AEB PERFORMANCE IN THE UK; A DECADE OF DEVELOPMENT

Zahra Sari
David Brookes
Matthew Avery
Thatcham Research
UK

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ABSTRACT

Automated Emergency Braking (AEB) first entered the UK market in November 2008 as standard fitment on the Volvo XC60. This system was a LIDAR based system operating up to 30km/h to address low-speed rear-end frontal collisions. There has been continuous increase in the number of vehicles offered with AEB systems as standard. As of January 2017, 1,586,103 vehicles in the UK are fitted with AEB representing 4.3% of the vehicle car parc. Testing of these systems has also broadened with AEB City and Inter-Urban tests entering the Euro NCAP assessment in 2014 with Pedestrian AEB entering in 2016 and by 2018 Cyclist AEB test will also be added to the Euro NCAP assessment. Other AEB tests have also been developed for reverse AEB systems with the intention of adopting these tests into the UK insurance group rating system.

An analysis of both Euro NCAP AEB City test results and insurance claims information shows that over the respective years of study AEB system performance has improved with a corresponding increase in system functionality. Recent vehicle tests show that a AEB system with City, Inter-Urban and Pedestrian functions will score 100% compared to the highest City only average of 81%. Statistical analysis on the effect AEB equipped vehicles compared to a control cohort of similar vehicles showed that Third Party Injury claim frequency is reduced by 38% for a City & Inter-Urban system compared to 28% for a City only system.

It is expected that the ADAS development required to enable assisted and automated driving will continue to improve the efficacy of AEB systems and further real-world safety benefits will be realised.
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INTRODUCTION

Automated Emergency Braking (AEB) first entered the UK market in November 2008 as standard fitment on the Volvo XC60. This system was a LIDAR based system operating up to 30km/h to address low-speed rear-end frontal collisions. There has been continuous increase in the number of vehicles offered with AEB systems as standard. As of January 2017, 1,586,103 vehicles in the UK are fitted with AEB representing 4.3% of the vehicle car parc. Testing of these systems has also broadened with AEB City and Inter-Urban tests entering the Euro NCAP assessment in 2014 with Pedestrian AEB entering in 2016 and by 2018 Cyclist AEB test will also be added to the Euro NCAP assessment. Other AEB tests have also been developed for reverse AEB systems with the intention of adopting these tests into the UK insurance group rating system.

Several retrospective studies have published results for the effectiveness of AEB systems when compared against a cohort or control vehicles. Initial studies used insurance claims to study the effect of own damage, third party damage and third party injury claims. IIHS showed in 2015 that Volvo City Safety Systems offered a -21%, -14% and -28% reduction in first party accident damage, third party accident damage and third party injury claims respectively [1]. An analysis of Swedish insurance data also showed a 28% overall reduction between rates of rear end frontal collisions, comparing groups of Volvo models with and without city safety [2]. Previous Thatcham Research studies of UK insurance based claims for the Volvo XC60 against a cohort of SUV control vehicles showed a -6%, -8% and -21% reduction in first party accident damage, third party accident damage and third party injury claims respectively. The same study also showed a -1%, -20% and -45% reduction in first party accident damage, third party accident damage and third party injury claims respectively for the Volkswagen Golf Mk7, a Radar based Inter-Urban and City AEB system [3].

Based on an analysis of police reported injurious accidents throughout Europe, Euro NCAP analysed the effect of AEB City systems using the induced exposure method and showed a 38% reduction in accidents compared to a control group of cohort vehicles [4]

Given the demonstrable effectiveness of AEB in both test and real-world scenarios and therefore the potential to reduce insurance claim risk, the Euro NCAP City AEB test was incorporated in the UK Insurance Group Rating with insurers offering on average a 10% discount on the insurance premium price.

As the sophistication of AEB systems, through improved sensors and object detection algorithms, has grown to cover more scenarios and object partners there has been an increase in basic performance in the City AEB test. This paper aims to explore if there has also been a corresponding increase in the effectiveness of these systems relative to non-AEB and City only AEB systems and expands on previous real-world analysis by considering additional AEB equipped vehicles beyond the Volvo XC60 and Volkswagen Golf of previous studies [3].

METHODS

The paper discusses two aspects of AEB performance, test performance and real-world effectiveness.

Firstly, AEB track performance testing is conducted in accordance with the Euro NCAP AEB City test protocol, a car to car rear stationary test at 5km/h increments up to 50 km/h. Vehicle motion towards the stationary EVT test target is controlled under GPS guided robot control (Anthony Best Dynamics steering and pedal robots in combination with an Oxford Technical Solutions motion pack). Braking performance is determined from analysis of the resulting vehicle kinematic data during AEB braking. The data presented are test results from either Euro NCAP or UK insurance group rating tests.

Secondly, real-world analysis uses insurance claims data to analyse the effects of AEB on claim frequencies and severity. Two main analyses were studied, individual vehicle AEB effect against a cohort of similar control vehicle to the vehicle of study and an aggregated AEB effect against all vehicle types in the insurance claims dataset. The individual vehicles studied were the Volvo XC60, Volvo V40, Volkswagen Golf and Nissan Qashqai. The analysis of the Volvo XC60 and Volkswagen Golf is a continuation of the previous analyses of these vehicles [3] but now encompassing a greater level of exposure due to two years additional claims data. Appendix A lists the control cohort vehicles for the individually studied vehicles. An extended analysis of the Volvo V40 was performed comparing the Volvo V40 with standard City AEB and Volvo V40 with optional Inter-Urban AEB, Lane Keep Assist and Lane Departure Warning.

Appendix B lists the AEB equipped vehicles used in the aggregate study. Control vehicles were all over cars in the insurance claim dataset.

The real-world effect analysis is based on the liability types of 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 object, but also covers non-fault incidents such as hit by an unknown third-party, weather damage, animal strike and 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/policy holder.

Data Sources

Test results are taken from either Euro NCAP or UK insurance group rating tests that have been complied into a dataset for use by Thatcham Research insurer members for underwriting purposes.

The real-world study uses two datasets. Insurance claims information including costs paid by the policyholder's insurer with exposure information in terms of insured vehicle years (IVYs) and where possible a free text description or categorisation of the accident type resulting in the claim. A vehicle insured for 6 months will have an IVY of 0.5, two vehicles of the same type insured for 6 months will have an IVY of 1 year. The supplied data covers claims from 2009 to 2015, thus encompassing the first possible AEB claims for the Volvo XC60 and all subsequent AEB equipped vehicles.

The other dataset is Thatcham Research's Research Claim Database; this details insurer authorised repairs and lists damage locations, parts damaged and repair costs and times for both parts, paint and labour. Whilst all claim types can appear in this database it mostly comprises of repaired vehicles and thus represents collision damage more so than injurious accidents were typically the vehicle is a total loss and may not be estimated for repair. The database cover 90% of the UK insurer market by volume.

From both datasets, only at fault accident damage claims were used in the assessment, excluding fire, theft and other similar losses. The liability was determined if there was a third party claim paid.

Statistical Analysis

AEB effectiveness is compared in terms of claims frequency relative to exposure in IVYs and claim severity in terms of average claims cost or average repair time and an overall effect in terms of the average loss payment per insured vehicle year. A generalised linear model is used to model the claim frequency (per 100 IVYs) or claim severity as the response variables with the covariates of model, year of exposure, driver age band, driver gender and vehicle mileage band. Previous covariates were only model and claim year [3]. These statistical models were used to compare the AEB study vehicle loss experience with that of the weighted average of the appropriate control cohort. A Poisson distribution was used for the claims frequency analysis and a Gamma distribution for the claims 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. As the response variable is related to the model series categorical variables by a log link function, the relative ration of a given model series to the AEB study vehicle baseline is found by taking the exponential of its regression coefficient.

For the Volvo V40 vs. Volvo V40 with optional safety pack analysis it was found that the severity data on repair costs and times had a non-normal distribution with several outlying data points. To account for the non-normal distribution MANCOVA and Mann-Whitney nonparametric tests were used for the analysis, both provided comparable results.

There are several factors that may affect the analysis of severity when only looking at repair estimate costs mainly this has been addressed by selecting the control cohort vehicle by the same or similar body style to control for any variation in repair costs through different styling effecting which parts are damaged in an impact through to the time required to repair a vehicle of a certain size. Control cohorts of medium cars, medium SUVs and small and medium SUVs were used for the Volkswagen Golf and Volvo V40, Volvo XC60 and Nissan Qashqai respectively. See Appendix A for the list of vehicle by cohort.

RESULTS

AEB Test performance:

Since 2012 65 separate vehicles have been tested for inclusion in the UK Group Rating formula. Figure 1 shows the AEB City test score as a percentage by year of test and AEB system functionality. This analysis shows that between 2012 and 2016 average system performance by year has improved by 72%. Those systems that also supplement AEB City with Inter-Urban and/or Pedestrian functionality generally have a higher score compared to City only systems. These higher performing systems are typified by camera and/or radar systems, offering improved range and detection.

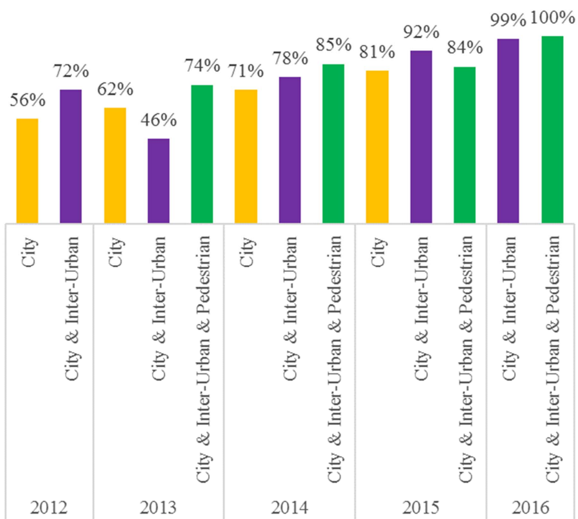

Figure 1.
Average AEB City test performance by Year and AEB system type

Statistical Analysis:

Table 1a.
Volvo XC60 Claim Frequency Analysis

	IVYs	% Effect	95% CI
Own Damage	22,041	2%	(-1%, 5%)
Third Party Damage	22,041	-9%	(-12%, -6%)
Combined Damage	22,041	2%	(-1%, 6%)
Third Party Injury	22,041	-26%	(-30%, -21%)

Table 1b.
Volvo XC60 Claim Severity Analysis

	IVYs	% Effect	95% CI
Own Damage	22,041	-3%	(-6%, -1%)
Third Party Damage	22,041	-8%	(-11%, -5%)
Combined Damage	22,041	-3%	(-6%, -1%)
Third Party Injury	22,041	7%	(-2%, 17%)

The Poisson regression analysis for frequency analysis showed that although there is a 2% increase in Own Damage claims compared to the control cohort this result is not statistically significant. A small beneficial effect is seen for the Gamma regression severity/cost analysis but Third Party Injury costs are slight greater at 7%. This analysis suggests while injury rate is reducing the remaining injury claims are potentially of a higher severity compared to the control, thus an increase claim cost.

Table 2a.
Volkswagen Golf Claim Frequency Analysis

	IVYs	% Effect	95% CI
Own Damage	17,126	-10%	(-14%, -6%)
Third Party Damage	17,126	-24%	(-29%, -19%)
Combined Damage	17,126	-12%	(-15%, -9%)
Third Party Injury	17,126	-20%	(-28%, -12%)

Table 2b.
Volkswagen Golf Claim Severity Analysis

	IVYs	% Effect	95% CI
Own Damage	17,126	-11%	(-15%, -7%)
Third Party Damage	17,126	-11%	(-16%, -5%)
Combined Damage	17,126	-14%	(-18%, -10%)
Third Party Injury	17,126	-1%	(-9%, 8%)

Results for the Volkswagen Golf with a City and Inter-Urban AEB system show a consistent reduction in claim rate across all liabilities as potentially expected with a broader performing system, Again, injury severity is not showing an expected benefit compared to the claim frequency reduction but this may be explained by the severity of the residual injury claims.

Table 3a.
Nissan Qashqai Claim Frequency Analysis

	IVYs	% Effect	95% CI
Own Damage	5,277	3%	(-5%, 12%)
Third Party Damage	5,277	-30%	(-37%, -21%)
Combined Damage	5,277	-1%	(-8%, 6%)
Third Party Injury	5,277	-38%	(-49%, -25%)

Table 3b.
Nissan Qashqai Claim Severity Analysis

	IVYs	% Effect	95% CI
Own Damage	5,277	-16%	(-23%, -9%)
Third Party Damage	5,277	-19%	(-27%, -11%)
Combined Damage	5,277	-16%	(-22%, -10%)
Third Party Injury	5,277	20%	(4%, 38%)

For the Nissan Qashqai, results indicate that, the 3% increase in Own Damage is not statistically significant but there is a significant reduction in Third Party claim frequencies. Again, there is an increase in injury severity. At 5,277 IVYs, exposure is potentially low and based on previous AEB effectiveness analyses [1] this figure might increase to show less benefit.

Table 4a.
Volvo V40 Claim Frequency Analysis

	IVYs	% Effect	95% CI
Own Damage	6,175	-4%	(-9%, 0%)
Third Party Damage	6,175	-19%	(-24%, -13%)
Combined Damage	6,175	-9%	(-13%, -5%)
Third Party Injury	6,175	-28%	(-40%, -24%)

Table 4b.
Volvo V40 Claim Severity Analysis

	IVYs	% Effect	95% CI
Own Damage	6,175	19%	(13%, 25%)
Third Party Damage	6,175	-4%	(-10%, 3%)
Combined Damage	6,175	14%	(8%, 19%)
Third Party Injury	6,175	0%	(-12%, 12%)

The Volvo V40 result are largely consistent with the effects observed for the other AEB study vehicles but Own Damage severity is markedly higher at 19% compared to the control cohort. Like injury severity this may be a result of residual accidents being more severe or that the Volvo V40 is a more expensive vehicle to repair than the control cohort

Table 5a.
Aggregated AEB Claim Frequency Analysis

	IVYs	% Effect	95% CI
Own Damage	48,330	4%	(-1%, 9%)
Third Party Damage	48,330	-20%	(-26%, -14%)
Combined Damage	48,330	-5%	(-9%, -1%)
Third Party Injury	48,330	-28%	(-37%, -19%)

Table 5b.
Aggregated AEB Claim Severity Analysis

	IVYs	% Effect	95% CI
Own Damage	48,330	-7%	(-12%, -2%)
Third Party Damage	48,330	-5%	(-11%, 2%)
Combined Damage	48,330	-8%	(-12%, -3%)
Third Party Injury	48,330	-7%	(-17%, 4%)

The aggregated AEB analysis is aligned with the results for the AEB equipped vehicles, which potentially illustrates that in this type of analysis if there is enough AEB equipped vehicle across a broad range of manufacturers and body styles that a control cohort becomes less of a requirement.

In the analysis of the Volvo V40 vs. Volvo V40 with the optional safety pack, 7234 vehicles had Standard City Safety AEB and 1045 vehicle were fitted with the additional safety pack. Average total repair hours and average total repair costs were 10% and 9% lower respectively for the Volvo V40 with the optional safety pack.

DISCUSSION

The AEB study vehicles can be split into two distinct groups, by their AEB systems, the Volvo XC60 and Volvo V40 are both equipped with LiDAR based low speed City systems whereas the Volkswagen Golf and Nissan Qashqai have Radar based systems City and Inter-Urban systems, operating across a broader speed range for front to car longitudinal accidents.

The results from the series of statistical analysis comparing the liability types of Own Damage, Third Party Damage and Third Party Injury also suggest a corresponding performance split regarding the two system types. For the City AEB only systems Third Party Damage frequency is 9% and 19% less than the control cohort. For the same metric, the City and Inter-Urban systems have a reduction of 24% and 30%. The same trend is also seen for Third Party Damage severity, a greater reduction for the higher performing system of 11% and 19% versus 4% and 8%. It is likely that these additional reductions between the systems is proportional to the additional number of accident scenarios addressed by the broader operating speed, through avoidance and mitigation.

Third Party Injury frequency is reduced by a similar amount for all systems 20%, 26%, 28% and 38% indicating that all the systems are potentially very selective to the designed crash type.

One area of the analysis were the benefits between systems is less marked or even shows an increase for the AEB vehicles compared to the control cohorts is in Third Party Injury severity. In the case of the Nissan Qashqai there is a 20% increase in claim cost compared to the control cohort. A rational conclusion for this result could be that due to the system avoiding and mitigating low to mid-speed accident the residual accidents are those of a greater injurious nature and therefore attract a higher claim value. The other results for the frequency and severity analysis support that the system is effective in avoiding accidents therefore supports this possible explanation. The same effect is also seen for the Volvo XC60 but to less of an extent, a 7% increase in Third Party Injury costs. It is also observed in insurer data that injury claim costs for whiplash injury do not vary greatly across a range of impact severities, as determined from photographic evidence with linked claim records, therefore the observed benefits could be biased due to a tendency for whiplash claims irrespective of severity.

Based on the rational of the increased Third Party Injury costs a similar effect could be summarised for the Volvo V40 for Own Damage, a 19% increase. It could be that the residual non-low speed accidents that City AEB does not address gives rise to a greater mean value of claims compared to the control cohort group.

Further analysis of the claims both for accident damage and injury would help support these hypotheses but this type of information is not readily collected by Thatcham Research or analysed by insurers.

Compared to the previous analysis of the Volkswagen Golf [3] one of largest changes in the results is for Third Party Injury frequency, -45% vs. -20%. To understand if the change was due to the increase in covariates used in this analysis compared to the previous study, a Poisson regression was undertaken using just model and exposure year covariates as per the previous study. Third Party Injury frequency was -16% [-24%, -7%] therefore there is more than variation in model fit effecting the result, the main influencer is likely to be the increase in exposure (IVYs). This type of change was also observed by IIHS in their studies of the Volvo XC60 a change from -51% to -33%.

The analysis of the aggregated dataset shows that, apart for Own Damage frequency, there is a consistent small reduction across all AEB effect metrics. The main aim of this analysis was to substantiate the discount rate currently offered in Group Rating.

Whilst the AEB test performance is near 100% for the latest vehicles and still high for older vehicles, regardless of AEB system, there is a disparity between observed test performance and real-world effectiveness. A detailed analysis of repair estimate photographs where the accident type was front to rear in longitudinal traffic showed that while 48% resulted in full width damage to the vehicle, suggesting a similar crash scenario to the Euro NCAP test – square on to the test target, 10% occurred with two-thirds overlap or centre damage only and 11% occurred with an overlap of less than a quarter of the vehicle width. 95% of impacts occurred with a PDoF at 6 or 12 o'clock. Provisional testing of overlap situations indicates a degradation in systems performance by 40% for a camera and radar based system when tested at 100% and 40% overlap. This highlights the importance of using real-world analysis to further the development of both test procedures and ADAS systems.

CONCLUSION

Since the introduction of the first AEB system in the UK market in 2008 there has been a consistent improvement in both test and real-world performance of vehicles fitted with increasingly more comprehensive AEB systems in terms of functionality and therefore addressing a greater number of accident scenarios.

Along with improved sensor capabilities to allow such functions as AEB Pedestrian and Cyclist these sensor developments also are providing an enabler for other ADAS systems based around camera and radar fusion such as Lane Keep Assist, Emergency Lane Keep and Automated Evasive Steering. It is therefore expected that further development in both consumer and regulatory tests will drive manufacturers to continue advancing the state of art in terms of AEB and start to address the remaining proportion of accident scenarios in the next 10 years, especially to ensure the availability and proliferation of Autonomous driving in the vehicle fleet.

REFERENCES

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APPENDIX A: Control cohort vehicles by body style

Body Style		
Medium Cars	Medium SUV	Small and Medium SUV
Audi A4	Audi Q3	Audi Q3
BMW 3 Series	Audi Q5	BMW X1
Ford Focus	BMW X1	BMW X3
Honda Civic	BMW X3	Citroen C4 Cactus
Infiniti Q50	Citroen C4	Ford Eco Sport
Kia Cee'd	Ford Kuga	Ford Kuga
Lexus IS	Honda CR-V	Honda CR-V
Mazda 3	Hyundai IX35	Hyundai IX35
Renault Megane	Hyundai Tucson	Infiniti QX50
Mercedes C-Class	Infiniti EX	Jeep Cherokee
Nissan Pulsar	Infiniti QX50	Kia Sportage
Octavia	Jeep Cherokee	Mitsubishi Outlander
Peugeot 308	Kia Sportage	Nissan Juke
Skoda Octavia	Land Rover Discovery	Nissan Qashqai
Toyota Auris	Land Rover Freelander	Nissan X-Trail
Toyota Avensis	Land Rover Evoque	Peugeot 2008
Volkswagen Golf	Mercedes-Benz ML	Peugeot 5008
	Mitsubishi Outlander	Porsche Macan
	Nissan Qashqai+2	Renault Captur
	Nissan X-Trail	Renault Scenic XMOD
	Peugeot 5008	Skoda Yeti
	Porsche Macan	Suzuki Grand Vitara
	Renault Scenic	Suzuki SX4 S-Cross
	Suzuki Grand Vitara	Toyota Rav-4
	Toyota Rav-4	Vauxhall Mokka
	Vauxhall Antara	Volvo XC70
	Volvo XC70	

APPENDIX B : AEB vehicles in the Aggregated AEB study

BMW 2 Series Active Tourer
BMW X5
BMW X6
Fiat 500L
Ford Focus
Honda Civic
Land Rover Discovery Sport
Mazda 2
Mazda 3
Mazda 6
Mazda CX-5
Mercedes-Benz B-Class
Mercedes-Benz C-Class
Mercedes-Benz C-Class
Mercedes-Benz CLA
Mercedes-Benz CLS Class
Mercedes-Benz E-Class
Mercedes-Benz GLA-Class
Mercedes-Benz S-Class
Mitsubishi Outlander
Nissan Pulsar
Nissan Qashqai
Nissan X-Trail
Skoda Fabia
Skoda Octavia
Tesla Model-S
Volkswagen e-Golf
Volkswagen Golf
Volkswagen Golf Non AEB
Volkswagen Golf SV
Volkswagen Passat
Volvo S60
Volvo S80
Volvo V40
Volvo V60
Volvo V70
Volvo XC60
Volvo XC70

APPENDIX C: Comprehensive Results - Statistical Analysis

Volvo XC60 AEB Frequency Analysis

	Volvo XC60			Control	AEB Effect	
	Exposure (IVYs)	Claim Count	Claim per 100 IVYs	Claim per 100 IVYs	% Difference	95% CI
Own Damage	22,041	974	4.42	4.33	2%	(-1%, 5%)
Third Party Damage	22,041	585	2.65	2.91	-9%	(-12%, -6%)
Combined Damage	22,041	1,269	5.76	5.62	2%	(-1%, 6%)
Third Party Injury	22,041	152	0.69	0.93	-26%	(-30%, -21%)

Volvo XC60 AEB Severity Analysis

	Volvo XC60		AEB Effect	
	Exposure (IVYs)	Claim Cost per Exposure (IVYs)	% Difference	95% CI
Own Damage	22,041	£2,084	-3%	(-6%, -1%)
Third Party Damage	22,041	£1,897	-8%	(-11%, -5%)
Combined Damage	22,041	£2,014	-3%	(-6%, -1%)
Third Party Injury	22,041	£12,032	7%	(-2%, 17%)

Volkswagen Golf AEB Frequency Analysis

	Volkswagen Golf			Control	AEB Effect	
	Exposure (IVYs)	Claim Count	Claim per 100 IVYs	Claim per 100 IVYs	% Difference	95% CI
Own Damage	17,216	765	4.47	4.97	-10%	(-14%, -6%)
Third Party Damage	17,216	293	1.71	2.26	-24%	(-29%, -19%)
Combined Damage	17,216	871	5.09	5.78	-12%	(-15%, -9%)
Third Party Injury	17,216	114	0.67	0.84	-20%	(-28%, -12%)

Volkswagen Golf AEB Severity Analysis

	Volkswagen Golf		AEB Effect	
	Exposure (IVYs)	Claim Cost per Exposure (IVYs)	% Difference	95% CI
Own Damage	17,216	£2,024	-11%	(-15%, -7%)
Third Party Damage	17,216	£1,901	-11%	(-16%, -5%)
Combined Damage	17,216	£1,990	-14%	(-18%, -10%)
Third Party Injury	17,216	£9,487	-1%	(-9%, 8%)

Nissan Qashqai AEB Frequency Analysis

	Nissan Qashqai			Control	AEB Effect	
	Exposure (IVYs)	Claim Count	Claim per 100 IVYs	Claim per 100 IVYs	% Difference	95% CI
Own Damage	5,277	213	4.04	4.04	3%	(-5%, 12%)
Third Party Damage	5,277	76	1.44	2.04	-30%	(-37%, -21%)
Combined Damage	5,277	245	4.64	4.69	-1%	(-8%, 6%)
Third Party Injury	5,277	27	0.51	0.83	-38%	(-49%, -25%)

Nissan Qashqai AEB Severity Analysis

	Nissan Qashqai		AEB Effect	
	Exposure (IVYs)	Claim Cost per Exposure (IVYs)	% Difference	95% CI
Own Damage	5,277	£1,843	-16%	(-23%, -9%)
Third Party Damage	5,277	£1,675	-19%	(-27%, -11%)
Combined Damage	5,277	£1,799	-16%	(-22%, -10%)
Third Party Injury	5,277	£8,927	20%	(4%, 38%)

Volvo V40 AEB Frequency Analysis

	Volvo V40			Control	AEB Effect	
	Exposure (IVYs)	Claim Count	Claim per 100 IVYs	Claim per 100 IVYs	% Difference	95% CI
Own Damage	6,175	292	4.73	4.96	-4%	(-9%, 0%)
Third Party Damage	6,175	109	1.77	2.20	-19%	(-24%, -13%)
Combined Damage	6,175	324	5.25	5.79	-9%	(-13%, -5%)
Third Party Injury	6,175	33	0.53	0.80	-32%	(-40%, -24%)

Volvo V40 AEB Severity Analysis

	Volvo V40		AEB Effect	
	Exposure (IVYs)	Claim Cost per Exposure (IVYs)	% Difference	95% CI
Own Damage	6,175	£2,422	19%	(13%, 25%)
Third Party Damage	6,175	£1,875	-4%	(-10%, 3%)
Combined Damage	6,175	£2,273	14%	(8%, 19%)
Third Party Injury	6,175	£8.262	0%	(-12%, 12%)

Aggregated AEB Frequency Analysis

	Aggregated AEB			Control	AEB Effect	
	Exposure (IVYs)	Claim Count	Claim per 100 IVYs	Claim per 100 IVYs	% Difference	95% CI
Own Damage	48,330	2,229	4.76	5.14	4%	(-1%, 9%)
Third Party Damage	48,330	880	1.82	2.28	-20%	(-26%, -14%)
Combined Damage	48,330	2,613	5.41	5.68	-5%	(-9%, -1%)
Third Party Injury	48,330	299	0.62	0.86	-28%	(-37%, -19%)

Aggregated AEB Severity Analysis

	Exposure (IVYs)	Claim Cost	Average cost per Claim	% Difference	95% CI
Own Damage	48,330	£4,869,466	£2,118	-7%	(-12%, -2%)
Third Party Damage	48,330	£1,718,374	£1,953	-5%	(-11%, 2%)
Combined Damage	48,330	£6,587,840	£2,072	-8%	(-12%, -3%)
Third Party Injury	48,330	£2,763,775	£9,243	-7%	(-17%, 4%)