



Honda Accord collision avoidance features: initial results

This analysis examines insurance loss results for two Honda Accord collision avoidance systems: Forward Collision Warning (FCW) paired with a Lane Departure Warning (LDW) system and LaneWatch, a passenger side blind spot information system. The combined FCW/LDW system is associated with reductions in claim frequency for all 5 coverage types examined—collision (4 percent), property damage liability (14 percent), bodily injury liability (40 percent), medical payments (27 percent), and personal injury protection (11 percent). Only the reductions in property damage, bodily injury liability and medical payment frequencies were statistically significant, which is consistent with FCW function to prevent front-to-rear collisions. It is also associated with statistically significant reductions in collision claim severity and overall losses, so it does not suffer the same penalty of earlier FCW systems studied by the Highway Loss Data Institute that were enabled by expensive radar units mounted near the front of the car. In contrast, the Accord's combined system uses a camera mounted behind the windshield. LaneWatch also shows reductions in physical damage claim frequencies, but the declines are not significant. There currently are not enough data to produce stable estimates for LaneWatch's effect on injury claim frequencies, but two of the three injury coverages indicate reductions. This represents the first HLDI evaluation of the effectiveness of crash avoidance systems on high-volume non-luxury vehicles.

▶ Introduction

Collision avoidance technologies are becoming popular among U.S. passenger vehicles, and more and more automakers are touting their potential safety benefits. However, the actual benefits in terms of crash reductions still are being measured. This Highway Loss Data Institute (HLDI) bulletin examines the early insurance claims experience for Honda Accord vehicles fitted with two systems.

Forward Collision Warning 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 more than 10 mph and can be deactivated by the driver. At each ignition cycle, the system defaults to the previous on/off setting. Vehicles with Forward Collision Warning also have Lane Departure Warning.

Lane Departure Warning 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 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.

LaneWatch is Honda's term for a passenger-side-only blind spot monitor. A camera mounted behind the external passenger side rearview mirror monitors the passenger side of the vehicle and displays an 80-degree field of view on the console-mounted information screen when the turn signal indicator is activated. Reference lines are also provided to indicate proximity. Both the turn signal indicator and reference lines are driver-controllable settings and can be deactivated. An upcoming navigation system maneuver can also be given priority over the LaneWatch display. LaneWatch can be deactivated by the driver. At each ignition cycle, it will default to the previous on/off setting.

All of the vehicles in this study were equipped with rear cameras. As there are no vehicles without this feature their effectiveness cannot be evaluated in this analysis. The vehicles in this analysis may also have been equipped with optional rear parking sensors. This feature was not controlled for in the analysis as the availability of rear parking sensors on a vehicle was not discernible from the VIN. The Touring trim level of the Accord four-door was excluded from the analysis because it is equipped with a different forward collision warning system that uses a radar system instead of a camera and includes adaptive cruise control functionality. Consequently, despite similar FCW function, these systems should be evaluated separately. However, there is too little exposure to produce reliable estimates of effectiveness at this time. The total collision coverage exposure was only 3,138 years.

► Method

Vehicles

Several trim levels are offered on the 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. LaneWatch and the combination of Forward Collision Warning and Lane Departure Warning are offered as standard equipment on several 2013 Honda Accord models (trims). Honda Accords without these features served as the control vehicles in the analysis. **Table 1** lists total exposure, measured in insured vehicle years, and the exposure of each feature as a percentage of total exposure.

Make	Series	Model year range	Forward Collision Warning (includes Lane Departure Warning)	LaneWatch	Total exposure
Honda	Accord 2dr	2013	69%	83%	15,183
Honda	Accord 4dr	2013	40%	51%	157,309
Honda	Crosstour 4dr	2013	72%	78%	2,408
Honda	Crosstour 4dr 4WD	2013	100%	100%	1,968

Insurance Data

Automobile insurance covers damages to vehicles and property as well as injuries to people involved in 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 property damage liability, collision, bodily injury liability, personal injury protection, and medical payment coverages. Exposure is measured in insured vehicle years. An insured vehicle year is one vehicle insured for 1 year, two vehicles for 6 months, etc.

Because different crash avoidance features may affect different types of insurance coverage, it can be 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 other vehicle; this coverage is common to all 50 states. Property damage liability (PDL) coverage insures against vehicle damage that at-fault drivers cause to other people's vehicle 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).

Coverage of injuries is more complex. Bodily injury (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; although motorists in most states may have BI coverage, this information is analyzed only in states where the at-fault driver has first obligation to pay for injuries (33 states with traditional tort insurance systems). Medical payment (MedPay) coverage, also sold in the 33 states with traditional tort insurance systems, covers injuries to insured drivers and the passengers in their vehicles, but not injuries to people in other vehicles involved in the crash. Seventeen other states employ no-fault injury systems (personal injury protection coverage, or PIP) that pay up to a specified amount for injuries to occupants of involved-insured vehicles, regardless of who is at fault in a collision. The District of Columbia has a hybrid insurance system for injuries and is excluded from the injury analysis.

Statistical methods

Regression analysis was used to quantify the effect of vehicle feature while controlling for other covariates. The covariates included calendar year, model year, garaging state, vehicle density (number of registered vehicles per square mile), rated driver age group, rated driver gender, rated driver marital status, deductible range (collision coverage only), and risk. For each safety feature studied, a variable was included.

Claim frequency was modeled using a Poisson distribution, whereas claim severity (average loss payment per claim) was modeled using a Gamma distribution. Both models used a logarithmic link function. Estimates for overall losses were derived from the claim frequency and claim severity models. Estimates for frequency, severity, and overall losses are presented for collision and property damage liability. For PIP, BI, and MedPay, three frequency estimates are presented. The first frequency is the frequency for all claims, including those that already have been paid and those for which money has been set aside for possible payment in the future, known as claims with reserves. The other two frequencies include only paid claims separated into low and high severity ranges. Note that the percentage of all injury claims that were paid by the date of analysis varies by coverage: 70.6 percent for PIP, 49.3 percent for BI, and 53.7 percent for MedPay. The low severity range was <\$1,000 for PIP and MedPay, <\$5,000 for BI; high severity covered all loss payments greater than that.

A separate regression was performed for each insurance loss measure for a total of 15 regressions (5 coverages x 3 loss measures each). For space reasons, only the estimates for the individual crash avoidance features are shown on the following pages. To illustrate the analyses, however, [Appendix A](#) contains full model results for collision claim frequencies. 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 effect of Forward Collision Warning (including Lane Departure Warning) on PDL claim frequency was -0.15083; thus, vehicles with the feature had 14.0 percent fewer PDL claims than expected ($(\exp(-0.15083)-1)*100=-14.0$).

► Results

Results for Honda Accord's Forward Collision Warning System including Lane Departure Warning are summarized in **Table 2**. The lower and upper bounds represent the 95 percent confidence limits for the estimates. For vehicle damage losses, frequency and severity of claims as well as overall losses are down. The reductions are significant (indicated in blue in the table), with the exception of the decrease in collision claim frequency and property damage liability claim severity.

For the injury related coverage types, all measures of frequency for all coverage types show a reduction. The bodily injury liability and medical payment reductions are significant.

Table 2: Change in insurance losses for Forward Collision Warning and Lane Departure Warning

Vehicle damage coverage type	Lower bound	FREQUENCY	Upper bound	Lower bound	SEVERITY	Upper bound	Lower bound	OVERALL LOSSES	Upper bound
Collision	-9.1%	-3.8%	1.8%	-\$668	-\$409	-\$132	-\$71	-\$45	-\$17
Property damage liability	-21.8%	-14.0%	-5.4%	-\$418	-\$169	\$104	-\$26	-\$17	-\$6

Injury coverage type	Lower bound	FREQUENCY	Upper bound	Lower bound	LOW SEVERITY FREQUENCY	Upper bound	Lower bound	HIGH SEVERITY FREQUENCY	Upper bound
Bodily injury liability	-57.7%	-39.5%	-13.5%	-66.3%	-31.8%	38.1%	-75.5%	-47.3%	13.7%
Medical payments	-45.0%	-27.3%	-4.0%	-65.0%	-21.7%	74.9%	-52.2%	-26.0%	14.4%
Personal injury protection	-27.8%	-10.7%	10.3%	-41.1%	-5.9%	50.4%	-37.5%	-16.3%	12.1%

Results for Honda Accord's LaneWatch System are summarized in **Table 3**. Again, the lower and upper bounds represent the 95 percent confidence limits for the estimates. Reductions in claim frequency are estimated for both first and third-party vehicle damage coverages, yet resulting in somewhat higher claim severity. Loss per insured vehicle year (overall losses) declined under both property damage liability and collision coverage. However, none of the estimated effects for LaneWatch on collision or PDL losses are statistically significant.

Under injury coverages, the frequency of claims is lower for both MedPay and PIP, but not for BI, and none of the differences is statistically significant. Among paid claims, no clear pattern emerges.

Table 3: Change in insurance losses for LaneWatch

Vehicle damage coverage type	Lower bound	FREQUENCY	Upper bound	Lower bound	SEVERITY	Upper bound	Lower bound	OVERALL LOSSES	Upper bound
Collision	-7.8%	-2.5%	3.1%	-\$190	\$99	\$409	-\$30	-\$1	\$31
Property damage liability	-16.0%	-7.8%	1.1%	-\$162	\$102	\$392	-\$14	-\$4	\$8

Injury coverage type	Lower bound	FREQUENCY	Upper bound	Lower bound	LOW SEVERITY FREQUENCY	Upper bound	Lower bound	HIGH SEVERITY FREQUENCY	Upper bound
Bodily injury liability	-22.9%	7.9%	51.0%	-56.4%	-15.7%	63.1%	-41.8%	19.5%	145.4%
Medical payments	-32.0%	-11.1%	16.1%	-58.4%	-10.0%	95.0%	-44.1%	-14.9%	29.4%
Personal injury protection	-31.3%	-15.8%	3.3%	-34.2%	4.2%	65.1%	-33.5%	-11.9%	16.7%

► Discussion

This is the first analysis of the effectiveness of crash avoidance features involving a high-volume non-luxury model. For example, in 2013 the Accord outsold the most popular Volvo model (Volvo S60) 10 to 1. It is also less expensive than midsize cars in the luxury class; \$23,270 for the four-door Accord compared with a range of \$32,645-\$62,495 for midsize luxury cars. As such, results of this analysis may give a better estimate of the potential crash reductions associated with these features than analyses examining only luxury class vehicles.

The results for these two Honda Accord collision avoidance features — Forward Collision Warning (with Lane Departure Warning) and LaneWatch — are encouraging. The combined FCW/LDW systems show a reduction in claim frequencies across all coverages. The pattern of findings for vehicle damage coverages is consistent with the expected benefits; that is, the reduction in claims is greater for property damage liability coverage than for collision coverage. Forward Collision Warning operates in following traffic and is intended to reduce the occurrence and/or severity of front-to-rear collisions. These types of crashes are more common among property damage liability claims than among collision claims, as the latter often include single-vehicle collisions. The forward collision warning system does not have autonomous braking, yet the significant 14 percent reduction in property damage liability claim frequency is at least as large as HLDI's earlier estimates for autobraking systems from Acura and Mercedes-Benz as well as the low-speed autobraking system, City Safety, from Volvo (HLDI, 2012a, 2012b, 2013). All prior forward collision warning systems evaluated by HLDI have been bundled with adaptive cruise control (ACC). The Honda study vehicles are not equipped with ACC. While the effects of ACC could not be isolated in prior analysis, if used by drivers ACC could reduce the likelihood that drivers get into situations that lead to a crash. Given that the Honda forward collision warning system is not bundled with ACC and the favorable loss results for the Honda system, if ACC did contribute to lower claim rates for previously studied systems where FCW and ACC was bundled then it may indicate that the FCW system from Honda is even more effective than previously studied systems.

It is also interesting to note that the current estimates for the effectiveness of this combined FCW/LDW system are greater than the estimates for a Volvo combined FCW/LDW system that included autobraking (HLDI, 2012c). At the time, it was hypothesized that the presence of LDW was decreasing the effectiveness of the Volvo combined system. This was based on estimates of claim frequency increases associated with LDW presence on Buick and Mercedes-Benz vehicles compared with estimates for Acura and Mercedes-Benz FCW with autobrake systems which did not include LDW. In the context of the current results, LDW may not be as deleterious as previously hypothesized. This would be consistent with the significant reduction in property damage liability claim frequency, another effect not observed for the Volvo combined system. Alternately, the forward collision warning system on the Accord is much more effective than those previously studied. It may be the case that these warning systems are more effective for drivers of mainstream cars than drivers of luxury models.

Honda's forward collision warning system is camera-based and unlike the previously evaluated systems from other manufacturers that use a radar-based system, typically mounted in the vulnerable front grille of the vehicle. Analysis of Mercedes-Benz and Volvo forward collision systems showed increases in collision claim severity, likely associated with replacement of the radar units in crashes not avoided (HLDI, 2012a, 2012b). This analysis of Honda Accords showed a significant decrease in collision claim severity, which may be attributed to the better protected interior location of the camera.

Effects of Honda's LaneWatch, a passenger-side blind spot detection system, although not statistically significant, are patterned as expected. Incursion into an occupied adjacent lane would be expected to result in a two-vehicle crash that would lead to a property damage liability claim against the encroaching driver. Although neither estimate is statistically significant, the estimated reduction in property damage liability claims is much larger than the reduction estimated for collision claims. This is consistent with the fact that the reductions in collision claims from such crashes would be diluted by the many single-vehicle crashes that result in collision claims and are unaffected by the LaneWatch system.

As previously mentioned, the collision avoidance systems are tied to the vehicle trim levels. In order to be confident that the measured differences were attributable to the collision avoidance features and not the trim levels, a supplemental analysis was conducted including loss data for model year 2012 Honda Accord vehicles. While the Honda Accord was redesigned in 2013 the trim levels in 2012 and 2013 were comparable. The inclusion of loss data for the 2012 model year, in which no crash avoidance features were present, allowed the supplemental analysis to include the vehicle trim level in addition to the control variables used in the primary analysis. Thus the supplemental analysis assumes that loss differences attributable the different trim levels were the same in both model years. The summary results of the supplemental analysis are included in [Appendix B](#) and the full regression analysis results for collision claim frequencies are shown in [Appendix C](#). The supplemental results for the combination FCW/LDW system are largely the same as in the original analysis with all of the estimated effects within the confidence bounds of the original. Results for the LaneWatch system are mostly similar to the original except that PDL frequency and PDL overall loss estimates did not fall within the confidence bounds of the original. They both estimated increases whereas the original analysis estimated decreases. Due to the similarity of the two analyses and uncertainty about the applicability of 2012 model trim level differences to the redesigned 2013 models, the original analysis is expected to be the better predictor of the effects on losses of these two systems.

► 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 of the drivers in these vehicles turned off a 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. 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 does not include detailed crash information. Information on point of impact and the vehicle's transmission status is not available. The technologies in this report target certain crash types. For example, LaneWatch is designed to prevent sideswipe-type collisions. All collisions, regardless of the ability of a feature to mitigate or prevent the crash, are included in the analysis.

References

Highway Loss Data Institute. 2012a. Mercedes-Benz collision avoidance features: initial results. *Loss Bulletin* Vol. 29, No 7. Arlington, VA.

Highway Loss Data Institute. 2012b. Volvo City Safety loss experience: an update. *Loss Bulletin* Vol. 29, No. 23. Arlington, VA.

Highway Loss Data Institute. 2012c. Volvo collision avoidance features: initial results. *Loss Bulletin* Vol. 29, No. 5. Arlington, VA.

Highway Loss Data Institute. 2013. Acura collision avoidance features: an update. *Loss Bulletin* Vol. 30, No. 15. Arlington, VA.

► Appendix A

Appendix A: Illustrative regression results — collision frequency									
Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald 95% confidence limits		Chi-square	P-value
Intercept		1	-8.9726		0.5086	-9.9694	-7.9758	311.23	<0.0001
Calendar year	2012	1	-0.4699	-37.5%	0.0485	-0.5650	-0.3748	93.85	<0.0001
	2013	0	0	0	0	0	0		
Vehicle model year and series	2013 Accord 2dr	1	0.2560	29.2%	0.0951	0.0695	0.4425	7.24	0.0071
	2013 Accord 4dr	1	0.1087	11.5%	0.0920	-0.0716	0.2890	1.40	0.2375
	2013 Crosstour 4dr 2WD	1	0.0486	5.0%	0.1211	-0.1888	0.2860	0.16	0.6883
	2013 Crosstour 4dr 4WD	0	0	0	0	0	0		
Rated driver age group	14-20	1	0.3899	47.7%	0.0575	0.2771	0.5026	45.92	<0.0001
	21-24	1	0.3289	38.9%	0.0396	0.2512	0.4065	68.91	<0.0001
	25-39	1	0.1733	18.9%	0.0218	0.1306	0.2161	63.12	<0.0001
	65+	1	0.1229	13.1%	0.0245	0.0748	0.1710	25.09	<0.0001
	Unknown	1	0.1444	15.5%	0.0439	0.0584	0.2304	10.83	0.0010
	40-64	0	0	0	0	0	0		
Rated driver gender	Male	1	-0.0202	-2.0%	0.0201	-0.0595	0.0191	1.02	0.3136
	Unknown	1	-0.1513	-14.0%	0.0696	-0.2877	-0.0149	4.72	0.0297
	Female	0	0	0	0	0	0		
Rated driver marital status	Single	1	0.2342	26.4%	0.0219	0.1913	0.2771	114.50	<0.0001
	Unknown	1	0.2122	23.6%	0.0691	0.0768	0.3475	9.44	0.0021
	Married	0	0	0	0	0	0		
Risk	Nonstandard	1	0.1819	19.9%	0.0362	0.1111	0.2528	25.32	<0.0001
	Standard	0	0	0	0	0	0		
State	Alabama	1	-0.1702	-15.7%	0.5065	-1.1630	0.8225	0.11	0.7368
	Arizona	1	-0.0584	-5.7%	0.5049	-1.0480	0.9312	0.01	0.9079
	Arkansas	1	0.0571	5.9%	0.5135	-0.9493	1.0634	0.01	0.9115
	California	1	0.2529	28.8%	0.5007	-0.7285	1.2344	0.26	0.6135
	Colorado	1	-0.0399	-3.9%	0.5093	-1.0381	0.9583	0.01	0.9375
	Connecticut	1	-0.1421	-13.2%	0.5061	-1.1340	0.8499	0.08	0.7789
	Delaware	1	-0.1086	-10.3%	0.5199	-1.1277	0.9105	0.04	0.8346
	District of Columbia	1	0.4169	51.7%	0.5283	-0.6186	1.4523	0.62	0.4301
	Florida	1	-0.2386	-21.2%	0.5015	-1.2214	0.7442	0.23	0.6342
	Georgia	1	-0.1401	-13.1%	0.5029	-1.1258	0.8456	0.08	0.7805
	Hawaii	1	0.3382	40.2%	0.5162	-0.6736	1.3500	0.43	0.5124
	Idaho	1	-0.5532	-42.5%	0.5718	-1.6739	0.5675	0.94	0.3333
	Illinois	1	-0.0307	-3.0%	0.5025	-1.0156	0.9543	0.00	0.9514
	Indiana	1	-0.2169	-19.5%	0.5077	-1.2120	0.7781	0.18	0.6692
	Iowa	1	-0.1347	-12.6%	0.5245	-1.1626	0.8933	0.07	0.7974
	Kansas	1	0.0158	1.6%	0.5149	-0.9933	1.0249	0.00	0.9755
	Kentucky	1	-0.3336	-28.4%	0.5135	-1.3401	0.6729	0.42	0.5159
	Louisiana	1	0.2241	25.1%	0.5033	-0.7623	1.2105	0.20	0.6561
	Maine	1	-0.2200	-19.7%	0.5529	-1.3036	0.8636	0.16	0.6907

Appendix A: Illustrative regression results — collision frequency

Parameter	Degrees of freedom	Estimate	Effect	Standard error	Wald 95% confidence limits		Chi-square	P-value
Maryland	1	0.0668	6.9%	0.5025	-0.9180	1.0516	0.02	0.8943
Massachusetts	1	0.0739	7.7%	0.5073	-0.9205	1.0682	0.02	0.8842
Michigan	1	0.2745	31.6%	0.5062	-0.7176	1.2667	0.29	0.5876
Minnesota	1	-0.1709	-15.7%	0.5097	-1.1699	0.8281	0.11	0.7374
Mississippi	1	-0.0621	-6.0%	0.5104	-1.0625	0.9383	0.01	0.9032
Missouri	1	-0.1909	-17.4%	0.5083	-1.1873	0.8054	0.14	0.7072
Montana	1	-0.8978	-59.3%	0.6712	-2.2133	0.4177	1.79	0.1810
Nebraska	1	-0.1166	-11.0%	0.5288	-1.1531	0.9199	0.05	0.8255
Nevada	1	-0.2760	-24.1%	0.5160	-1.2874	0.7354	0.29	0.5928
New Hampshire	1	-0.1079	-10.2%	0.5177	-1.1226	0.9068	0.04	0.8350
New Jersey	1	-0.0414	-4.1%	0.5016	-1.0244	0.9417	0.01	0.9343
New Mexico	1	-0.0671	-6.5%	0.5229	-1.0918	0.9577	0.02	0.8979
New York	1	0.2583	29.5%	0.5009	-0.7235	1.2401	0.27	0.6061
North Carolina	1	-0.3855	-32.0%	0.5032	-1.3718	0.6008	0.59	0.4437
North Dakota	1	-0.3347	-28.4%	0.6013	-1.5133	0.8439	0.31	0.5778
Ohio	1	-0.1924	-17.5%	0.5026	-1.1775	0.7927	0.15	0.7019
Oklahoma	1	0.0427	4.4%	0.5090	-0.9550	1.0404	0.01	0.9331
Oregon	1	0.1113	11.8%	0.5095	-0.8873	1.1098	0.05	0.8271
Pennsylvania	1	0.0099	1.0%	0.5021	-0.9742	0.9939	0.00	0.9843
Rhode Island	1	0.0155	1.6%	0.5161	-0.9960	1.0270	0.00	0.9761
South Carolina	1	-0.2156	-19.4%	0.5053	-1.2060	0.7749	0.18	0.6697
South Dakota	1	-0.4461	-36.0%	0.6124	-1.6464	0.7542	0.53	0.4663
Tennessee	1	-0.1267	-11.9%	0.5051	-1.1166	0.8632	0.06	0.8020
Texas	1	-0.0318	-3.1%	0.5012	-1.0142	0.9505	0.00	0.9493
Utah	1	-0.1737	-15.9%	0.5206	-1.1941	0.8467	0.11	0.7386
Vermont	1	-0.1491	-13.9%	0.5628	-1.2523	0.9540	0.07	0.7910
Virginia	1	-0.0211	-2.1%	0.5023	-1.0056	0.9634	0.00	0.9665
Washington	1	0.0784	8.2%	0.5051	-0.9115	1.0684	0.02	0.8766
West Virginia	1	-0.4545	-36.5%	0.5359	-1.5048	0.5958	0.72	0.3963
Wisconsin	1	-0.0208	-2.1%	0.5085	-1.0175	0.9759	0.00	0.9674
Wyoming	1	-0.3746	-31.2%	0.6712	-1.6901	0.9408	0.31	0.5767
Alaska	0	0	0	0	0	0		
Deductible range								
0-250	1	0.4765	61.0%	0.0315	0.4148	0.5382	229.20	<0.0001
251-500	1	-0.0776	-7.5%	0.1759	-0.4224	0.2673	0.19	0.6592
1001+	1	0.3064	35.9%	0.0274	0.2528	0.3600	125.43	<0.0001
501-1000	0	0	0	0	0	0		
Registered vehicle density								
0-99	1	-0.2548	-22.5%	0.0339	-0.3213	-0.1883	56.38	<0.0001
100-499	1	-0.1506	-14.0%	0.0219	-0.1936	-0.1076	47.11	<0.0001
500+	0	0	0	0	0	0		
Forward Collision Warning & Lane Departure Warning	1	-0.0388	-3.8%	0.0288	-0.0954	0.0177	1.81	0.1782
LaneWatch	1	-0.0254	-2.5%	0.0285	-0.0812	0.0304	0.80	0.3720

► **Appendix B: Supplemental analysis results for Honda Accord variants with control variables included for model year, vehicle series and trim**

Change in insurance losses for Forward Collision Warning and Lane Departure Warning									
Vehicle damage coverage type	Lower bound	FREQUENCY	Upper bound	Lower bound	SEVERITY	Upper bound	Lower bound	OVERALL LOSSES	Upper bound
Collision	-13.9%	-7.7%	-1.1%	-\$638	-\$335	-\$6	-\$75	-\$48	-\$17
Property damage liability	-26.2%	-17.3%	-7.4%	-\$534	-\$255	\$57	-\$36	-\$25	-\$12

Injury coverage type	Lower bound	FREQUENCY	Upper bound	Lower bound	LOW SEVERITY FREQUENCY	Upper bound	Lower bound	HIGH SEVERITY FREQUENCY	Upper bound
Bodily injury liability	-55.9%	-34.2%	-2.0%	-65.1%	-24.8%	62.0%	-76.8%	-46.5%	23.2%
Medical payments	-43.6%	-21.9%	8.2%	-75.8%	-37.2%	63.2%	-46.5%	-11.9%	45.1%
Personal injury protection	-19.9%	2.7%	31.7%	-39.2%	5.7%	83.7%	-29.5%	-1.0%	38.9%

Change in insurance losses for LaneWatch									
Vehicle damage coverage type	Lower bound	FREQUENCY	Upper bound	Lower bound	SEVERITY	Upper bound	Lower bound	OVERALL LOSSES	Upper bound
Collision	-4.8%	1.8%	8.9%	-\$250	\$76	\$429	-\$21	\$11	\$47
Property damage liability	1.0%	12.6%	25.5%	-\$325	-\$36	\$288	-\$5	\$11	\$30

Injury coverage type	Lower bound	FREQUENCY	Upper bound	Lower bound	LOW SEVERITY FREQUENCY	Upper bound	Lower bound	HIGH SEVERITY FREQUENCY	Upper bound
Bodily injury liability	-24.8%	9.1%	58.2%	-56.0%	-10.5%	82.1%	-48.1%	13.4%	147.7%
Medical payments	-26.5%	0.2%	36.5%	-51.8%	20.0%	198.7%	-41.8%	-6.5%	50.3%
Personal injury protection	-26.6%	-7.2%	17.4%	-33.5%	12.9%	91.6%	-29.0%	-2.1%	34.8%

► **Appendix C**

Appendix C: Illustrative regression results for secondary analysis — collision frequency									
Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald 95% confidence limits	Chi-square	P-value	
Intercept		1	-8.5425		0.2607	-9.0533 -8.0316	1074.06	<0.0001	
Calendar year	2011	1	-0.3089	-26.6%	0.0428	-0.3928 -0.2249	51.98	<0.0001	
	2012	1	-0.0251	-2.5%	0.0112	-0.0470 -0.0033	5.07	0.0243	
	2013	0	0	0	0	0	0		
Model year	2012	1	-0.0642	-6.2%	0.0151	-0.0938 -0.0345	18.01	<0.0001	
	2013	0	0	0	0	0	0		
Vehicle series and trim	Accord 2dr EX	1	0.0953	10.0%	0.0484	0.0003 0.1902	3.87	0.0492	
	Accord 2dr EX-L	1	0.1744	19.1%	0.0397	0.0966 0.2523	19.28	<0.0001	
	Accord 2dr EX-L V6	1	0.0957	10.0%	0.0389	0.0195 0.1719	6.06	0.0138	
	Accord 2dr LX-S	1	0.1690	18.4%	0.0403	0.0900 0.2480	17.57	<0.0001	
	Accord 4dr EX	1	-0.0842	-8.1%	0.0361	-0.1549 -0.0135	5.45	0.0195	
	Accord 4dr EX-L	1	-0.0424	-4.2%	0.0332	-0.1074 0.0226	1.64	0.2010	
	Accord 4dr EX-L V6	1	-0.0716	-6.9%	0.0337	-0.1376 -0.0056	4.52	0.0335	
	Accord 4dr LX	1	-0.0318	-3.1%	0.0318	-0.0941 0.0305	1.00	0.3171	
Accord 4dr Sport	1	-0.0454	-4.4%	0.0322	-0.1085 0.0178	1.98	0.1591		

Appendix C: Illustrative regression results for secondary analysis — collision frequency

Parameter	Degrees of freedom	Estimate	Effect	Standard error	Wald 95% confidence limits	Chi-square	P-value
Accord Crosstour 4dr 2WD EX	1	-0.1086	-10.3%	0.0606	-0.2273 0.0101	3.22	0.0730
Accord Crosstour 4dr 2WD EX-L	1	0.0073	0.7%	0.0597	-0.1097 0.1244	0.02	0.9021
Accord Crosstour 4dr 2WD EX-L V6	1	-0.0138	-1.4%	0.0557	-0.1230 0.0955	0.06	0.8047
Accord Crosstour 4dr 4WD EX-L V6	0	0	0	0	0 0		
Rated driver age group							
14-20	1	0.3847	46.9%	0.0308	0.3243 0.4451	155.79	<0.0001
21-24	1	0.3195	37.6%	0.0219	0.2765 0.3624	212.51	<0.0001
25-39	1	0.1349	14.4%	0.0119	0.1116 0.1583	128.20	<0.0001
65+	1	0.0775	8.1%	0.0139	0.0502 0.1047	31.05	<0.0001
Unknown	1	0.1287	13.7%	0.0244	0.0810 0.1765	27.90	<0.0001
40-64	0	0	0	0	0 0		
Rated driver gender							
Male	1	-0.0347	-3.4%	0.0111	-0.0564 -0.0130	9.80	0.0017
Unknown	1	-0.2493	-22.1%	0.0321	-0.3123 -0.1863	60.18	<0.0001
Female	0	0	0	0	0 0		
Rated driver marital status							
Single	1	0.2076	23.1%	0.0120	0.1839 0.2312	296.80	<0.0001
Unknown	1	0.2927	34.0%	0.0318	0.2304 0.3551	84.75	<0.0001
Married	0	0	0	0	0 0		
Risk							
Nonstandard	1	0.1961	21.7%	0.0160	0.1647 0.2274	150.27	<0.0001
Standard	0	0	0	0	0 0		
State							
Alabama	1	-0.2951	-25.6%	0.2617	-0.8080 0.2178	1.27	0.2594
Arizona	1	-0.2500	-22.1%	0.2612	-0.7619 0.2619	0.92	0.3384
Arkansas	1	-0.0494	-4.8%	0.2655	-0.5698 0.4710	0.03	0.8525
California	1	0.0453	4.6%	0.2587	-0.4616 0.5523	0.03	0.8608
Colorado	1	-0.2247	-20.1%	0.2635	-0.7411 0.2917	0.73	0.3938
Connecticut	1	-0.2455	-21.8%	0.2613	-0.7576 0.2666	0.88	0.3475
Delaware	1	-0.2482	-22.0%	0.2692	-0.7759 0.2795	0.85	0.3567
District of Columbia	1	0.2620	30.0%	0.2734	-0.2740 0.7979	0.92	0.3380
Florida	1	-0.4478	-36.1%	0.2590	-0.9555 0.0599	2.99	0.0838
Georgia	1	-0.3466	-29.3%	0.2599	-0.8560 0.1627	1.78	0.1822
Hawaii	1	0.0148	1.5%	0.2721	-0.5184 0.5481	0.00	0.9566
Idaho	1	-0.6291	-46.7%	0.2990	-1.2151 -0.0430	4.43	0.0354
Illinois	1	-0.2561	-22.6%	0.2597	-0.7651 0.2528	0.97	0.3240
Indiana	1	-0.3606	-30.3%	0.2621	-0.8744 0.1531	1.89	0.1689
Iowa	1	-0.2584	-22.8%	0.2714	-0.7902 0.2735	0.91	0.3411
Kansas	1	-0.4052	-33.3%	0.2696	-0.9336 0.1231	2.26	0.1328
Kentucky	1	-0.4197	-34.3%	0.2649	-0.9389 0.0995	2.51	0.1131
Louisiana	1	-0.0576	-5.6%	0.2605	-0.5682 0.4530	0.05	0.8251
Maine	1	-0.3724	-31.1%	0.2892	-0.9392 0.1944	1.66	0.1979
Maryland	1	-0.1263	-11.9%	0.2598	-0.6354 0.3828	0.24	0.6268
Massachusetts	1	-0.2144	-19.3%	0.2613	-0.7265 0.2976	0.67	0.4118
Michigan	1	0.0946	9.9%	0.2615	-0.4179 0.6071	0.13	0.7175
Minnesota	1	-0.4576	-36.7%	0.2636	-0.9744 0.0591	3.01	0.0826
Mississippi	1	-0.3107	-26.7%	0.2648	-0.8298 0.2084	1.38	0.2407

Appendix C: Illustrative regression results for secondary analysis — collision frequency

Parameter	Degrees of freedom	Estimate	Effect	Standard error	Wald 95% confidence limits		Chi-square	P-value
Missouri	1	-0.3751	-31.3%	0.2629	-0.8905	0.1402	2.04	0.1536
Montana	1	-0.3047	-26.3%	0.3030	-0.8986	0.2892	1.01	0.3147
Nebraska	1	-0.5450	-42.0%	0.2774	-1.0887	-0.0013	3.86	0.0495
Nevada	1	-0.3703	-30.9%	0.2673	-0.8943	0.1537	1.92	0.1660
New Hampshire	1	-0.0001	0.0%	0.2651	-0.5197	0.5195	0.00	0.9997
New Jersey	1	-0.2362	-21.0%	0.2591	-0.7439	0.2715	0.83	0.3619
New Mexico	1	-0.3387	-28.7%	0.2739	-0.8756	0.1982	1.53	0.2164
New York	1	-0.0315	-3.1%	0.2587	-0.5386	0.4757	0.01	0.9032
North Carolina	1	-0.5197	-40.5%	0.2600	-1.0292	-0.0102	4.00	0.0456
North Dakota	1	-0.4686	-37.4%	0.3132	-1.0824	0.1452	2.24	0.1346
Ohio	1	-0.4561	-36.6%	0.2597	-0.9651	0.0528	3.09	0.0790
Oklahoma	1	-0.2825	-24.6%	0.2646	-0.8011	0.2360	1.14	0.2855
Oregon	1	-0.2437	-21.6%	0.2655	-0.7641	0.2767	0.84	0.3586
Pennsylvania	1	-0.1477	-13.7%	0.2593	-0.6560	0.3605	0.32	0.5689
Rhode Island	1	-0.0613	-5.9%	0.2657	-0.5822	0.4595	0.05	0.8174
South Carolina	1	-0.4584	-36.8%	0.2615	-0.9710	0.0542	3.07	0.0797
South Dakota	1	-0.4737	-37.7%	0.3100	-1.0813	0.1339	2.33	0.1265
Tennessee	1	-0.3558	-29.9%	0.2611	-0.8675	0.1559	1.86	0.1730
Texas	1	-0.2716	-23.8%	0.2589	-0.7792	0.2359	1.10	0.2941
Utah	1	-0.3516	-29.6%	0.2709	-0.8826	0.1794	1.68	0.1943
Vermont	1	-0.2408	-21.4%	0.2919	-0.8129	0.3313	0.68	0.4094
Virginia	1	-0.2353	-21.0%	0.2597	-0.7442	0.2736	0.82	0.3648
Washington	1	-0.1991	-18.1%	0.2618	-0.7123	0.3141	0.58	0.4470
West Virginia	1	-0.3866	-32.1%	0.2748	-0.9253	0.1520	1.98	0.1595
Wisconsin	1	-0.3599	-30.2%	0.2632	-0.8758	0.1560	1.87	0.1715
Wyoming	1	-0.3631	-30.4%	0.3418	-1.0331	0.3068	1.13	0.2880
Alaska	0	0	0	0	0	0		
Deductible range								
0-250	1	0.4662	59.4%	0.0169	0.4330	0.4994	756.72	<0.0001
1001+	1	-0.3305	-28.1%	0.1140	-0.5539	-0.1070	8.40	0.0037
251-500	1	0.2462	27.9%	0.0146	0.2176	0.2748	284.42	<0.0001
501-1000	0	0	0	0	0	0		
Registered vehicle density								
0-99	1	-0.2511	-22.2%	0.0192	-0.2887	-0.2135	170.98	<0.0001
100-499	1	-0.1751	-16.1%	0.0122	-0.1990	-0.1511	205.00	<0.0001
500+	0	0	0	0	0	0		
Forward Collision Warning & Lane Departure Warning	1	-0.0804	-7.7%	0.0355	-0.1501	-0.0108	5.13	0.0236
LaneWatch	1	0.0178	1.8%	0.0345	-0.0497	0.0854	0.27	0.6046

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