing prevalence of very heavy passenger vehicles (>1900 kg). The prevalence of these vehicles amongst new vehicles sold in 2009 appears to be over 20%, more than twice the number bought 10 years ago. Meanwhile, the sales of vehicles between 1600 and 1800 kg appear to have declined over the last decade, offset by sales of lighter vehicles as well as heavier vehicles. There is a polarisation of vehicle mass emerging in the fleet, which may present crash compatibility problems in the future. The meaning of nominal vehicle segments has changed over the last decade with the average mass of vehicles increasing such that the average mass of each segment (light, small, medium and large) is now greater than the average mass of the proceeding segment two decades (or even one decade) ago. For example, the average 'medium' passenger vehicle is now heavier than the average 'large' car in 1991.

The prevalence of several safety features and other attributes were examined by year of sale in the two groups of vehicles and compared. While it was not the intention to perform a formal evaluation of the effectiveness of features by comparing the prevalence in the two groups of vehicles, it was nonetheless of interest to see whether certain features were under-represented in the crashed vehicles sample, which may be indicating some protective effect. This was only ever likely to be shown in the data for primary safety features where a particular feature may be preventing crashes from occurring in the first place. A secondary safety feature may well prevent injury, but the ability of such features to convert a serious crash to a more minor class of crash is only likely to occur in cases at the lower margin of the serious crash classification, and hence it was less likely that we would detect under-representation for these features.

A particular feature of this analysis was the linkage of registration and accident records to price and specification data and VFACTS data from RL Polk Australia. Polk receives sales data from the Federal Chamber of Automotive Industries. This allowed the linkage of vehicles in registration and crash records to further information about the vehicle in this study: in the case of price and specifications, the data were generic to that make and model identifier, and in the case of VFACTS data (details about the sale) specific to the actual vehicle in the registration/crash record. The generic nature of the price and specification data meant that it was not possible to identify whether particular vehicles were fitted with some features when that feature was optional. However, it is reasonable to assume that the take-up rate of optional safety features is quite low in general.

Scully and Newstead (2007) outlined similar methods of identifying vehicle features, but in that study, several datasets and some hand matching was employed to identify the prevalence of a single feature (ESC). In the present report, the method allowed rapid matching and the determination of the many vehicle attributes simultaneously.

As mentioned above, the linkage of vehicle attributes to individual vehicles allowed this study to examine those attributes across year-of-sale cohorts and across the two groups of vehicles (registered and crashed); and in general, crashed vehicles and registered vehicles were the same in respect of the prevalence of safety attributes at the levels of aggregation examined in this report. While crashed vehicles and registered vehicles had about the same rate of installation of many features within a year of sale cohort, given the older age of crashed vehicles, the overall rate of installation was lower in crashed vehicles compared to the registered fleet sample.

The one feature that seemed to be clearly underrepresented in crashed vehicles was electronic stability control (ESC) – while the numbers were small, it was clear that the prevalence of ESC systems in serious casualty crashes was smaller than in the general registered fleet, indicating that ESC systems are preventing crashes in South Australia. An additional analysis of single and multiple vehicle crashes revealed that, indeed, ESC equipped vehicles are substantially under-represented in single vehicle serious casualty crashes.

The analysis showed that the introduction of a safety technology into new vehicles has generally taken between 10 and 20 years to reach saturation (for those technologies that have achieved an almost 100% fitment rate). The rate of uptake may well be slower than it might otherwise be. For example, Sweden is similar to Australia in that the average age of vehicles is about 10 years (while the mix of makes and model of vehicles is likely to be quite different). ESC was deployed into new vehicles very quickly in Sweden such that the fitment rate had risen to 95% in new vehicles in 2008, from a rate of 15% in 2003 (not dissimilar to that in SA at that time) (Krafft et al., 2009).

On the positive side, occupant safety ratings of vehicles are rapidly improving such that South Australia should soon see more than half of its new vehicle sales rated at five stars in the ANCAP program. However, the average star rating of all registered vehicles that have a rating is 3.78 stars, and given that ratings exist for only 42% of registered vehicles, the average of all registered vehicles is likely to be much lower than this (possibly under 3 stars), demonstrating that even the improved passive safety of vehicles in the general registered fleet is a work in progress. Unfortunately, the pedestrian safety ratings of vehicles have not kept apace with occupant ratings and the average star ratings of the newest vehicles remains under 2 stars (of a possible 4) and has remained almost unchanged over the last 10 years.

The use of fleet purchasing as a method of increasing the uptake of technology was examined in more detail and the analysis showed that aggressive uptake of new safety technologies by government and private fleets can be effective in increasing the prevalence of those technologies in the overall fleet. For example, earlier adoption of ESC amongst fleets might have meant that South Australia could have had more than double the number of installations in the registered fleet today. The effect of early adoption in fleets is highest for technologies that are relatively recent, and by the time a technology has saturated new vehicle sales, further effects are obviously nil, and any overall effect will have disappeared after 20 years or so. But given that further technological advances are emerging in primary safety areas, there will be still great opportunities to maximise the uptake of new safety technologies in new vehicles in the coming decade. Strategies to target fleets to encourage early adoption of these technologies should therefore be encouraged.

These comments are not to diminish the importance of targeting private buyers of vehicles. The importance of vehicle safety to the safety of the community should be emphasised.

Emerging technologies are likely to mainly tackle primary safety by focusing on crash causations and mechanisms. Several new primary safety technologies are still emerging and the vehicle of the future will have ever-tighter integration of primary and secondary safety features. But while primary safety features appear to offer much, their potential to reduce crashes remains, for many, uncertain. However, preliminary assessments suggest significant benefits from intelligent speed adaptation (Doecke et al., 2010) and forward collision detection and avoidance (Anderson et al., 2010).

These and other technologies include:

- Intelligent speed adaptation
- Active forward collision detection and intervention
- Lane departure warning
- Side blind spot/ lane change warning
- Seatbelt interlock/intrusive reminder
- Active pedestrian detection system
- Night vision enhancement
- Fatigue warning system
- Alcohol interlock
- Automatic crash notification
- Vehicle to vehicle and vehicle to infrastructure communication systems

It would be useful for forecasting, if it were possible to model the future prevalence of safety technologies in vehicles that are at risk of crashing (i.e. vehicles up to 20 years old, in equal proportions), based on the pattern of deployment in new vehicles. Such a model might allow us to predict the prevalence of, for example, ESC into the future, in vehicles likely to be at risk of single vehicle crashes. Predicting future effects of technologies that are only establishing themselves would allow for a nuanced approach to investment in activities aimed an encouraging uptake, and in the coordination of associated road infrastructure investment.

Acknowledgements

This study was funded by the South Australian Department of Planning, Transport and Infrastructure (DPTI) through a Project Grant to the Centre for Automotive Safety Research.

The Centre for Automotive Safety Research is supported by both the South Australian Department of Planning, Transport and Infrastructure and the South Australian Motor Accident Commission.

The views expressed in this report are those of the authors and do not necessarily represent those of the University of Adelaide or the funding organisations.

I would like to acknowledge the valuable input and advice from Craig Kloeden, Giulio Ponte and Paul Hutchinson, also from CASR

Data from Registration and Licensing was made available with the helpful cooperation of Peter Bravey and Paul Hutchinson at DPTI.

Part of this analysis was made possible through a project commissioned by Queensland Transport and Main Roads. NSW Registration data was helpfully provided by the Roads and Transport Authority of NSW.

I thank members of the New Technology Task Force of the SA Road Safety Advisory Council for our fruitful discussions and collegiality.

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Appendix A – Vehicle safety attributes retrieved from RL Polk

date of sale
state
postcode
buyer type
vehicle ID
vehicle name
vehicle revision
make
series
model
grade
body
version
release date
recommended retail price
market class
market segment
discontinued date
cylinders
capacity
maximum power
power
torque
combined
ABS type
ABS number of channels
ABS number of sensors
ABS operation
length
width
height
wheelbase
track front
track rear
kerb mass
GVM
tare mass
acceleration
maximum speed
VIN sample
engine number sample
FCAI class
FCAI sub market
FCAI segment
crash test standard
driver rating
pedestrian protection rating
ANCAP identifier
ANCAP make
ANCAP model
ANCAP vtype id
ANCAP year
ANCAP link type
anti lock brakes
electronic brake distribution system
brake assist system

precrash collision safety system
drivers airbag
front side thorax airbags
front side thorax airbag door mounted
front side thorax airbag seat mounted
front head airbags side curtain
front passenger airbags
rear side thorax aribags
rear side thorax airbags door mounted
rear side thorax airbags seat mounted
rear head airbags side curtain
driver knee airbag
front passenger knee airbags
driver seat belt pretensioner
front passenger seat belt pretensioners
second row rear seat belt pretensioners
driver seat belt with force limiter
front passenger seat belts with force limiters
rear seat belts with force limiters
height adjustable front seat belts
height adjustable second row rear seat belts
centre second row rear lap sash belt
ALR for centre seat second row rear lap sash seat belt
rear child safety seat
double rear child safety seat
side door anti intrusion beams
high mount rear stop lamp
cruise control
cruise control adaptive
lane keeping assist system
head restraints all seats
second row rear headrests
second row rear high seat backs outboard seats
second row rear seat head restraints outboard seats
second row rear seat head restraint centre seat
second row rear seat head restraints height adjustable
second row rear seat head restraints electrically adjustable
park distance control front
park distance control rear
reversing camera
bull bar
bull bar airbag compatible
nudge bar
active suspension
hill holder system
auto decent control
traction control system
brake actuated traction and road holding control system (ESC)