AEB REAL WORLD VALIDATION USING UK MOTOR INSURANCE CLAIMS DATA

Murray Doyle
Alix Edwards
Matthew Avery
Thatcham MIRRC Research
UK

Paper Number 15-0058

ABSTRACT

City Safety is a low-speed autonomous emergency braking (AEB) technology, first made available as standard by Volvo on their XC60 model series, and released in the UK in 2008. This technology has since been made available on a growing number of models, including the high volume seller Volkswagen Golf 7. This paper presents an analysis of the impact of AEB in the UK on claim losses using real world Insurer claims data. Statistical regression was used to compare the claims losses for the XC60 to that of a SUV control cohort of vehicles without any such system, and quantify any AEB effects identified. The influences of calendar year and vehicle age on claim risk were accounted for in the analysis. Estimated claim frequencies for the XC60 were lower than those of the control cohort, in all liability types: 8% lower for Third Party Damage, 6% lower for Own Damage, and 21% lower for Third Party Injury. More recently this approach has been employed to compare claim frequencies for the Golf 7 with the Front Assist AEB system with that of a Small Family car control cohort of vehicles, with similar qualitative results observed from an analysis of the initial data available. Furthermore a study of claim damage severity based around claim costs and repair times estimated lower severity levels for the XC60 relative to control cohorts, for own damage liability, of the order of 10%-15%. This study is the first of its kind using UK claims and indicates the potential benefit of AEB technology. Further statistical analysis is intended with additional risk information for the XC60 and Golf 7, and other AEB study vehicles.

INTRODUCTION

In recent years, collision avoidance or mitigation systems have become a feature on an increasing number of new vehicles, and show the potential to reduce injury and vehicle damage. Autonomous Emergency Braking or `AEB' is a safety technology which monitors the traffic conditions ahead and automatically brakes the car if the driver fails to respond to an emergency situation. AEB systems use various different names even where the functionality is similar. Systems also feature different sensors to monitor the traffic situation, such as cameras, lasers and radars. Some systems use a number of these together in sensor 'fusion'. These systems also have different speed ranges where they are active and they have different injury reduction potential. City Safety is a low-speed AEB technology, first made available as standard by Volvo on their XC60 model, and released in the UK in November 2008. The technology is designed to help prevent or mitigate front-to-rear impacts, at speeds up to 30 km/h, which is one of the common types of crashes. However City Safety may well have an effect in other crash configurations so long as the collision speeds are minimal and its sensor has time to allow a vehicle to react. City Safety works using a LIDAR (light detection and ranging) sensor mounted onto the upper windscreen to detect other vehicles travelling in the same direction around 6-8 metres in front of the vehicle. This technology has subsequently been fitted as standard to a number of other Volvo vehicles. This sensor is manufactured by Continental and is low cost, and as such has allowed proliferation.

The Volkswagen Golf 7 has the Front Assist AEB system fitted as standard to all of its trim levels with the exception of the base version, and has been available in the UK since November 2012. This system consists of a long-range RADAR (radio detection and ranging) manufactured by Bosch and fitted to the front grille, and can detect vehicles up to 80m ahead. Front Assist applies full braking up to 30km/h, and between 30-80km/h provides driver warning of a stationary object; between 30-200km/h the system applies its full capacity of driving warnings, partial braking and brake assistance.

A number of international studies have used real world data to establish the impact of AEB on claims' frequency and cost. In the USA the Highway Loss Data Institute (HLDI) have conducted statistical studies around the experience of the Volvo XC60 and S60 compared with appropriate vehicle control cohorts, while controlling for factors such as age, gender, population density, US State, and calendar year [1-2]. Since the City Safety system has been standard fit, identification of a cohort of appropriate vehicles was simple. Their research also addresses a possible `Volvo-effect' by comparing the loss experience of these Volvo City Safety vehicles against Volvos without it. Their most recent published results on this demonstrated frequency reductions arising from City Safety [3-4], for each of 1st and 3rd party damage and 3rd party injury liabilities. A similar analysis of damage severity using claim cost data generated mixed results.

A Swedish study carried out jointly by the Volvo Car Corporation and the leading Swedish Insurer Volvia focused solely on rear-end crashes [5]. In particular the real world data was used to measure the effectiveness of City Safety in avoiding crashes for the striking vehicle, by comparing the XC60 against other Volvo car models without this technology, while controlling for car ownership and size types. Their analysis demonstrated 23% effectiveness for City Safety in reducing front-into-rear crashes, when compared against a selection of other Volvo models, and 30% effectiveness when compared against XC70. Another recent Swedish study undertaken by Folksam [6] to analyse police reported front-into-rear crashes with at least one injured occupant, used the induced exposure method to compare a range of City Safety models to a selection of different control cohorts and for different impact speed ranges. Results demonstrated a range of levels of effectiveness of City Safety. A preliminary analysis was carried out by AZT Automotive/Allianz on the claims experience for the XC60 City Safety in Germany [7]. In their modelling of this they compared the XC60 to a number of its competitors, while controlling for a number of factors, for both comprehensive coverage and third party liability coverage. The conclusion of this study indicated no clear City Safety effect on claim frequency or average; however the selection of competitor vehicles was limited.

Because avoiding or mitigating the speed/severity of a crash is going to have a beneficial effect for society by reducing injuries and damage to vehicles, it is important to study the impact of such systems on UK roads. The research presented in this paper is concerned with an analysis of the effect of the Volvo City Safety and Volkswagen Front Assist on UK claim experience using available real world data, and the implications for injury reduction.

METHODS

This study uses real world insurance claims data to analyse the effects of AEB on claim frequencies and costs, focusing primarily on the Volvo XC60 with City Safety fitted as standard since November 2008, but also the Volkswagen Golf 7 with its Front Assist system. All collision types are considered, not just front-into-rear impacts that AEB is designed to address. Potential AEB benefit is measured by comparing the XC60 against a control cohort of appropriate small SUV models without AEB fitted, and similarly for the Golf 7 (AEB) and a small family car control cohort.

The XC60 sits in the compact (small) SUV class, with a UK new purchase price varying between £25,000 and £40,000 at the time of writing. Some are fitted with 4-wheel drive whilst others with 2-wheel drive. A cohort of control vehicles were selected to include some 4x4s and some `cross-overs', all seen as being similar to the XC60 and also likely to feature in any such buyer's potential list. Of these vehicles only those with build dates of 2008 or later were used. The Golf 7 is a small family car and currently the third most popular selling vehicle in the UK, launched in late 2012. AEB is fitted as standard on all its trim levels with the exception of the base model. A control cohort of small family cars was selected to compare against, which includes the Golf 6 model and Golf 7 base model.

The analysis is carried out separately across the liability types Own Damage, Third Party Damage and Third Party Injury. An Own Damage claim relates to claims payable to the insured party for damage to their vehicle. In practice this primarily includes at-fault claims involving other vehicles or fixed objects, but also covers non-fault incidents such as hit by unknown third party, weather damage, animal strike, and possibly vandalism. A Third Party Damage claim relates to the struck vehicle or object for the third/other parties. A Third Party Injury relates to third/other parties injured through the actions of the insured/policyholder.

Data Sources

Two datasets featured in this study, with key characteristics and differences listed in Table 1.

Insurer Dataset: A request for anonymous claims data was submitted to UK Insurers in 2013 to monitor the effects of AEB. This was completed by 12 Insurers and represents nearly 60% of the motor Insurance market in the UK by gross written premium. The resulting dataset includes claims count, cost and exposure information for the XC60 and Golf 7 and their respective control cohorts. For the XC60 study claims dating 2009 to Mid-2014 were collated, and for the Golf 7 this date range was 2013 to Mid-2014. Exposure is defined in Insured Vehicle Years (IVYs), whereby a vehicle insured for 6 months would have an exposure of 0.5.

Research Claims Database: This database of Insurer authorised vehicle repair claims is utilised by Thatcham for research purposes, and includes approximately 90% of the UK Insurance market by volume. The claims data held within the Research Claims Database lends itself to a study of damage severity, given that it contains information on repair costs and times, for a wide range of vehicles. Claims are for all liability types, but are mostly unidentifiable in this database; however the vast majority is related to vehicle collision damage. It has been assumed that claims involving damage to a front bumper are the striking vehicle, and therefore classifiable as Own Damage; however it is noted that front bumper damage could arise if a given vehicle is struck by a reversing vehicle, but this is a relatively minor subset. This analysis has been undertaken on the XC60 only to date.

Table1.
Summary of available dataset characteristics and differences.

	Insurer Dataset	Research Claims Database Dataset
Liability Type	Identifiable by Own Damage, Third Party Damage, Third Party Injury	Not available; estimates with front bumper damage assumed to be Own Damage
Impact circumstance	Not available	Not available
Claim Status	Settled and outstanding	Authorised Insurer claims; some retail
Claim Count	Split by vehicle Make/Model/Variant	Split by vehicle Make/Model/Bodyshape
Claim Cost	Cost to Insurer; Include ancillary costs where appropriate	Repair costs and times; no ancillary cost information
Exposure	Included	Not available
Total Losses	Included; not identifiable	Included; identifiable
Claim Year	2009 to Mid-2014	2009 to 2014
Vehicle Age	2008-on	2008-on

Statistical Analysis

Claim frequency is the number of claims in a period of unit exposure, typically recorded in insured vehicle years. Vehicle claim severity may be measured as an average claim cost or average repair time. A generalised linear model was employed to model this claim frequency (per 100 Insured Vehicle Years) or claim severity as response variables, with model series and claim calendar year as predictor variables. These statistical models were used to compare the AEB study vehicle (XC60 or Golf 7) loss experience with that of the weighted average of the appropriate control cohort, while controlling for effects of calendar year. A Poisson distribution was used for the claim frequency analysis and a Gamma distribution for the claim severity analysis, in both cases using a logarithmic link function.

The AEB study vehicle was set as the baseline for the model series variable, and all its control cohort vehicles were calculated relative to it. Given that the response variable is related to model series categorical variables by a log link function, the relative ratio of a given model series to the AEB study vehicle baseline level is found by taking the exponential of its regression coefficient.

Frequency analysis was carried out using the Insurer dataset, given that this included data on exposure by model series. Severity analysis presented here utilised the Research Claims Database dataset, looking separately at estimate costs, parts costs and repair times. A number of key factors may potentially distort the findings of the analysis of claim severity, which are outlined here along with approaches adopted to counter their influence:

1) Claim costs are not only influenced by levels of damaged incurred, but also by the cost incurred in replacing the parts (the replacement parts cost). It is therefore sensible to control for the effect of varying parts costs in a severity analysis based around claim costs. This was achieved by limiting the control cohort vehicles to only those with comparable parts costs to that of the XC60.

2) Differences in vehicle design will result in variation in levels of damage sustained, and this must be taken into consideration when drawing conclusions from an analysis of impact severity based on repair times. For example, some of the SUV cohort will have different repair or styling strategies. This will also be affected by passive pedestrian protection strategies that can increase component damage in a given impact. This design issue has been investigated using an alternate measure of vehicle susceptibility to damage, discussed below (see Results: Severity Analysis).

3) Vehicle Age is an important factor in explaining claim frequency and cost, with newer vehicles likely to have higher claim incidence relative to older vehicles, but lower claim costs and times. Therefore vehicles registered pre-2008 have been excluded from the XC60 analysis, and vehicles registered pre-2013 have been excluded from the Golf 7 analysis. Also vehicle age where available has been used as a predictor.

4) Vehicle Mass in theory can influence damage severity, with a lighter vehicle more likely to sustain more damage than a heavier vehicle. However an analysis of vehicle kerb weight for the model series' under consideration here does not show any correlation with repair costs or times.

RESULTS

Frequency Analysis: Volvo XC60

A Poisson regression analysis was carried out separately for damage and injury liabilities. Table 2 summarises the results obtained for the predictors for Third Party Injury, while Table 3 provides details of the statistical model output for each control vehicle and calendar year. The intercept value corresponds to the claim frequency for the baseline, which is the claim frequency for the XC60 in 2014. All other coefficients are relative to these.

Table2.
Predictors for Third Party Injury

	Degrees of Freedom	Wald Chi-Square	P-Value
Model Series	27	106.5	< 0.0001
Calendar Year	5	31.75	< 0.0001

Table3.
Frequency Analysis for Third Party Injury: Statistical Output

Category Variable	Coefficient	Standard Error	95% Wald Confidence Interval Lower	Upper	Wald Chi-Square	Hypothesis Test Degrees of Freedom	P-Value
Intercept	-5.18	.0840	-5.345	-5.016	3803.67	1	<0.0001
Chevrolet Captiva 2007	.734	.1615	.417	1.050	20.64	1	<0.0001
Chevrolet Captiva 2011	.534	.2361	.071	.997	5.11	1	.024
Honda CRV 2010	.088	.1047	-.118	.293	.69	1	.403
Range Rover Evoque 2011	.400	.1135	.178	.623	12.46	1	<0.0001
Land Rover Freelander 2007	.212	.0854	.045	.379	6.17	1	.013
Land Rover Freelander 2011	.073	.1833	-.286	.432	.16	1	.691
Suzuki Grand Vitara 2007	.106	.1555	-.199	.411	.47	1	.494
Suzuki Grand Vitara 2011	.220	.1874	-.147	.587	1.38	1	.240
Hyundai IX35 2010	.194	.1032	-.008	.396	3.54	1	.060
Renault Koleos 2008	.433	.1388	.161	.705	9.75	1	.002
Ford Kuga 2008	.149	.0862	-.020	.318	2.99	1	.083
Mercedes M Class 2009	.428	.1020	.228	.628	17.64	1	<0.0001
Mitsubishi Outlander 2007	-.063	.2414	-.536	.410	.07	1	.793
Mitsubishi Outlander 2011	.123	.2176	-.304	.550	.32	1	.572
Audi Q3 2011	.218	.1372	-.051	.487	2.52	1	.112
Audi Q5 2009	.307	.0966	.117	.496	10.08	1	.001
Nissan Qashqai 2009	.287	.0835	.123	.451	11.81	1	.001
Toyota Rav 4 2010	-.042	.1579	-.351	.268	.07	1	.792
Lexus RX 2009	.518	.1232	.276	.759	17.65	1	<0.0001
Kia Sportage 2010	.401	.0950	.215	.588	17.87	1	<0.0001
Volkswagen Tiguan 2008	.155	.0873	-.016	.326	3.15	1	.076
Nissan X-Trail 2008	.078	.1336	-.184	.340	.34	1	.559
BMW X1 2010	.000	.1143	-.224	.224	.000	1	.997
BMW X3 2007	.090	.1602	-.224	.404	.32	1	.574
BMW X3 2011	.153	.2555	-.348	.654	.36	1	.549
Volvo XC90 2007	.465	.1013	.266	.663	21.04	1	<0.0001
Volvo XC90 2010	.539	.1291	.286	.792	17.45	1	<0.0001
Volvo XC60 2009	0	0	0	0	0	0	
2009	.248	.0879	.076	.421	7.99	1	.005
2010	.264	.0624	.141	.386	17.85	1	<0.0001
2011	.263	.0526	.160	.366	24.97	1	<0.0001
2012	.170	.0486	.074	.265	12.17	1	<0.0001
2013	.125	.0460	.035	.215	7.39	1	.007
2014	0	0	0	0	0	0	

From the Insurer dataset there were 177 XC60 Third Party Injury claims from a corresponding 26,715 insured vehicle years. This actual claim frequency of 0.66 per 100 insured vehicle years is compared against those estimated for the control vehicles. The XC60 is found to have an injury claim frequency that is 21% lower than that of the weighted average of the control cohort, with a 95% confidence interval for this result estimated between 8% and 32%. Figure 1 depicts the actual claim frequency for the XC60, and the estimated claim frequency for control cohort vehicles with confidence intervals relative to the XC60. Three of the control vehicles are found to have lower claim frequencies than the XC60, but these are not statistically significant. A number of the control vehicles with claims frequencies higher than the XC60 are also not significant.

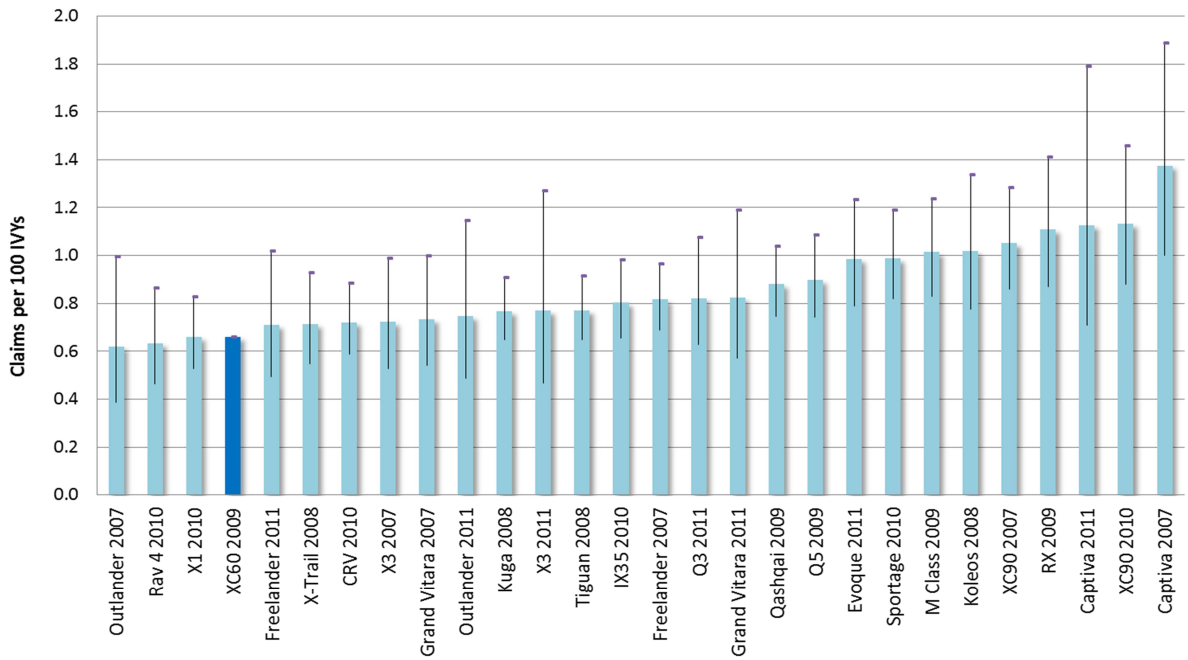

Figure1. Claim frequency for Volvo XC60 compared to control SUVs: Third Party Injury.

Table 4 summarises the results of the analysis across all three liability types, and a combined Own Damage and Third Party Damage category. In all liability types the model series and calendar year variables were statistically significant, and the XC60 is found to have a lower claims frequency compared to the weighted average of the control cohort.

Table4.
Summary of Liability Results for XC60 compared to SUV Control Cohort

	XC60			SUV Control	XC60 Claim Frequency Reduction	
	Exposure (IVYs)	Claim Count	Claims per 100 IVYs (Actual)	Claims per 100 IVYs (Estimated)	% Reduction	Confidence Interval
Own Damage	26,715	1,757	6.58	7.00	**-6%**	(-10%, -1%)
Third Party Damage	26,715	844	3.16	3.45	**-8%**	(-14%, -1%)
Own & Third Party Damage Combined	26,715	2,601	9.74	10.49	**-7%**	(-11%, -3%)
Third Party Injury	26,715	177	0.66	0.84	**-21%**	(-32%, -8%)

Figure. 2 shows the loss experience for the XC60 and the individual control cohort vehicles, for Own Damage and Third Party Damage combined. Here again there are control vehicles with a claim frequency lower than that of XC60, which are in most cases not statistically significant; though one exception to this is the Ford Kuga. It is suspected that the lack of further predictor variables available for claim frequency, such as driver age, annual mileage, urban versus rural etc., is impacting the claim frequency estimation for individual control vehicles here.

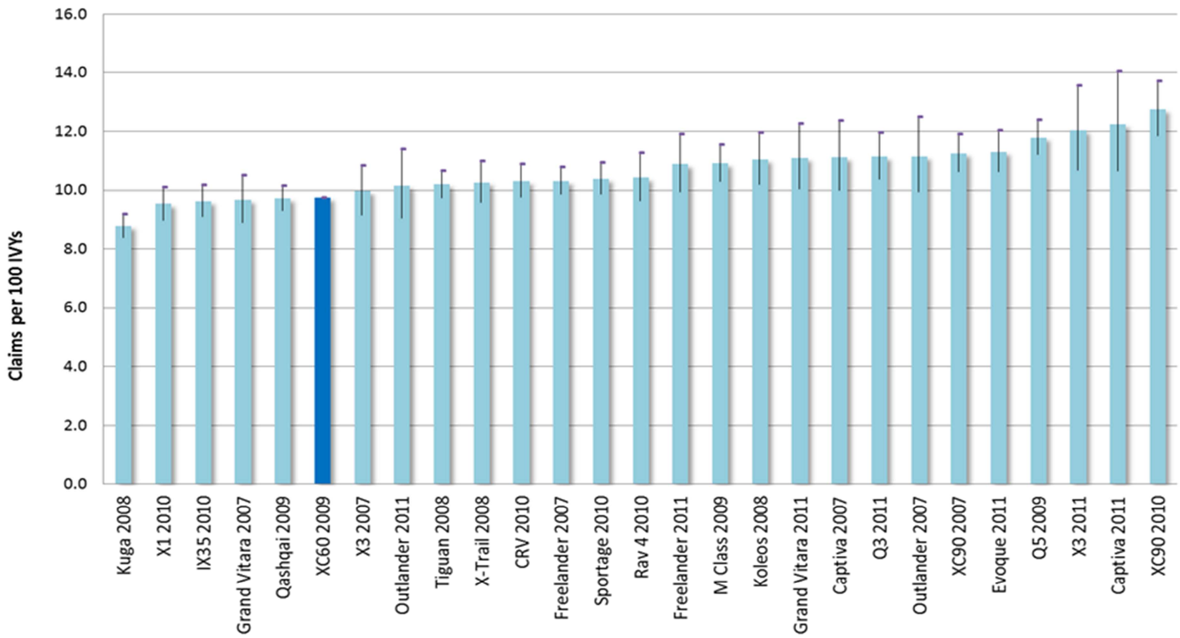

Figure2. Claim frequency for Volvo XC60 compared to control: Own Damage & Third Party Damage combined.

The `Volvo-driver' is an expression used to refer to the belief that individuals that buy a Volvo car are already safety-conscious, and are therefore pre-disposed to safe driving, with or without AEB. It is therefore sensible to consider this potential factor within this AEB benefit study: in this analysis the XC60 has a lower claims frequency than the Volvo XC90 for both damage and injury liabilities, which suggest the lower claim frequencies observed for the XC60 are not explained by this Volvo driver issue.

Frequency Analysis: Volkswagen Golf 7 (AEB)

Results for the analysis of Third Party Injury claims for the Golf 7 (AEB) when compared against the small family car control cohort are shown in Table 5. Calendar Year is not found to be statistically significant and is therefore excluded. Table 6 provides details of the statistical model output for each control vehicle. The intercept value corresponds to the claim frequency for the baseline, which in this case is the claim frequency for the Golf 7 (AEB); all other coefficients are relative to these. Figure 3 depicts the actual claim frequency for the Golf 7 (AEB), and the estimated claim frequency for control cohort vehicles with confidence intervals relative to the Golf 7 (AEB).

Table5.
Predictor for Third Party Injury

	Degrees of Freedom	Wald Chi-Square	P-Value
Model Series	13	32.1	0.002

Table6.
Frequency Analysis for Third Party Injury: Statistical Output

Category Variable	Coefficient	Standard Error	95% Wald Confidence Interval Lower	Upper	Wald Chi-Square	Hypothesis Test Degrees of Freedom	P-Value
Intercept	-5.273	.1644	-5.595	-4.951	1028.84	1	<0.0001
BMW 1 Series 2011	.682	.1815	.327	1.038	14.14	1	<0.0001
Peugeot 208 2012	.527	.1789	.177	.878	8.69	1	.003
Mercedes A Class 2012	.632	.2054	.229	1.034	9.47	1	.002
Audi A3 2012	.615	.2160	.192	1.039	8.12	1	.004
Vauxhall Astra 2010	.823	.1924	.445	1.200	18.27	1	<0.0001
Toyota Auris 2010	.396	.3564	-.302	1.095	1.24	1	.266
Toyota Auris 2012	.677	.2531	.180	1.173	7.14	1	.008
Honda Civic 2012	.237	.2043	-.163	.638	1.35	1	.245
Ford Fiesta 2013	.654	.1743	.312	.995	14.06	1	<0.0001
Ford Focus 2011	.536	.1834	.177	.896	8.55	1	.003
VW Golf 2009	.441	.3434	-.233	1.114	1.65	1	.200
VW Golf 2012 (no AEB)	.730	.3138	.115	1.345	5.42	1	.020
Renault Megane 2012	.494	.2621	-.020	1.008	3.55	1	.059
VW Golf 2012 (AEB)	0	0	0	0	0	0	

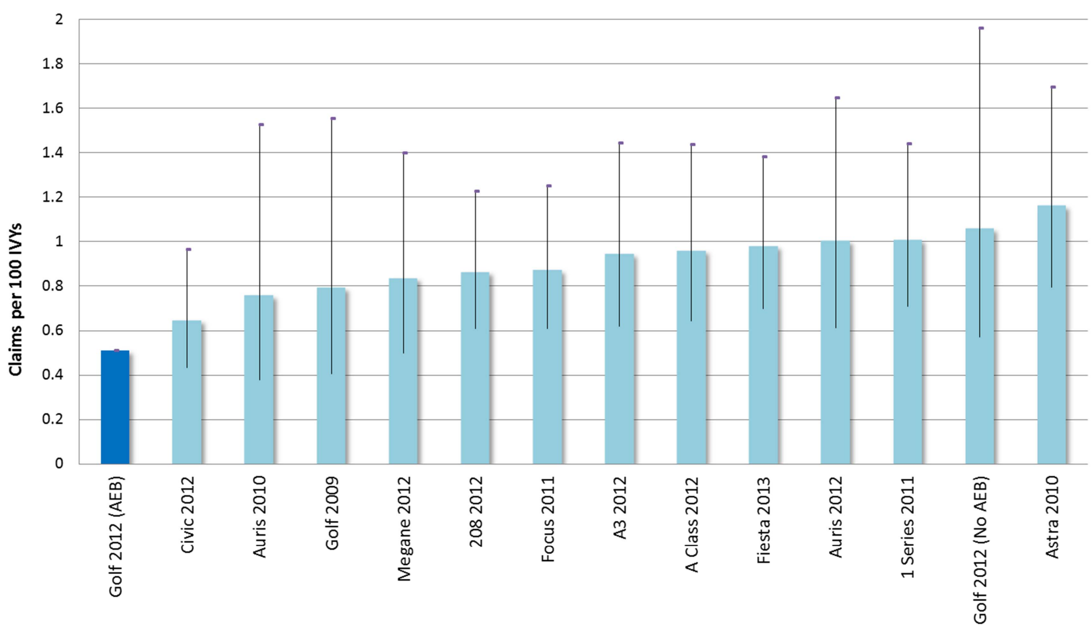

Figure3. Claim frequency for Volkswagen Golf 7 (AEB) compared to control cohort: Third Party Injury.

Table 7 summarises the results of the Golf 7 (AEB) analysis across all three liability types, and a combined Own Damage and Third Party Damage category. In all liability types the model series was statistically significant, while calendar year is also significant in the damage claims' analyses. For Third Party Injury and Third Party Damage liabilities the Golf 7 (AEB) is found to have a clearly lower claims frequency compared to the weighted average of the control cohort. For Own Damage liability this is not the case, with effectively no difference in claim frequency observed between the Golf 7 (AEB) and the weighted average of the control cohort. In general the Own Damage category includes a greater presence of claim types that are immune to AEB than is the case for Third Party

Damage, and it is therefore consistent that any Own Damage AEB effectiveness observed is lower than that of Third Party Damage. Additional exposure and claims volume for the Golf 7 (AEB) is required to further validate these results, and also whether differences between LIDAR and RADAR sensor technology are being manifested in these Golf 7 (AEB) and XC60 findings.

Table7.
Summary of Liability Results for Golf 7 (AEB) compared to Small Family Car Control Cohort

	Golf 7 (AEB)			Small Family Car Control	Golf 7 (AEB) Claim Frequency Reduction	
	Exposure (IVYs)	Claim Count	Claims per 100 IVYs (Actual)	Claims per 100 IVYs (Estimated)	% Reduction	Confidence Interval
Own Damage	7,216	610	8.45	8.51	**-1%**	(-9%, 8%)
Third Party Damage	7,216	844	2.55	3.18	**-20%**	(-31%, -7%)
Own & Third Party Damage Combined	7,216	2,601	11.00	11.81	**-7%**	(-13%, 0%)
Third Party Injury	7,216	177	0.51	0.94	**-45%**	(-61%, -24%)

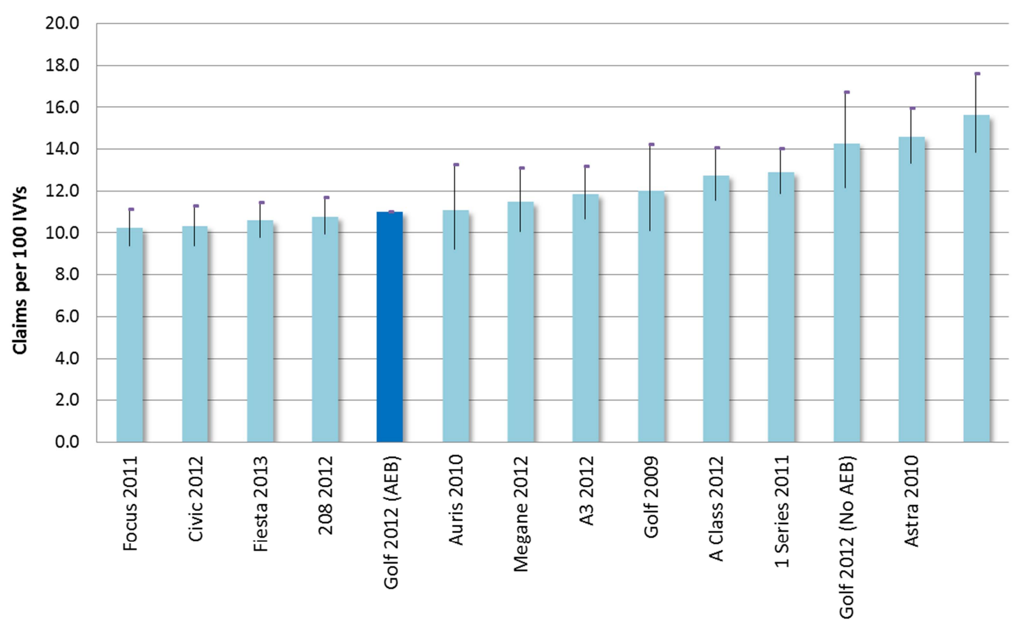

Figure4. Claim frequency for Golf 7 (AEB) compared to control: Own & Third Party Damage combined.

Severity Analysis: Volvo XC60

The Research Claims Database dataset is used to study the impact of AEB on claim severity, and is measured using claims costs and times. A subset of Own Damage claims, identified as those involving damage to the front bumper and registered 2008 or later, has been extracted for the XC60 and its control cohort. Gamma regression was used to model average cost and time quantities, with model series, calendar year and vehicle age as predictor variables.

For the regression analysis of average repair time the predictor variables model series, calendar year and vehicle age were all significant. The XC60 is found to have a repair time that is on average 10% lower than the weighted average of the SUV Control cohort, with a 95% confidence interval for this result estimated between 4% and 15%. Again a number of vehicles have an estimated average repair time that is lower than the XC60, but none of these reached statistical significance.

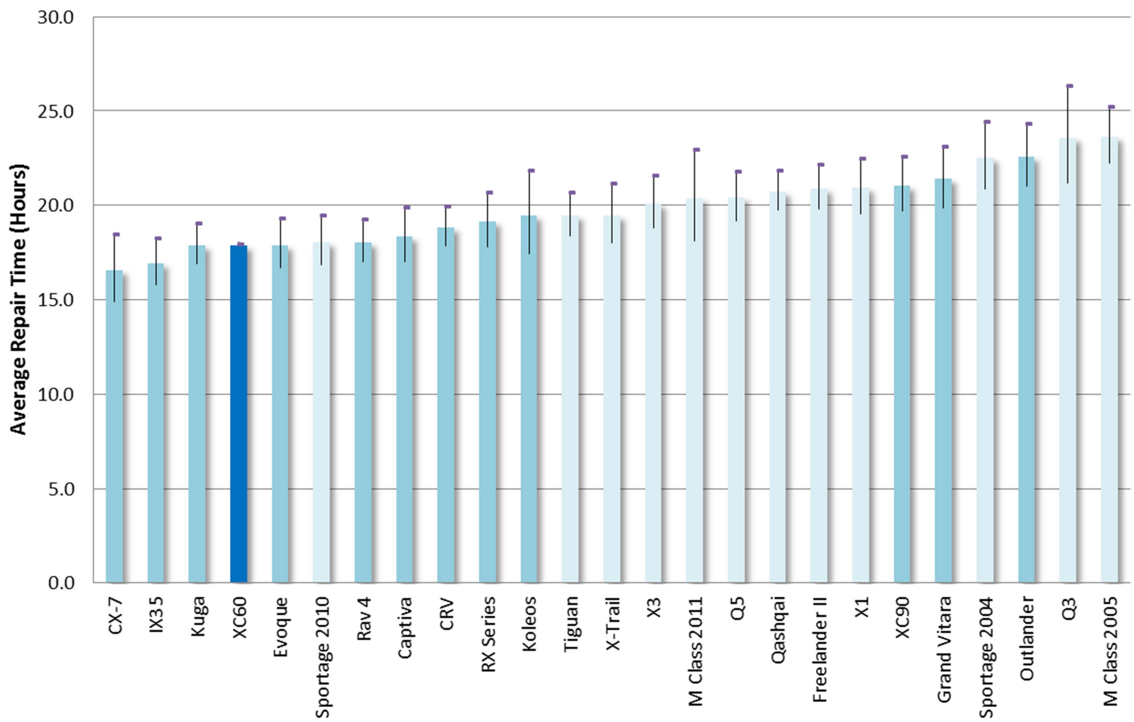

Figure5. Average repair time for Volvo XC60 compared to control SUVs: Own Damage.

Any discussion of severity as measured by repair time must also consider the issue of vehicle design susceptibility to damage. Thatcham Research carries out an assessment of every new vehicle to evaluate this issue, using a standardised 15 km/h offset barrier test. These damageability and repairability times, known more commonly as `D&R Times', form part of the UK Insurance group rating system, and have been used as a guide when considering this real world data. The D&R Times (unpublished) for the control cohort list range from 10 hours up to 31 hours; the XC60 lies in the mid-range. However it is noted that all of the control cohort vehicles with a D&R Time lower than that of the XC60 are estimated by the statistical model as having an average repair time greater than the XC60, indicated by the lighter-coloured bars in Figure 5. Or expressing this another way, the claim severity for the XC60 relative to the control cohort as estimated by the statistical model is lower than would have been expected by the D&R Times assessment data. This consideration of D&R Times does not remove the influence of vehicle design susceptibility to damage from this severity study, but does demonstrate that the XC60 severity reduction result is not explained by it.

Table 8 and Figures 6 and 7 summarise the findings from this repair time study, and also from analyses of claim repair costs and claim parts costs within the Research Claims Database dataset. For these costs studies only those control cohort vehicles with parts costs comparable to that of the XC60 were included. Again the model series predictor variable was significant, but calendar year and vehicle age were not. For both the repair cost and parts cost studies the XC60 was found to have a lower average cost relative to the control cohort, by 14% and 13% respectively. Available D&R Times data suggests that vehicle design was not the explanation behind these severity results. For both of these repair cost studies the Renault Koleos had the lowest estimated cost, and in the parts cost study this was significantly lower compared to the XC60. Again vehicle design issues may play a role here.

Given that this analysis is of claims with front bumper damage, it is suggested that the observed cost and repair time reduction for the XC60 relative to the control cohorts is explained by the presence of impact mitigation as well as prevention. If all incidents are front-end Own Damage claims and therefore all equally preventable by AEB, then any reduction in frequency of these is unlikely to much alter the average claim cost or time for the XC60. It follows then that any reduction in the average cost or time could be brought about by mitigation of these impacts.

Table8.
Summary of Damage Severity Results for XC60 compared to SUV Control Cohort

	XC60		SUV CONTROL	XC60 CLAIM SEVERITY EFFECT	
	Claim Count	Own Damage	Own Damage	% Reduction	Confidence Interval
Average Repair Time	1,501	17.9 hours	19.8 hours	-10%	(-15%, -4%)
Average Repair Cost	1,501	£2,683	£3,111	-14%	(-22%, -6%)
Average Parts Cost	1,501	£1,770	£2,024	-13%	(-23%, -4%)

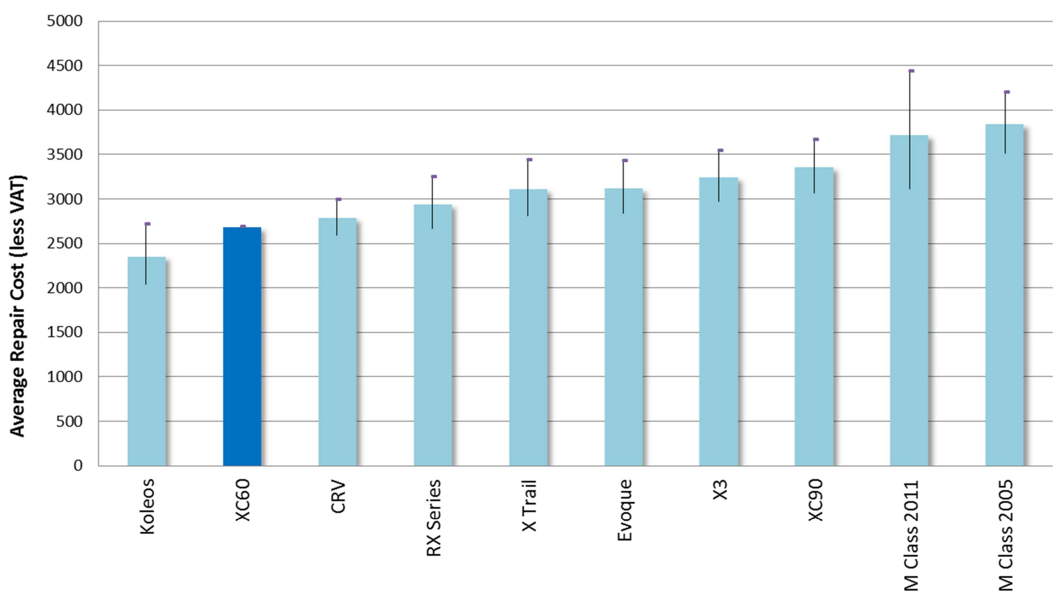

Figure6. Own Damage Repair Cost Severity Analysis: Volvo XC60 v SUV Control Cohort

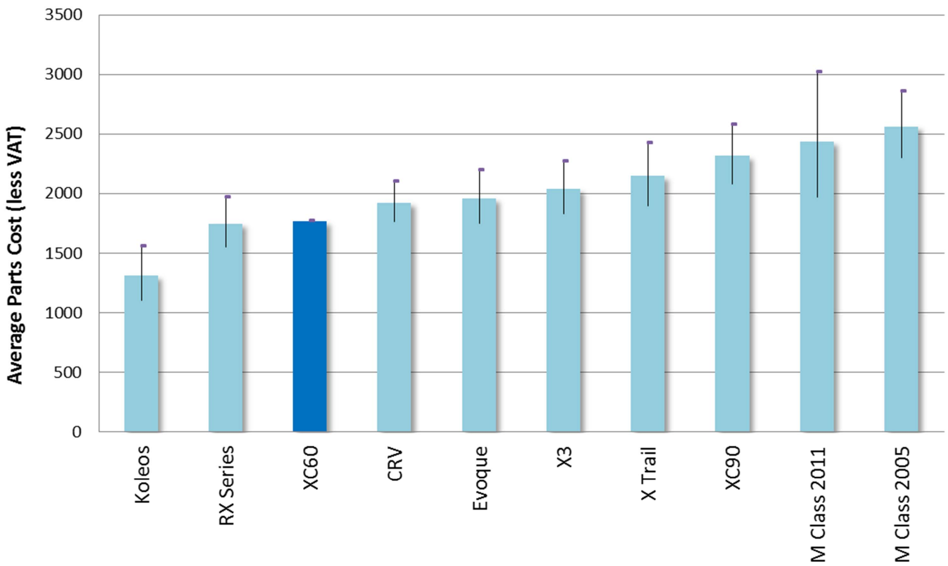

Figure7. **Own Damage Parts Cost Severity Analysis: Volvo XC60 v SUV Control Cohort**

DISCUSSION

A series of statistical analyses of claim frequency and severity for the Volvo XC60 and Volkswagen Golf 7 with their respective AEB standard-fit systems, compared against appropriate control cohorts, across damage and injury liability types, has generated a range of results that suggest an AEB benefit. Calendar year and vehicle age were controlled for throughout this study. Real world claims data was utilised from two different datasets, and the strengths and shortcomings of both of these have been outlined.

For frequency analysis an apparent AEB effect is detected across each liability type. Third Party Injury claim frequency for the XC60 was 21% lower than the control cohort. For Third Party Damage the XC60 has a claim frequency that is 8% lower than the control cohort, and for Own Damage the XC60 is 6% lower. Given that Own Damage includes more collision scenarios than Third Party Damage which are immune to AEB, the lesser frequency reduction observed for the Own Damage is in line with this. Analysis of the Golf 7 (AEB) also demonstrated substantial AEB benefits for Third Party Injury and Third Party Damage, of 45% and 20% respectively; however for Own Damage no AEB effect was observed. It may be the case that differences in sensor technology affecting target recognition and thus warning and auto-brake intervention strategies of the Volvo City Safety and Volkswagen Front Assist systems are being manifested in these results. The latter has functionality across the full range of driving speeds and therefore has the potential to be effective in some of the higher speed crashes and injuries that are beyond the speed range of Volvo City Safety system. Additional claims data for the Golf 7 will also help confirm these results. The injury reduction results reported here can be expected to have a substantial societal impact.

AEB also has the potential to reduce claim costs through prevention and mitigation of impacts, and results from severity analyses of the XC60 using claim costs and repair times suggest this is the case. An analysis of total repair cost and parts cost for claims with front bumper damage extracted from the Research Claims Database show respectively 14% and 13% cost reductions for the XC60 compared to an appropriate control cohort. A reduction in average claim cost may be interpreted in the context of the distribution of Own Damage claim costs, and whether those claims prevented by AEB have the effect of shifting the average of this distribution towards a lower value. This may indeed be the case if medium-high cost front-end impacts are being removed from this cost distribution. However this reduction may also be explained by impact mitigation having the effect of lowering the average repair cost, which is more applicable to the front bumper claims-only dataset, since distribution of costs are likely to be less dispersed and its average claim cost less affected by the aforementioned impact prevention. Repair times were also employed as a measure of damage severity, and the average repair time for the XC60 was 10% lower than that of the control cohort. This repair time severity analysis lends itself to the same interpretations as the cost studies.

The available claims data analysed here does not feature factors such as driver age and gender, driver profession, annual mileage, previous driving offences, population density, and so on, which are generally known to be significant in the study of claim risk. Inclusion of factors such as these would improve the accuracy of the statistical modelling of claim frequency and severity, and assessment of AEB benefits. In the analysis reported here the XC60 has a lower claims frequency than the Volvo XC90 across all three liability types, and a lower average claim severity for Own Damage, which suggests the results observed for the XC60 are not explained by any `Volvo-driver' effect.

The UK frequency reduction results discussed here are broadly in agreement with those reported elsewhere, in particular those by HLDI. Compared to the 21% injury claim effectiveness for the XC60 and the 45% injury claim effectiveness for the Golf 7 (AEB) relative to their respective control cohort reported in this UK study, HLDI [3] observed a 33% lower claim frequency for the XC60 compared to an SUV control cohort and 34% lower than a Volvo control cohort; and the City Safety Volvo S60 has an 18% lower claim frequency than a midsize luxury car control cohort, and 22% lower relative to the Volvo control cohort. These USA results were generated from statistical models which included a number of significant claim risk predictors, which increased the accuracy of their AEB impact estimation. In the USA the closest equivalent to Own Damage is referred to as Collision coverage and is understood to include proportionally more crash types that are preventable by AEB. This may go some way to explaining the higher claim frequency reductions of 20% and 9% for XC60 and S60 respectively observed for this, compared to the 6% XC60 effectiveness result for UK Own Damage. For Third Party Damage the equivalent liability category results reported by HLDI were a 15% lower claim frequency for the XC60 and 16% for the S60, which are comparable with the 8% and 20% results for the XC60 and Golf 7 (AEB) studies respectively observed in UK data. Overall, given the agreement between this UK study and that from HLDI there is good evidence that AEB is having a significant effect to reduce both damage and injury claims.

Findings from the analysis of UK claim severity also shows some agreement with similar studies carried out by HLDI: for Collision coverage the XC60 had a 10% lower average claim cost relative to the control cohort, and 13% lower for the S60; UK results here were of the order of 10%-15%.

CONCLUSIONS

This paper summarises the findings from an analysis of UK Insurer claims data and appears to demonstrate that AEB is responsible for substantial claim prevention of Third Party Injury arising in vehicle claims. The study considered the Volvo XC60 with City Safety, and the Volkswagen Golf 7 with Front Assist, and these were compared to an appropriate control cohort and findings have been interpreted in terms of impact on claims. The absence of additional predictor variables is recognised as a shortcoming of this research, the inclusion of which would improve model accuracy and reliability of the findings. It is also the case that further clarity on crash circumstances within the liability data would be valuable in measuring AEB benefits, in particular front-to-rear claims data. This research is a first of its kind in the UK to look at the issue of AEB impact of claims experience, and further studies around Insurer claims data with enhanced detail and risk information are intended to build on the findings reported here. As more vehicles with this technology become available Thatcham Research will continue to monitor AEB performance trends.

This study shows the effectiveness and value of AEB systems, especially in the reduction of injuries and in particular whiplash cases. The results of these and other findings have supported the implementation of an insurance discount system for AEB systems, and also the testing of such systems with Euro NCAP and other consumer test organisations which will encourage the proliferation of AEB within the vehicle parc.

ACKNOWLEDGEMENT

The authors would like to acknowledge the contribution of the real world claims data from the Insurers, and to thank HLDI for their support with analytical methodology.

REFERENCES

[1] Highway Loss Data Institute (HLDI). 2011 Volvo City Safety Loss Experience – Initial Results. HLDI Bulletin, 2011, 28(6).
[2] Insurance Institute for Highway Safety (IIHS) 2010. Avoid crashes. Status Report, 2010, 46(6).
[3] Highway Loss Data Institute (HLDI) 2012. Volvo City Safety Loss Experience – an update. HLDI Bulletin, 2012, 29(3).
[4] Insurance Institute for Highway Safety (IIHS) 2013. Crash Avoidance. Status Report, 2013, 48(3).
[5] Isaksson-Hellman, I and Lindman, M. 2012. The Effect of a Low-Speed Automatic Brake System Estimated from Real Life Data. Annals of Advanced Automotive Medicine, 2012, 56, p. 231–240.
[6] Kullgren, A. AEB Analysis. 2014, RCAR P-Safe meeting, March.
[7] Lauterwasser, C and Redlich J. 2011. Preliminary Analysis of the Claims Experience with Standard City Safety based on GDV/Allianz data. 2011, RCAR AGM, presentation by AZT & German Insurance Research Association.