HLDI
Highway Loss Data Institute

Bulletin | Vol. 37, No. 7 : April 2020

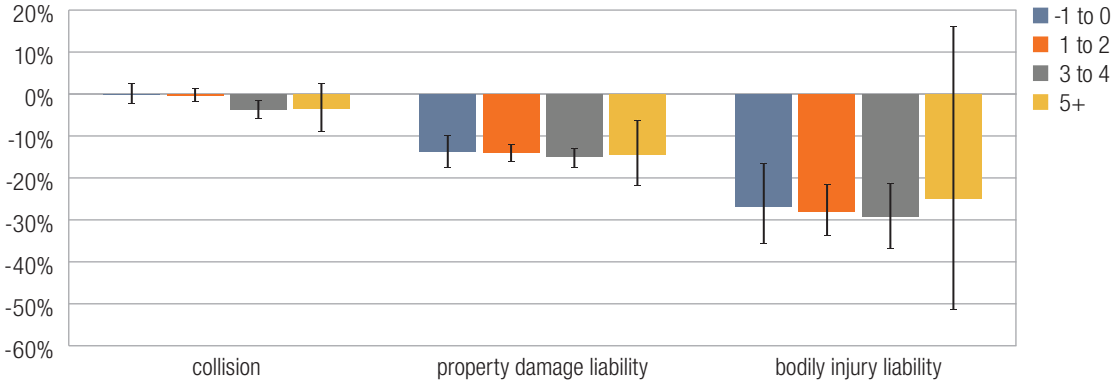
Changes in collision, PDL, and BI claim frequencies for Subaru and Honda vehicles equipped with front crash prevention systems, by vehicle age

Summary

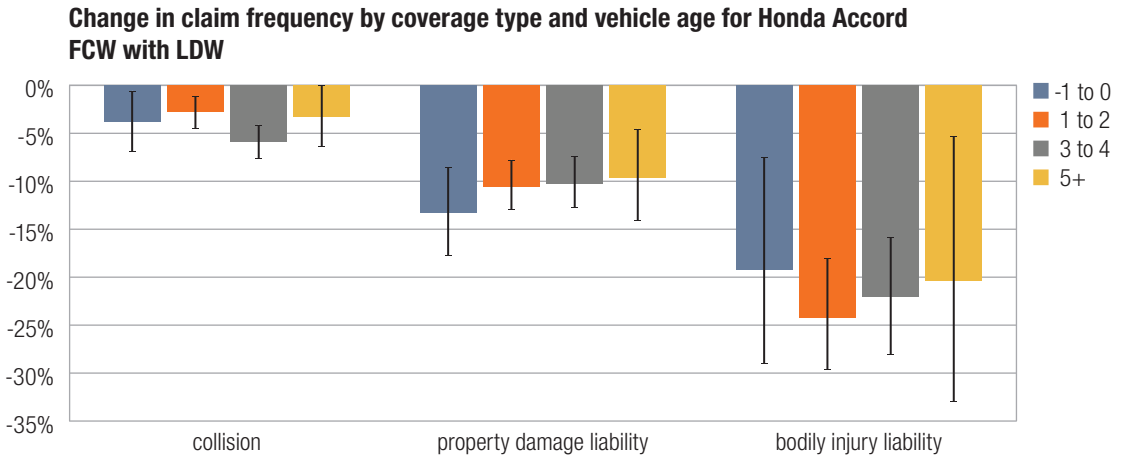
Since 2014, the Highway Loss Data Institute (HLDI) has done a series of research studies on Subaru and Honda collision avoidance systems, and the insurance loss benefits for their front crash prevention systems are clear. The latest studies (HLDI, 2019a, 2019b) have found Subaru's EyeSight system and Honda's forward collision warning (FCW) with lane departure warning (LDW) to be beneficial for most crash-related coverage types. However, comparing the results across studies shows that benefits for some coverages have attenuated over time. For example, when first examined in 2014, Honda's FCW with LDW was associated with a significant 14 percent reduction in property damage liability (PDL) claim frequency, but it was 11 percent in the latest study. The purpose of the current study is to examine if the benefits of Subaru and Honda front crash prevention systems persist as the vehicles age.

The following figure suggests that the benefits of Subaru's EyeSight system do persist as the vehicles age. The benefit of EyeSight in collision claim frequency increased with vehicle age, but only the result for vehicles 3 to 4 years old was statistically significant, and differences between the vehicle ages were not significant. For PDL, significant reductions in claim frequency were seen across different vehicle ages, and the benefits remained relatively stable over time. For bodily injury (BI) liability claims, the largest benefit was also found for vehicles 3 to 4 years old, with a significant 29 percent reduction in claim frequency; while the benefit for vehicles 5 years old and older was a 25 percent reduction in claim frequency, but the result was not statistically significant with large confidence bounds.

Change in claim frequency by coverage type and vehicle age for vehicles equipped with Subaru EyeSight



For Honda Accord's FCW/LDW system, as shown in the following figure, benefits varied by age and coverage type. Statistically significant reductions were seen across all vehicle age groups, except for collision claim frequency for vehicles 5 years old and older. For collision claims, the largest benefits of FCW/LDW were found in vehicles 3 to 4 years old, but there was no obvious trend over time. PDL claim frequency benefits showed a decreasing trend, with older vehicles benefiting less compared with newer vehicles. BI claims showed a similar decreasing trend in frequency benefits beginning with vehicles 1 year old and older.



Introduction

This Highway Loss Data Institute (HLDI) bulletin provides a look at the impact of vehicle age on the insurance loss benefits of Subaru and Honda front crash prevention systems.

The features included in this analysis are as follows:

Subaru

EyeSight uses a dual-camera system located behind the windshield to assess the risk of a collision with leading traffic, and it includes the following four features:

Forward collision warning with automatic braking assesses the risk of a rear-end collision with an obstacle in front and warns the driver with an audible alert. If the driver does not take evasive action, the brakes are automatically applied to reduce impact damage or, if possible, prevent the collision. EyeSight is capable of avoiding a collision with a speed difference to the obstacle in front as high as 30 mph (48 km/h). However, not every situation under these conditions will result in full collision avoidance. Some of the functionality may be turned off by the driver and can be activated/deactivated via the instrument cluster controls but will reactivate at the next ignition cycle.

Adaptive cruise control with complete stop is a system that monitors traffic ahead and maintains the driver's selected speed and automatically reduces it to maintain a driver-selected following distance when the system detects a slower-moving vehicle ahead. Adaptive cruise control is available at speeds up to 90 mph (145 km/h) and can bring the car to a stop in traffic. Forward collision warning remains active even when adaptive cruise control is turned off.

Lane departure warning identifies traffic lane markings. Audio and visual warnings will indicate if the vehicle path deviates from the lane and the turn signal is not on. The system is functional at speeds at or above 32 mph (51 km/h). The system may be deactivated by the driver but will reactivate at the next ignition cycle.

Lead vehicle start alert notifies the driver by means of an audible tone and the lead vehicle indicator on the multi-informational display when the driver's vehicle remains stopped after the vehicle in front has started to move forward. When the EyeSight-equipped vehicle has stopped within 32 feet (10 m) of a stationary vehicle and both remain stopped for several seconds, this system will alert the driver of the EyeSight vehicle if his or her car remains stationary after the lead vehicle has moved 10 feet (3 m).

Besides EyeSight, Subaru also provides a rear-vision camera and Rear Vehicle Detection as options on its 2013-15 vehicles, whose results are not included in this study. However, these features are included in the regression models to separate effects for the EyeSight system.

Honda Accord

Forward collision warning (FCW) uses a camera system located behind the windshield to assess the risk of a collision with leading traffic. The warning system has three driver-selectable range settings. When a potential crash is detected, lights flash in the heads-up display, the FCW indicator blinks, and there is continuous beeping. The system is active only at speeds over 10 mph (16 km/h) and can be deactivated by the driver. At each ignition cycle, the system defaults to the previous on/off setting. Vehicles with FCW also have LDW.

Lane departure warning (LDW) utilizes the same camera as forward collision warning to also identify traffic lane markings. Audio and visual warnings will indicate if the vehicle path deviates from the intended lane. The system is functional at speeds between 40 and 90 mph (64 and 145 km/h) but does not warn if the turn signal is on or the movement is determined to be sufficiently sudden as to be evasive. The system can be deactivated by the driver. At each ignition cycle, the system defaults to the previous on/off setting.

Besides FCW and LDW, LaneWatch, a passenger-side-only blind spot monitor, is offered as standard equipment on several 2013–15 Honda Accord trims. It was controlled for in the regression models but the results for this side-assist system were not included in this analysis. In addition, all the Honda Accord vehicles in this study were equipped with rear cameras. Because there were no vehicles without this feature, camera effectiveness could not be evaluated in this analysis. The vehicles in this analysis also may have been equipped with optional rear parking sensors. This feature was not controlled for in the analysis, because the availability of rear parking sensors on a vehicle was not discernible from the vehicle identification number (VIN).

Method

Insurance data

Automobile insurance covers damages to vehicles and property in crashes plus injuries to people involved in the crashes. Different insurance coverages pay for vehicle damage versus injuries, and different coverages may apply depending on who is at fault. The current study is based on collision, property damage liability (PDL), and bodily injury (BI) liability coverages. Exposure is measured in insured vehicle years. An insured vehicle year is one vehicle insured for 1 year, two vehicles insured for 6 months, etc.

Because different crash avoidance features may affect different types of insurance coverage, it is important to understand how coverages vary among the states and how this affects inclusion in the analyses. Collision coverage insures against vehicle damage to an at-fault driver's vehicle sustained in a crash with an object or another vehicle; this coverage is common to all 50 states. PDL coverage insures against vehicle damage that at-fault drivers cause to other people's vehicles and property in crashes. This coverage exists in all states except Michigan, where vehicle damage is covered on a no-fault basis (each insured vehicle pays for its own damage in a crash, regardless of who is at fault). BI liability coverage insures against medical, hospital, and other expenses for injuries that at-fault drivers inflict on occupants of other vehicles or others on the road. BI losses are restricted to data from traditional tort states.

Vehicles studied

The vehicles included in this study were 2013–15 Subaru and Honda Accord vehicles. These vehicles were selected for this study because there is sufficient exposure to produce credible results by vehicle age.

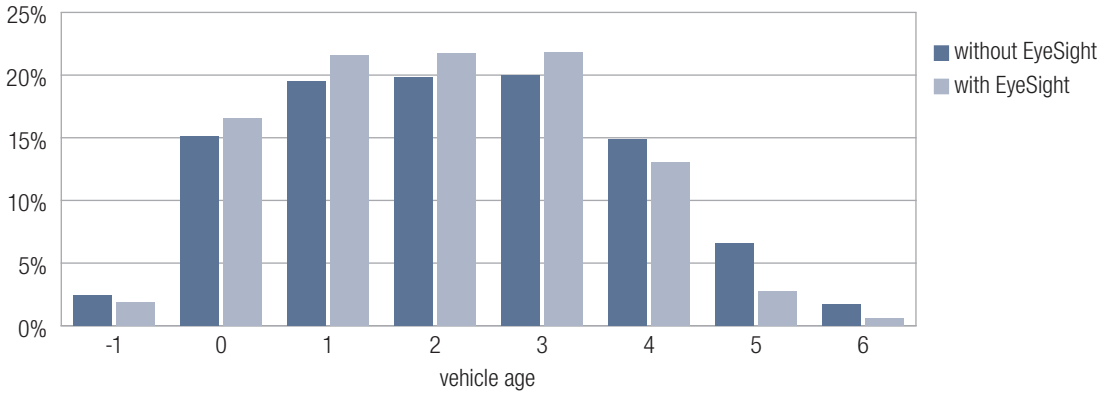
Subaru

EyeSight is offered as an option on various 2013–15 Subaru models. The presence or absence of EyeSight is discernible from the information encoded in the VINs. Besides EyeSight, Subaru also provides a rear-vision camera and Rear Vehicle Detection as options on some 2013–15 Subaru vehicles, whose results were not included in this study. However, as the presence or absence of these features could also affect the insurance losses, to better understand the effectiveness of individual systems, these features were included in the regression models to separate the effects for the EyeSight system. Subaru vehicles without the three features served as the control vehicles in this analysis. Table 1 lists the collision exposure by Subaru vehicle series, measured in insured vehicle years, and the exposure of EyeSight as a percentage of total exposure.

Table 1: Collision exposure by Subaru vehicle series				
Make	Series	Model years	EyeSight	Total exposure
Subaru	Forester 4dr	2014–15	15%	1,506,842
Subaru	Impreza 4dr	2015	9%	69,100
Subaru	Impreza station wagon	2015	9%	147,410
Subaru	Legacy 4dr	2013–15	15%	607,192
Subaru	Outback station wagon 4WD	2013–15	19%	1,658,618
Subaru	XV Crosstrek station wagon	2015	20%	229,988
Total			**17%**	**4,219,151**

Figure 1 summarizes the distribution of collision exposure for Subaru vehicles by vehicle age. About 40 percent of the insured vehicles were 1 or 2 years old, and 35 percent were 3 or 4 years old. Of the Subaru vehicles without EyeSight, only 9 percent were 5 or 6 years old. Of the vehicles equipped with EyeSight, only 3 percent were 5 or 6 years old.

Figure 1: Distribution of Subaru collision exposure by vehicle age



Honda Accord

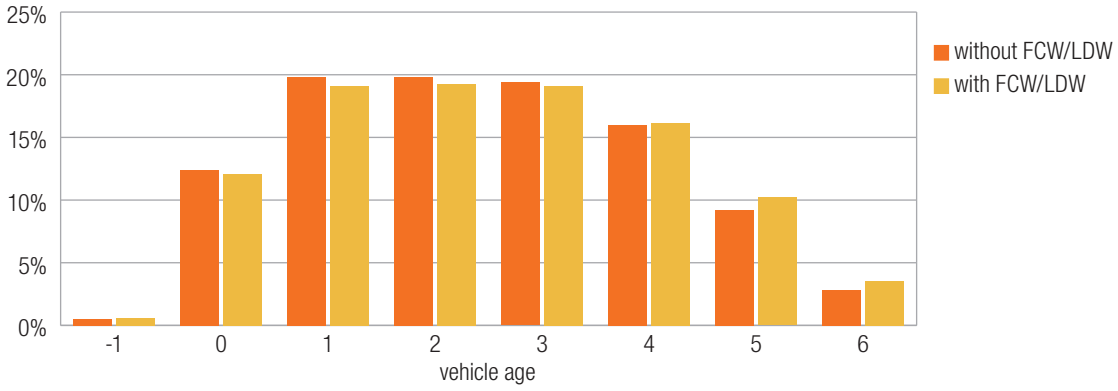
Several trim levels are offered on the Honda vehicles included in this study. Trim levels are bundles of vehicle options such as interior materials; engines; and comfort, convenience, and safety features. For example, the Honda Accord EX-L V6 is equipped with a 6-cylinder motor, leather seats, and several collision avoidance technologies. The less expensive LX is equipped with cloth seats, a 4-cylinder motor, and no collision avoidance technologies. For the Honda vehicles included in this study, the trim levels can be determined in the first 10 positions of the VIN. The collision avoidance features in this study are either standard or not available at the trim level. Consequently, by knowing the trim level, the presence of the collision avoidance features is known.

Forward collision warning (FCW) paired with lane departure warning (LDW) is available on most Honda Accords and on the related Honda Accord Crosstour. LaneWatch and the combination of FCW and LDW are offered as standard equipment on several 2013–15 Honda Accord models (trims). The Touring trim level of the Accord four-door was excluded from the analysis, because it is equipped with a different FCW system that uses a radar system instead of a camera and includes adaptive cruise control functionality. Honda Accord vehicles without these features served as the control vehicles in the analysis. Although controlled for in the regression models, the results for LaneWatch, the side-assist system for Honda, were not included in this study. Table 2 lists the collision exposure by Honda vehicle series, and the exposure of each feature as a percentage of total exposure.

Table 2: Collision exposure by Honda vehicle series				
Make	Series	Model years	Forward collision warning (includes lane departure warning)	Total exposure
Honda	Accord 2dr	2013–15	66%	375,615
Honda	Accord 4dr	2013–15	35%	3,956,706
Honda	Accord Crosstour 4dr 2WD	2013–15	71%	76,619
Honda	Accord Crosstour 4dr 4WD	2013–15	100%	66,847
Total			**40%**	**4,475,787**

Figure 2 summarizes the distribution of collision exposure for Honda Accord vehicles by vehicle age. The distributions for the vehicles with collision avoidance features and the control vehicles are similar. About 40 percent of the insured vehicles in each subgroup were 1 or 2 years old, and 35 percent were 3 or 4 years old. The majority of vehicles were less than 5 years old.

Figure 2: Distribution of Honda Accord collision exposure by vehicle age



Statistical methods

Regression analysis was used to quantify the effect of each vehicle feature by vehicle age while controlling for the other features and covariates. The covariates included model year, garaging state, vehicle density (number of registered vehicles per square mile), rated driver age, rated driver gender, rated driver marital status, deductible range (collision coverage only), and risk. For each safety feature studied, a binary variable was included. Vehicle age in this study is defined as vehicles that are –1 to 6 years old. For example, a 2013 model year vehicle in calendar year 2013 would have a vehicle age of 0, while a 2014 vehicle in the same calendar year could have a vehicle age of –1.

HLDI normally controls for both model year and calendar year in the regression model. For this analysis, vehicle age was included, which was determined by the difference between the model year and calendar year of the same vehicle. Due to the collinearity of model year, calendar year, and vehicle age, only model year and vehicle age were included in the regression model.

Claim frequency was modeled using a Poisson distribution, with a logarithmic link function. The interaction terms between each vehicle feature and vehicle age are included in the model, which represent the differences in the effects of each feature among different vehicle ages.

For space reasons, only the estimates for the individual crash avoidance features are shown on the following pages. To illustrate the analyses, however, the **Appendix** contains full model results for Honda Accord's collision claim frequency. To further simplify the presentation here, the exponent of the parameter estimate was calculated, 1 was subtracted, and the resultant multiplied by 100. The resulting number corresponds to the effect of the feature on that loss measure. For example, the estimate of the interaction between FCW/LDW and vehicle ages –1 and 0 on collision claim frequency was –0.0386; thus, Honda Accord vehicles –1 and 0 years old with FCW/LDW had 3.8 percent fewer collision claims than the control vehicles of the same age ((exp(–0. 0386)–1)×100=–3.8).

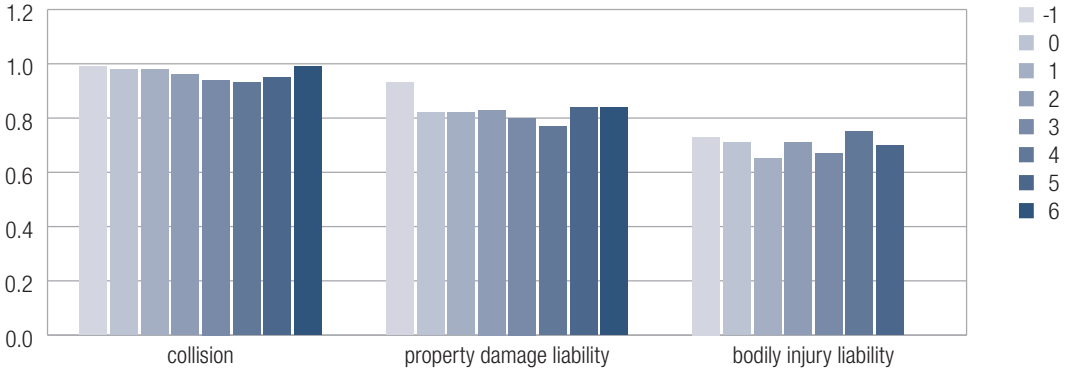
Results

Results for the Subaru and Honda vehicles in this study include two parts. In the first part, the results are presented as ratios of the observed claim frequency of vehicles equipped with front crash prevention systems to the observed claim frequency of control vehicles of the same age (**Figures 3 and 5**). If the ratio is less than 1, it means there were fewer claims made on vehicles with front crash prevention systems than those without. The second part includes the modeling results of the estimated differences in claim frequency for vehicles with and without front crash prevention systems by vehicle age (**Figures 4 and 6**).

Subaru

Figure 3 shows the ratio of observed claim frequencies for Subaru EyeSight-equipped vehicles and control vehicles by vehicle age. For vehicle damage coverages, both collision and PDL claim frequencies were lower for EyeSight-equipped vehicles than for the control vehicles. For collision, the differences in claim frequency between vehicles with and without EyeSight were slight and showed small changes over time. For PDL, the claim frequencies for EyeSight-equipped vehicles were much lower than for the control vehicles across all ages except –1. The claim frequency for BI showed large differences for vehicles with and without EyeSight. Vehicles with EyeSight had lower claim frequencies than the control vehicles across all vehicle ages, and there was no obvious trend over time.

Figure 3: Ratio of observed claim frequencies for Subaru EyeSight-equipped vehicles to control vehicles by vehicle age



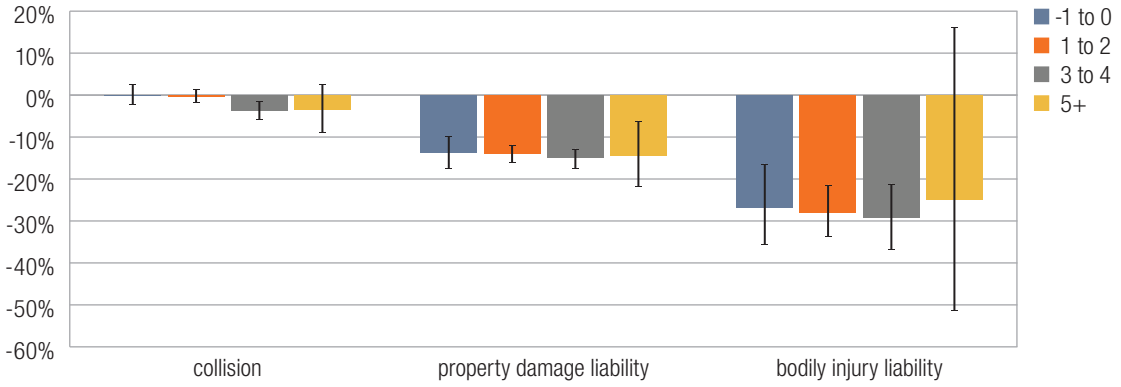
After controlling for other covariates, **Figure 4** shows the estimated differences in claim frequency for Subaru vehicles with and without EyeSight in different vehicle age groups. Here, and in subsequent figures, the vertical I-bars represent the 95 percent confidence limits for the estimates.

For collision claim frequency, EyeSight showed essentially no effect on vehicles –1 to 0 and 1 to 2 years old; while for vehicles 3 to 4 and 5 years old and older, EyeSight was associated with 4 and 3 percent lower claim frequencies than the control groups, respectively. Only the result for vehicles 3 to 4 years old was statistically significant.

For PDL, significant benefits for EyeSight were found for all vehicle ages. Reductions in claim frequencies were stable at around 14 to 15 percent for all vehicle age groups.

For BI, the benefits of EyeSight were even larger. For newer vehicles (–1 to 0 years old), BI claim frequency was associated with a significant 27 percent reduction; for vehicles 1 to 2 and 3 to 4 years old, claim frequency was significantly lower by 28 and 29 percent, respectively; for vehicles 5 years old and older, although statistically insignificant, claim frequency was down by 25 percent.

Figure 4: Change in claim frequency by coverage type and vehicle age for Subaru EyeSight



Honda Accord

Figure 5 summarizes the ratio of observed claim frequencies for Honda Accord vehicles with the FCW system with LDW and control vehicles by vehicle age. It is notable that since all vehicles with FCW/LDW were also equipped with LaneWatch, the observed ratios for the Honda Accords with FCW/LDW are calculated relative to the Accord vehicles with LaneWatch only.

Claim frequency reductions were observed for all vehicles equipped with FCW and LDW across all studied coverages and vehicle ages. For collision and PDL claims, the ratios generally increased as vehicles became older, which means the differences between vehicles with and without FCW/LDW diminished over time. However, for BI claims, the ratios remained relatively stable for vehicles 0 years old and older.

Figure 5: Ratio of observed claim frequencies for Honda FCW/LDW-equipped vehicles to control vehicles by vehicle age

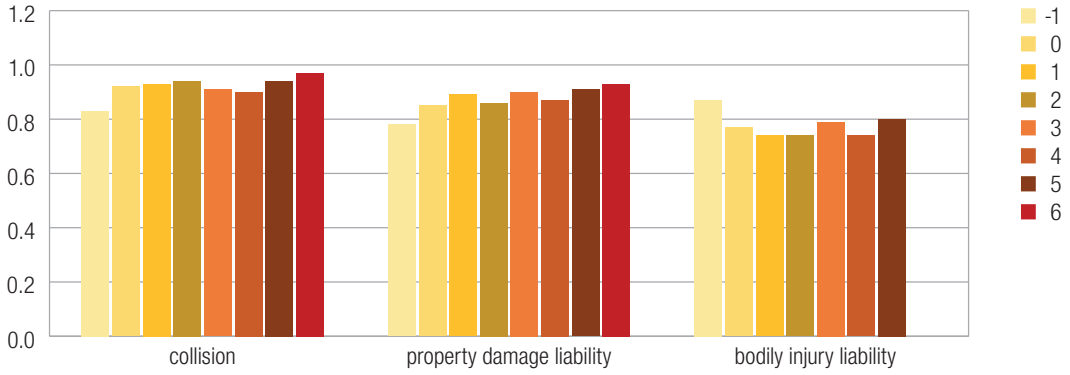
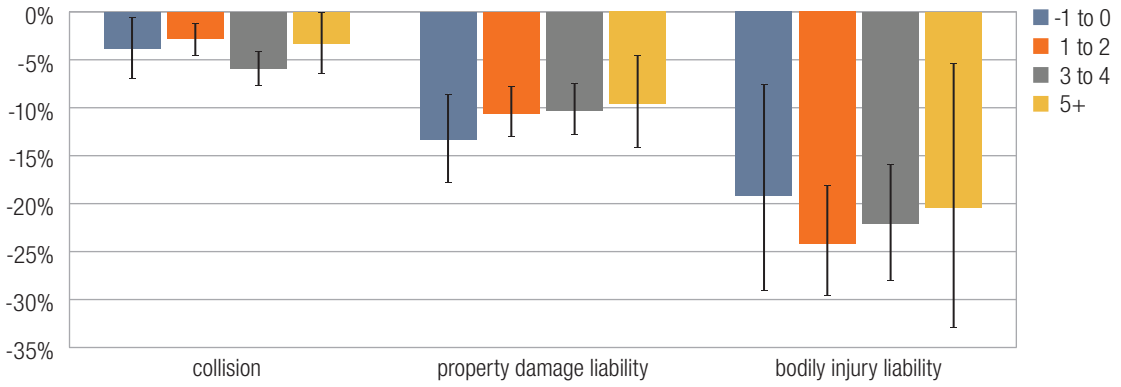


Figure 6 shows the estimated effects on claim frequency for Honda Accord's FCW system with LDW by vehicle age. Reductions in claim frequency were seen for all coverages and all vehicles regardless of age. All results were statistically significant, except for collision claim frequency for vehicles 5 years old and older. For collision claims, the largest benefit was found for vehicles 3 to 4 years old. The benefits for vehicles of other ages did not suggest an obvious trend.

For PDL claims, reductions in frequencies ranged from 10 percent for vehicles 5 years old and older to 13 percent for vehicles –1 to 0 years old, which showed a decreasing trend as vehicles became older. For BI claims, vehicles 1 to 2 years old benefited the most from Honda Accord's FCW/LDW system, while the benefits decreased for older vehicles. However, the least benefit was found with the newest vehicles (aged –1 to 0) with a 19 percent reduction in claim frequency.

Figure 6: Change in claim frequency by coverage type and vehicle age for Honda Accord FCW with LDW



Discussion

Since 2014, HLDI has published multiple reports of Subaru and Honda Accord collision avoidance systems, and the benefits of Subaru's EyeSight and Honda Accord's FCW/LDW are obvious. However, the latest updates (HLDI, 2019a, 2019b) have shown some signs of potential reductions in the claim frequency benefits of these systems over time. For example, Honda Accord's FCW/LDW was shown to reduce PDL claim frequency in all updates, but the claim frequency benefit decreased from 14 percent in the April 2014 study to 11 percent in the December 2019 study. Developing a more systematic approach to repairing vehicles with advanced driving assistance systems brings the need for understanding the benefits of these systems over the life of the vehicles. As vehicles age, the performance of these systems might degrade. Degradation could occur from damaged components, components out of alignment or components in need of recalibration.

The purpose of this study was to understand whether the benefits of these systems persist for the life of these vehicles.

Subaru

Subaru's EyeSight system was designed to assess the risk of a collision with leading traffic, which could prevent or mitigate front-to-rear crashes, which typically result in PDL and BI claims if an injury occurs in the struck vehicle. The results in this study suggest that EyeSight continues to show benefits across the studied coverages, especially for PDL and BI claims, which is consistent with the previous study (HLDI, 2019b). However, there was no common trend seen in the studied coverages. The PDL benefits showed essentially no change over time, which suggests that the benefit of EyeSight on PDL claims may persist. For BI coverage, the older vehicles (5 years old and older) benefited the least from the system. However, the confidence bounds for all of the BI estimates overlapped. The claim frequency for collision, however, showed an opposite trend in that the benefits for older vehicles were larger than for newer vehicles.

Honda Accord

The current study found benefits of Honda Accord's FCW/LDW for all vehicle age groups, which is consistent with the prior study (HLDI, 2019a). Statistically significant reductions in claim frequency were found for all coverages across different vehicle age groups, except for collision claim frequency for vehicles 5 years old and older. For PDL claims, a trend of decreasing frequency benefits as the vehicles aged was observed. For BI claims, there was also a trend of decreasing benefits for vehicles 1 year old and older, while the least benefit in frequency reduction was found for vehicles –1 to 0 years old. However, the confidence bounds for all of the PDL and BI estimates overlapped. There was no obvious trend for collision coverage.

Conclusion

In summary, both the results for Subaru and Honda Accord front crash prevention systems are promising. There is no clear evidence showing that the benefits of these systems have attenuated over time. For Subaru vehicles, only the results for BI claims showed a reduction in benefits for the oldest vehicles, but the result was not statistically significant. For Honda Accord vehicles, although the claim frequency reductions for older vehicles were smaller than those for newer vehicles, the results were still within the confidence bounds of each other. For both Subaru and Honda vehicles, improved benefits for some coverages were seen as the vehicles aged. Consequently, further research is needed to confirm the effectiveness of these systems over time as the data mature.

Limitations

There are limitations to the data used in this analysis. At the time of a crash, the status of a feature is not known. The features in this study can be deactivated by the driver, and there is no way to know how many, if any, of the drivers in these vehicles had manually turned off the system prior to the crash. However, surveys conducted by the Insurance Institute for Highway Safety indicate that large majorities of drivers with these types of systems leave them on (Reagan, Cicchino, Kerfoot, & Weast, 2018). If a significant number of drivers do turn these features off, any reported reductions may actually be underestimates of the true effectiveness of these systems.

Additionally, the data supplied to HLDI do not include detailed crash information. The specific crash types addressed by the different technologies cannot be isolated in these analyses. All collisions, regardless of the ability of a feature to mitigate or prevent the crash, are included in the analysis.

All of these features are optional and associated with increased costs. The type of person who selects these options may be different from the person who declines. While the analysis controls for several driver characteristics, there may be other uncontrolled attributes associated with people who select these features.

References

Highway Loss Data Institute. (2019a). 2013–15 Honda Accord collision avoidance features. *Loss Bulletin*, *36*(27). Arlington, VA.

Highway Loss Data Institute. (2019b). 2013–18 Subaru collision avoidance features. *Loss Bulletin*, *36*(3). Arlington, VA.

Reagan, I. J., Cicchino, J. B., Kerfoot, L. B., Weast, R. A. (2018). Crash avoidance and driver assistance technologies—are they used? *Transportation Research Part F*, 52, 176–190.

Appendix

Appendix: Illustrative regression results — collision claim frequency for Honda Accord									
Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald 95% confidence limits		Chi-square	P-value
Intercept		1	-8.6279		0.0295	-8.6858	-8.5699	85204.50	0
Vehicle age	-1 to 0	1	0.1103	11.7%	0.0092	0.0921	0.1285	141.06	<0.0001
	1 to 2	1	0.1211	12.9%	0.0077	0.1059	0.1363	244.67	<0.0001
	3 to 4	1	0.0753	7.8%	0.0078	0.0599	0.0906	92.90	<0.0001
	5+	0	0	0	0	0	0		
Vehicle model year and series	2013 Accord 2dr	1	0.1568	17.0%	0.0287	0.1005	0.2131	29.81	<0.0001
	2014 Accord 2dr	1	0.1626	17.7%	0.0294	0.1049	0.2203	30.54	<0.0001
	2015 Accord 2dr	1	0.1559	16.9%	0.0298	0.0973	0.2144	27.23	<0.0001
	2013 Accord 4dr	1	0.0478	4.9%	0.0278	-0.0067	0.1025	2.95	0.0857
	2014 Accord 4dr	1	0.0608	6.3%	0.0278	0.0061	0.1155	4.76	0.0291
	2015 Accord 4dr	1	0.0633	6.5%	0.0279	0.0085	0.1181	5.13	0.0235
	2013 Accord Crosstour 4dr	1	0.0490	5.0%	0.0327	-0.0151	0.1132	2.24	0.1344
	2014 Accord Crosstour 4dr	1	0.0380	3.9%	0.0391	-0.0386	0.1147	0.95	0.3309
	2015 Accord Crosstour 4dr	1	0.0419	4.3%	0.0415	-0.0394	0.1233	1.02	0.3129
	2013 Accord Crosstour 4dr 4WD	1	0.0818	8.5%	0.0340	0.0150	0.1487	5.77	0.0163
	2015 Accord Crosstour 4dr 4WD	1	0.0499	5.1%	0.0400	-0.0285	0.1283	1.56	0.2123
	2014 Accord Crosstour 4dr 4WD	0	0	0	0	0	0		
Rated driver age	14–24	1	0.2696	30.9%	0.0073	0.2551	0.2841	1330.98	<0.0001
	25–29	1	0.1603	17.4%	0.0066	0.1473	0.1733	582.72	<0.0001
	30–39	1	0.0323	3.3%	0.0056	0.0212	0.0434	32.71	<0.0001
	50–59	1	-0.0568	-5.5%	0.0058	-0.0684	-0.0453	93.25	<0.0001
	60–64	1	-0.0977	-9.3%	0.0076	-0.1127	-0.0826	162.31	<0.0001
	65–69	1	-0.0637	-6.2%	0.0080	-0.0794	-0.0480	63.15	<0.0001
	70+	1	0.0408	4.2%	0.0066	0.0278	0.0537	38.12	<0.0001
	Unknown	1	-0.0240	-2.4%	0.0099	-0.0434	-0.0045	5.88	0.0324
	40–49	0	0	0	0	0	0		
Rated driver gender	Male	1	-0.0432	-4.2%	0.0035	-0.0502	-0.0363	149.15	<0.0001
	Unknown	1	-0.2591	-22.8%	0.0140	-0.2866	-0.2316	340.88	<0.0001
	Female	0	0	0	0	0	0		
Rated driver marital status	Single	1	0.1936	21.4%	0.0038	0.1860	0.2012	2485.87	<0.0001
	Unknown	1	0.2544	29.0%	0.0141	0.2267	0.2821	324.33	<0.0001
	Married	0	0	0	0	0	0		
Risk	Nonstandard	1	0.2529	28.8%	0.0076	0.238	0.2679	1095.99	<0.0001
	Standard	0	0	0	0	0	0		
State	Alabama	1	0.0107	1.1%	0.0160	-0.0206	0.0422	0.45	0.5013
	Alaska	1	0.1496	16.1%	0.0935	-0.0335	0.3329	2.56	0.1094
	Arizona	1	0.0879	9.2%	0.0144	0.0596	0.1162	37.16	<0.0001
	Arkansas	1	-0.0128	-1.3%	0.0262	-0.0642	0.0384	0.24	0.6232
	California	1	0.3545	42.5%	0.0069	0.3409	0.3681	2597.22	<0.0001
	Colorado	1	0.0631	6.5%	0.0189	0.0261	0.1002	11.16	0.0008
	Connecticut	1	0.0694	7.2%	0.0153	0.0394	0.0994	20.59	<0.0001
	Delaware	1	0.0742	7.7%	0.0264	0.0224	0.1259	7.89	0.0050

Appendix: Illustrative regression results — collision claim frequency for Honda Accord									
Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald 95% confidence limits		Chi-square	P-value
	District of Columbia	1	0.5912	80.6%	0.0287	0.5348	0.6476	422.20	<0.0001
	Florida	1	-0.1009	-9.6%	0.0085	-0.1177	-0.0841	138.02	<0.0001
	Georgia	1	-0.0080	-0.8%	0.0108	-0.0292	0.0131	0.55	0.4575
	Hawaii	1	0.1731	18.9%	0.0262	0.1216	0.2245	43.53	<0.0001
	Idaho	1	-0.0765	-7.4%	0.0411	-0.1572	0.0040	3.46	0.0628
	Illinois	1	-0.0129	-1.3%	0.0110	-0.0345	0.0087	1.37	0.2415
	Indiana	1	-0.0764	-7.4%	0.0172	-0.1103	-0.0425	19.54	<0.0001
	Iowa	1	-0.1477	-13.7%	0.0314	-0.2093	-0.0861	22.10	<0.0001
	Kansas	1	-0.0768	-7.4%	0.0247	-0.1252	-0.0284	9.67	0.0019
	Kentucky	1	-0.2369	-21.1%	0.0230	-0.2821	-0.1917	105.54	<0.0001
	Louisiana	1	0.2459	27.9%	0.0127	0.2210	0.2709	372.47	<0.0001
	Maine	1	0.1121	11.9%	0.0407	0.0322	0.1919	7.57	0.0059
	Maryland	1	0.2654	30.4%	0.0099	0.2459	0.2850	708.14	<0.0001
	Massachusetts	1	0.7301	107.5%	0.0118	0.7069	0.7533	3801.98	<0.0001
	Michigan	1	0.3693	44.7%	0.0169	0.3361	0.4026	473.28	<0.0001
	Minnesota	1	-0.0929	-8.9%	0.0183	-0.1288	-0.0570	25.79	<0.0001
	Mississippi	1	0.1084	11.4%	0.0206	0.0679	0.1489	27.60	<0.0001
	Missouri	1	-0.0937	-8.9%	0.0181	-0.1293	-0.0582	26.73	<0.0001
	Montana	1	-0.2815	-24.5%	0.0676	-0.4141	-0.1488	17.31	<0.0001
	Nebraska	1	-0.1230	-11.6%	0.0338	-0.1893	-0.0567	13.23	0.0003
	Nevada	1	0.0578	6.0%	0.0216	0.0153	0.1003	7.12	0.0076
	New Hampshire	1	0.2242	25.1%	0.0250	0.1752	0.2733	80.30	<0.0001
	New Jersey	1	0.0291	3.0%	0.0090	0.0114	0.0469	10.41	0.0013
	New Mexico	1	0.0850	8.9%	0.0286	0.0289	0.1412	8.82	0.0030
	New York	1	0.3058	35.8%	0.0078	0.2903	0.3213	1502.73	<0.0001
	North Carolina	1	-0.1794	-16.4%	0.0114	-0.2020	-0.1569	244.35	<0.0001
	North Dakota	1	0.0906	9.5%	0.0553	-0.0177	0.1991	2.68	0.1013
	Ohio	1	-0.1306	-12.2%	0.0111	-0.1525	-0.1088	137.29	<0.0001
	Oklahoma	1	-0.1055	-10.0%	0.0217	-0.1482	-0.0628	23.47	<0.0001
	Oregon	1	-0.0192	-1.9%	0.0211	-0.0606	0.0221	0.83	0.3612
	Pennsylvania	1	0.1913	21.1%	0.0099	0.1719	0.2108	371.61	<0.0001
	Rhode Island	1	0.2288	25.7%	0.0243	0.1811	0.2765	88.45	<0.0001
	South Carolina	1	-0.0686	-6.6%	0.0146	-0.0974	-0.0398	21.80	<0.0001
	South Dakota	1	-0.0154	-1.5%	0.0582	-0.1295	0.0986	0.07	0.7909
	Tennessee	1	0.0014	0.1%	0.0142	-0.0263	0.0293	0.01	0.9180
	Utah	1	-0.1059	-10.0%	0.0257	-0.1564	-0.0554	16.92	<0.0001
	Vermont	1	0.0376	3.8%	0.0514	-0.0632	0.1386	0.54	0.4642
	Virginia	1	0.0729	7.6%	0.0102	0.0527	0.0930	50.36	<0.0001
	Washington	1	0.0216	2.2%	0.0150	-0.0078	0.0512	2.06	0.1508
	West Virginia	1	-0.1786	-16.4%	0.0379	-0.2531	-0.1042	22.13	<0.0001
	Wisconsin	1	-0.0507	-4.9%	0.0192	-0.0884	-0.0130	6.95	0.0084
	Wyoming	1	-0.0756	-7.3%	0.0831	-0.2386	0.0873	0.83	0.3631
	Texas	0	0.1731	18.9%	0.0262	0.1216	0.2245	43.53	<0.0001

Appendix: Illustrative regression results — collision claim frequency for Honda Accord									
Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald 95% confidence limits		Chi-square	P-value
Deductible range	0–250	1	0.1821	20.0%	0.0042	0.1737	0.1904	1831.41	<0.0001
	501–1000	1	-0.6768	-49.2%	0.0273	-0.7305	-0.6231	610.86	<0.0001
	1001+	1	-0.6774	-49.2%	0.0273	-0.7311	-0.6238	612.07	<0.0001
	251–500	0	0	0	0	0	0		
Registered vehicle density	0–99	1	-0.2600	-22.9%	0.0064	-0.2727	-0.2474	1629.83	<0.0001
	100–499	1	-0.1703	-15.7%	0.0041	-0.1785	-0.1622	1678.03	<0.0001
	500+	0	0	0	0	0	0		
Forward collision warning & lane departure warning x vehicle age	-1 to 0	1	-0.0386	-3.8%	0.0163	-0.0706	-0.0065	5.58	0.0182
	1 to 2	1	-0.0282	-2.8%	0.0094	-0.0467	-0.0097	8.97	0.0027
	3 to 4	1	-0.0603	-5.9%	0.0101	-0.0801	-0.0405	35.65	0.0000
	5+	1	-0.0338	-3.3%	0.0174	-0.0681	0.0003	3.76	0.0525
LaneWatch x vehicle age	-1 to 0	1	-0.0382	-3.7%	0.0157	-0.0691	-0.0073	5.90	0.0152
	1 to 2	1	-0.0587	-5.7%	0.0090	-0.0764	-0.0409	42.14	0.0000
	3 to 4	1	-0.0361	-3.5%	0.0097	-0.0552	-0.0171	13.87	0.0002
	5+	1	-0.0389	-3.8%	0.0170	-0.0724	-0.0054	5.20	0.0226

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