HLDI
Highway Loss Data Institute

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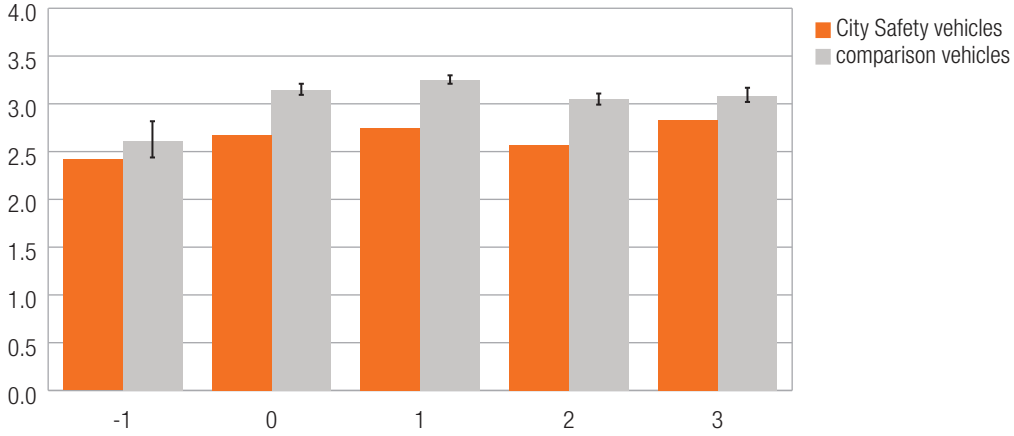
Volvo City Safety loss experience by vehicle age

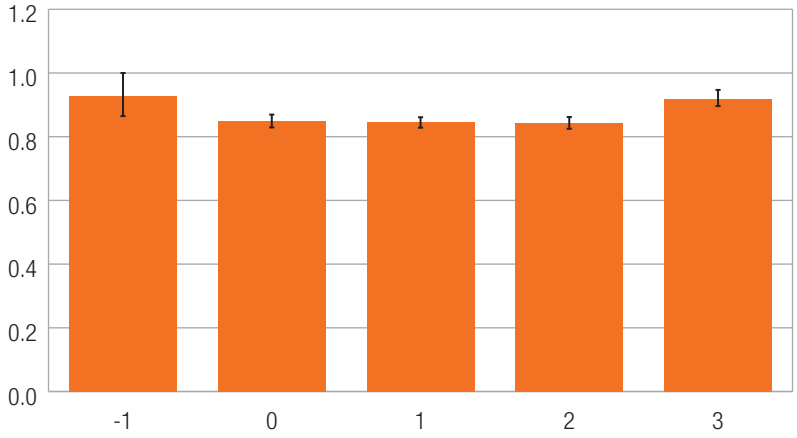
Summary

City Safety technology was first introduced by Volvo to the U.S. market with the 2010 XC60 as standard equipment. The Highway Loss Data Institute (HLDI) published bulletins in 2011 and 2012 presenting the relationship of this technology and insurance losses. The results showed that the City Safety system was associated with reductions in insurance losses. The purpose of this report is to see if the benefits of City Safety persist over time. To examine this, claim frequencies for City Safety-equipped vehicles and comparison vehicles were evaluated by vehicle age. There is some variability in the results by vehicle age but there is not an indication that there is a pattern of diminished benefits as the vehicles age.

PDL claim frequencies for City Safety-equipped vehicles and comparison vehicles by vehicle age



Ratio of PDL claim frequencies for City Safety-equipped vehicles to comparison vehicles by vehicle age



Introduction

This Highway Loss Data Institute (HLDI) bulletin provides a look at the impact of vehicle age on the insurance loss benefits of Volvo City Safety technology previously presented by HLDI. For this bulletin, the loss experience for Volvo XC60s and S60s equipped with City Safety were compared with losses for comparable vehicles without the system by vehicle age.

City Safety is a low-speed collision avoidance system first released as standard equipment on the 2010 Volvo XC60, a midsize luxury SUV, and on the 2011 S60, a midsize luxury car. The system was developed by Volvo to reduce low-speed front-to-rear crashes, which commonly occur in urban traffic, by assisting the driver in braking. According to a Volvo news release, 75 percent of all crashes occur at speeds up to 19 mph, and half of these occur in city traffic (Volvo, 2008). The City Safety system has an infrared laser sensor built into the windshield that detects other vehicles traveling in the same direction up to 18 feet in front of the vehicle. The system initially reacts to slowing or stopped vehicles by pre-charging the brakes. The vehicle will brake automatically if forward collision risk is detected and the driver does not react in time, but only at travel speeds up to 19 mph. If the relative speed difference is less than 9 mph, a collision can be avoided entirely. If the speed difference is between 9 and 19 mph, the speed will be reduced to lessen the collision severity. The City Safety system studied in this analysis operates at speeds up to 19 mph but a newer version of the system operates at speeds up to 31 mph. City Safety is automatically activated when the vehicle ignition is turned on but can be manually deactivated by the driver.

When examining the effect of City Safety on insurance losses, it is important to consider that the system is not designed to mitigate all types of crashes and that many factors can limit the system's ability to perform its intended function. City Safety works equally well during the day and at night, but fog, heavy rain, or snow may limit the ability of the system's infrared laser to detect vehicles. The driver is advised if the sensor becomes blocked by dirt, ice, or snow.

Method

Vehicles

In the initial analysis, loss results for the XC60 were compared with other midsize luxury SUVs, while loss results for the S60 were compared with other midsize luxury cars. For the results presented here, the XC60 and S60 were pooled, as were the comparison vehicles.

Sales of the 2010 Volvo XC60 began in February 2009, when other brands still were marketing 2009 models. Consequently, the control populations for the XC60 analyses included vehicles starting in model year 2009. The total study population for the XC60 was model years 2010–12 during calendar years 2009–14 with control vehicle model years of 2009–14. The loss experience of the model year 2009 vehicles in calendar year 2008 was excluded because no XC60s were on the road during this time period.

City Safety was added as standard equipment to the Volvo S60 in model year 2011. The analyses considered model years 2011–12 for the S60 and its control vehicles during calendar years 2010–14. Calendar year 2010 was not included in the S60 analysis because of the very small number of model year 2011 S60s insured that year.

Total exposure measured as insured vehicle years and the total number of claims for the XC60 and S60 are shown by insurance coverage type in **Table 1**. Because previous HLDI analyses have shown them to have different loss patterns, hybrids, convertibles, and two-door vehicles were excluded from the control groups.

Table 1: Exposure and claims by coverage type

	XC60		S60	
Coverage	Claims	Exposure	Claims	Exposure
Property damage liability	3,360	120,800	1,890	76,870
Bodily injury liability	298	50,524	159	26,930
Collision	6,880	120,800	5,597	76,870
Medical payment	270	38,005	166	20,925
Personal injury protection	491	57,144	416	37,565

The study and control vehicles in this analysis can also be equipped with optional collision avoidance features that have been shown to affect claim frequency in other studies by HLDI. It should be noted that this analysis does not account for their presence or absence because the information needed to identify the vehicles with the optional features is not available. Furthermore, the take rate for these features is thought to be low.

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. Data are supplied to HLDI by its member companies.

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 model claim frequency per insured vehicle year while controlling for various covariates. Claim frequency was modeled using a Poisson distribution. This model used a logarithmic link function.

The covariates included calendar year, model year, garaging state, vehicle density (number of registered vehicles per square mile), rated driver age, rated driver gender, marital status, collision deductible, and risk. A separate regression was performed for each vehicle age, study vehicle (XC60 and S60), and coverage type for a total of 50 models. To illustrate the analysis, the **Appendix** contains full model results for collision claim frequency for the XC60 at vehicle age 0.

Vehicle age in this study is defined as vehicles aged -1 to 3. For example, a 2012 model year vehicle in calendar year 2012 would have a vehicle age of 0, while a 2013 vehicle in the same calendar year would be aged -1. The results of this study are presented as ratios of claim frequency of City Safety-equipped vehicles to claim frequency of comparison vehicles. If the ratio is 1, there is no difference between the two types of vehicles being compared. If the ratio is less than 1, it means there are fewer claims made on vehicles with City Safety technology than those without.

The estimated effects of City Safety by age were calculated separately for the XC60 and S60, along with their respective standard errors. A combined, or pooled estimate was calculated as a weighted average of the two estimates, with weights proportional to the inverse variance (i.e. weight =1/SE2). Thus, if an estimate for the XC60 had a smaller standard error (tighter confidence interval) compared to that of the S60 estimate, it would have more influence on the combined estimate. The combined standard error for the weighted average was calculated based on the same assumptions.

Results

Results for this study are broken down by coverage type. **Figure 1** shows the PDL claim frequencies for City Safety-equipped vehicles and comparison vehicles by vehicle age. **Figure 2** shows the ratio of PDL claim frequencies for City Safety-equipped vehicles to comparison vehicles by vehicle age. At each vehicle age, the PDL claim frequency is significantly lower for City Safety-equipped vehicles than for comparison vehicles. Estimated effects range from 7 to 16 percent benefits for the City Safety-equipped vehicles. Vehicles from ages -1 to 3 indicate an increased benefit while age 3 is slightly less benefical than ages 0-2.

Figure 1: PDL claim frequencies for City Safety-equipped vehicles and comparison vehicles by vehicle age

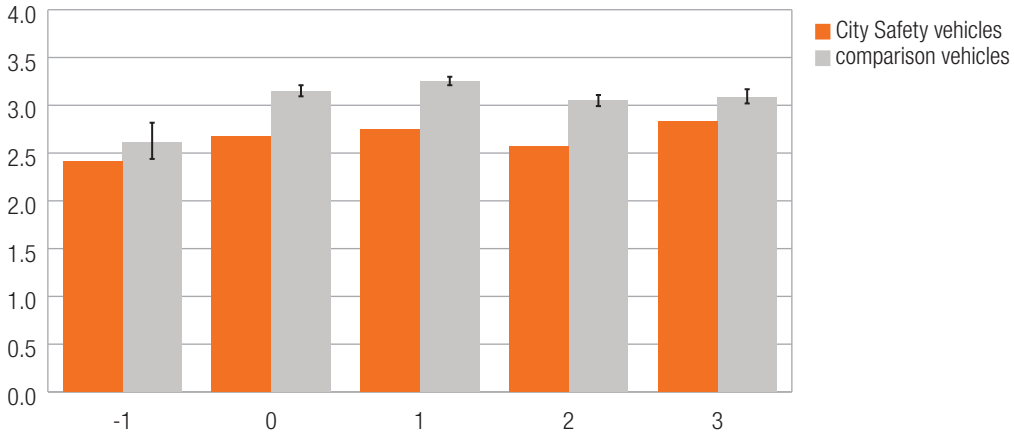


Figure 2: Ratio of PDL claim frequencies for City Safety-equipped vehicles to comparison vehicles by vehicle age

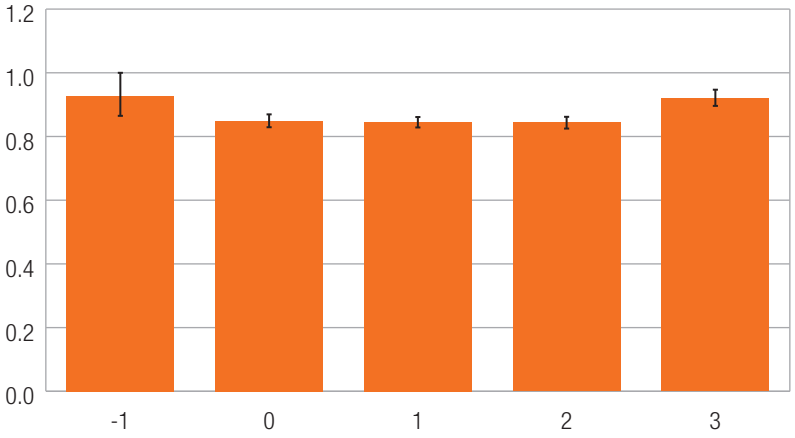
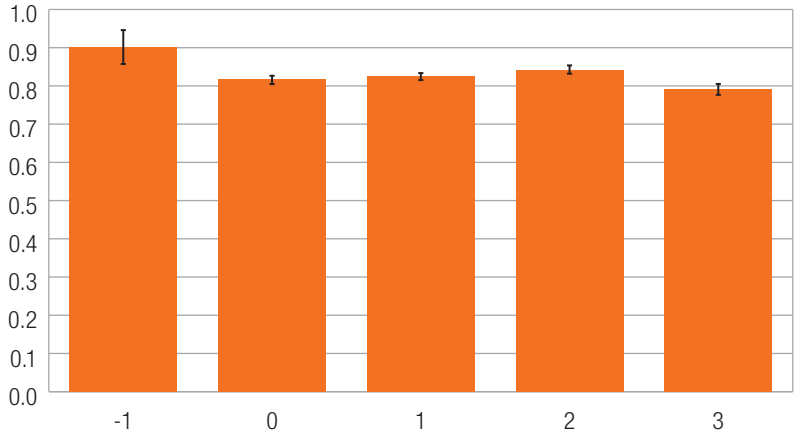


Figure 3 shows the collision claim frequency ratios of City Safety-equipped vehicles to comparison vehicles by vehicle age, and all ratios are below 1. For the newest vehicles, collision claim frequencies are about 10 percent lower for City Safety-equipped vehicles. For older vehicles (ages 0–3), the collision claim frequency ratios are similar to each other, at around 0.8.

Figure 3: Ratio of collision claim frequencies for City Safety-equipped vehicles to comparison vehicles by vehicle age



Figures 4–6 show the BI, PIP, and MedPay claim frequency ratios of City Safety-equipped vehicles to their comparison vehicles by vehicle age, respectively. All ratios are below 1, indicating that there are fewer injury claims made for City Safety-equipped vehicles than comparison vehicles at every vehicle age, and there does not appear to be a relationship between vehicle age and injury claims. In general, there are fewer injury claims in the HLDI database compared with collision and PDL claims, creating larger confidence intervals.

Figure 4: Ratio of bodily injury liability claim frequencies for City Safety-equipped vehicles to comparison vehicles by vehicle age

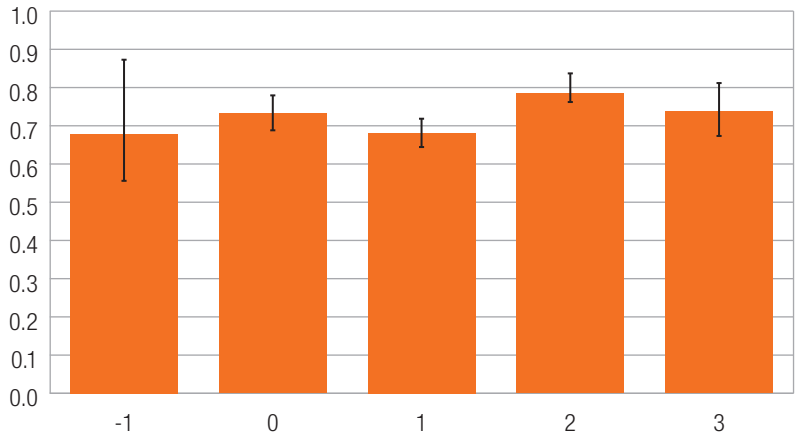


Figure 5: Ratio of personal injury protection claim frequencies for City Safety-equipped vehicles to comparison vehicles by vehicle age

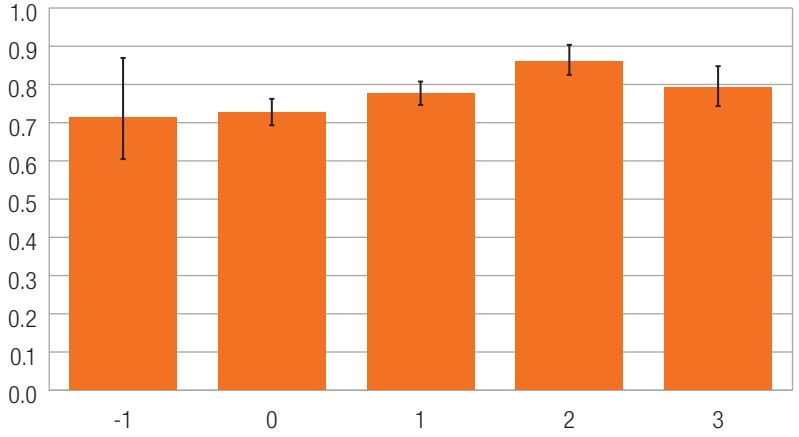
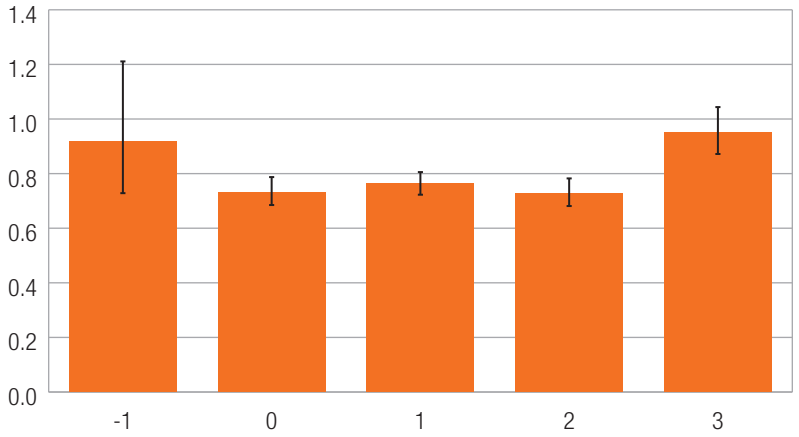


Figure 6: Ratio of MedPay claim frequencies for City Safety-equipped vehicles to comparison vehicles by vehicle age



Discussion

This is the first opportunity for HLDI to evaluate if the benefits of crash avoidance systems degrade over time. This is because collision avoidance systems are relatively new technologies to the vehicle fleet. For example, for the 2013 model year, front crash prevention was available on about 30 percent of vehicle series and will not reach 95 percent of the vehicle fleet until 2048 (HLDI, 2014).

The results presented here for the Volvo City Safety system are promising as there does not appear to be a clear change in the benefits of the system by vehicle age. This suggests no significant degradation of the City Safety system during the 3–5 years it has been available. Because the City Safety system uses the vehicle's brakes to prevent crashes, tire wear or brake aging could affect the City Safety system. As these vehicles age, these possibilities do not appear to be negatively impacting the success of the system.

Limitations

All of the XC60s and S60s included in the current study were equipped with the City Safety technology, but there was no way to know whether any drivers in the crash-involved vehicles had manually turned off the system prior to the crash. Also, most of the vehicles in this study, including the XC60 and S60, can be equipped with a variety of collision avoidance features that might also affect claim frequencies, and it was not possible, based on data available to HLDI at the time of the study, to control for the presence of these other features. The study and control vehicles may have other collision avoidance features that could be influencing the results. To fully understand the benefits of City Safety, subsequent analysis will be required as additional loss data become available involving more and potentially different drivers. This analysis controlled for a variety of possible demographic differences (rated driver age, gender, marital status, and risk) between the study and control populations. It still is possible that rated drivers who chose to purchase vehicles with City Safety differ in other ways that could affect crash likelihood — perhaps drivers who are more concerned about safety or who drive more cautiously because they have experienced prior collisions.

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Appendix

Appendix: Illustrative regression results - collision frequency for Volvo XC60 age 0

Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald 95% confidence limits		Chi-square	P-value
Intercept		1	-8.8162		0.0320	-8.8788	-8.7535	76103.60	<0.0001
Calendar year	2009	1	-0.1242	-11.7%	0.0150	-0.1536	-0.0949	69.02	<0.0001
	2010	1	0.0284	2.9%	0.0117	0.0055	0.0513	5.91	0.0151
	2011	1	0.0140	1.4%	0.0116	-0.0088	0.0368	1.45	0.2292
	2012	0	0	0	0	0	0		
Vehicle make and series	Acura MDX 4dr	1	0.0223	2.3%	0.0297	-0.0360	0.0806	0.56	0.4530
	Acura RDX 4dr	1	0.0052	0.5%	0.0359	-0.0651	0.0755	0.02	0.8839
	Acura ZDX 4dr	1	0.5933	81.0%	0.0834	0.4299	0.7567	50.66	<0.0001
	Audi Q5 QUATTRO 4dr	1	0.3403	40.5%	0.0304	0.2806	0.3999	125.05	<0.0001
	BMW X3 4dr	1	0.1507	16.3%	0.0366	0.0790	0.2223	16.99	<0.0001
	BMW X5 4dr	1	0.3140	36.9%	0.0295	0.2563	0.3717	113.64	<0.0001
	BMW X6 4dr	1	0.6046	83.1%	0.0433	0.5196	0.6896	194.55	<0.0001
	Cadillac SRX 4dr	1	0.3038	35.5%	0.0288	0.2473	0.3603	**111.20**	**<0.0001**
	Infiniti EX35 4dr	1	0.1221	13.0%	0.0485	0.0271	0.2172	6.34	0.0118
	Infiniti FX35 4dr	1	0.2500	28.4%	0.0391	0.1734	0.3267	40.87	<0.0001
	Infiniti FX50 4dr	1	0.3170	37.3%	0.1178	0.0861	0.5479	7.24	0.0071
	Land Rover LR2 4dr	1	0.2462	27.9%	0.0754	0.0985	0.3939	10.67	0.0011
	Lexus RX 350 4dr	1	0.3807	46.3%	0.0270	0.3278	0.4337	198.48	<0.0001
	Lincoln MKT 4dr	1	0.3242	38.3%	0.0526	0.2212	0.4273	38.06	<0.0001
	Lincoln MKX 4dr	1	0.1107	11.7%	0.0343	0.0436	0.1778	10.45	0.0012
	Mercedes-Benz GLK Class 4dr	1	0.2635	30.1%	0.0309	0.2029	0.3241	72.63	<0.0001
	Mercedes-Benz M Class 4dr	1	0.2236	25.1%	0.0297	0.1655	0.2818	56.79	<0.0001
	Saab 9-4X 4dr	1	-0.3371	-28.6%	0.7061	-1.7211	1.0470	0.23	0.6331
	Saab 9-7X 4dr	1	0.0827	8.6%	0.1310	-0.1741	0.3395	0.40	0.5278
	Volvo XC90 4dr	1	0.0677	7.0%	0.0391	-0.0089	0.1443	3.00	0.0832
	Volvo XC60 4dr	0	0	0	0	0	0		
State	Alabama	1	0.1554	16.8%	0.0487	0.0600	0.2507	10.19	0.0014
	Arizona	1	0.1091	11.5%	0.0398	0.0311	0.1870	7.51	0.0061

Appendix: Illustrative regression results - collision frequency for Volvo XC60 age 0									
Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald 95% confidence limits		Chi-square	P-value
	Arkansas	1	0.1775	19.4%	0.0729	0.0346	0.3204	5.93	0.0149
	California	1	0.2678	30.7%	0.0191	0.2303	0.3053	196.05	<0.0001
	Colorado	1	0.0776	8.1%	0.0379	0.0033	0.1519	4.19	0.0407
	Connecticut	1	0.1021	10.7%	0.0345	0.0346	0.1697	8.78	0.0030
	Delaware	1	0.0294	3.0%	0.0802	-0.1279	0.1867	0.13	0.7141
	District of Columbia	1	0.3739	45.3%	0.0682	0.2402	0.5076	30.02	<0.0001
	Florida	1	-0.1252	-11.8%	0.0212	-0.1667	-0.0837	**35.01**	**<0.0001**
	Georgia	1	-0.0854	-8.2%	0.0330	-0.1501	-0.0206	6.67	0.0098
	Hawaii	1	0.1084	11.4%	0.0673	-0.0235	0.2402	2.59	0.1072
	Idaho	1	-0.1488	-13.8%	0.1442	-0.4313	0.1338	1.06	0.3021
	Illinois	1	0.0869	9.1%	0.0242	0.0396	0.1343	12.95	0.0003
	Indiana	1	0.1296	13.8%	0.0508	0.0301	0.2290	6.52	0.0107
	Iowa	1	0.0425	4.3%	0.0802	-0.1147	0.1997	0.28	0.5962
	Kansas	1	0.0611	6.3%	0.0600	-0.0564	0.1786	1.04	0.3084
	Kentucky	1	-0.0438	-4.3%	0.0617	-0.1647	0.0772	0.50	0.4783
	Louisiana	1	0.1609	17.5%	0.0422	0.0783	0.2436	14.57	0.0001
	Maine	1	0.1782	19.5%	0.1314	-0.0793	0.4357	1.84	0.1749
	Maryland	1	0.0737	7.6%	0.0305	0.0138	0.1335	5.83	0.0158
	Massachusetts	1	0.2296	25.8%	0.0417	0.1479	0.3113	30.30	<0.0001
	Michigan	1	0.4318	54.0%	0.0309	0.3712	0.4923	195.37	<0.0001
	Minnesota	1	-0.0423	-4.1%	0.0473	-0.1351	0.0504	0.80	0.3712
	Mississippi	1	-0.0733	-7.1%	0.0827	-0.2355	0.0889	0.79	0.3756
	Missouri	1	0.0113	1.1%	0.0473	-0.0813	0.1040	0.06	0.8105
	Montana	1	-0.4565	-36.7%	0.2254	-0.8982	-0.0147	4.10	0.0428
	Nebraska	1	-0.1700	-15.6%	0.0867	-0.3400	-0.0001	3.85	0.0499
	Nevada	1	0.0895	9.4%	0.0559	-0.0200	0.1990	2.57	0.1090
	New Hampshire	1	0.2652	30.4%	0.0714	0.1253	0.4051	13.80	0.0002
	New Jersey	1	0.0963	10.1%	0.0223	0.0526	0.1400	18.68	<0.0001
	New Mexico	1	-0.0533	-5.2%	0.0839	-0.2178	0.1112	0.40	0.5255
	New York	1	0.1488	16.0%	0.0194	0.1107	0.1869	58.65	<0.0001
	North Carolina	1	-0.2851	-24.8%	0.0397	-0.3629	-0.2073	51.63	<0.0001
	North Dakota	1	0.2208	24.7%	0.1976	-0.1665	0.6080	1.25	0.2638
	Ohio	1	-0.0596	-5.8%	0.0330	-0.1242	0.0050	3.27	0.0704
	Oklahoma	1	0.0382	3.9%	0.0554	-0.0703	0.1467	0.48	0.4903
	Oregon	1	0.0451	4.6%	0.0564	-0.0655	0.1557	0.64	0.4244
	Pennsylvania	1	0.2225	24.9%	0.0240	0.1754	0.2696	85.68	<0.0001
	Rhode Island	1	0.2203	24.6%	0.0718	0.0796	0.3610	9.42	0.0021
	South Carolina	1	-0.1366	-12.8%	0.0534	-0.2412	-0.0320	6.55	0.0105
	South Dakota	1	0.2593	29.6%	0.1639	-0.0620	0.5805	2.50	0.1137
	Tennessee	1	0.1367	14.6%	0.0420	0.0543	0.2190	10.57	0.0011
	Utah	1	0.0509	5.2%	0.0749	-0.0958	0.1977	0.46	0.4964
	Vermont	1	0.2176	24.3%	0.1351	-0.0472	0.4823	2.59	0.1073
	Virginia	1	0.1440	15.5%	0.0272	0.0907	0.1974	27.99	<0.0001
	Washington	1	0.1634	17.8%	0.0371	0.0908	0.2361	19.44	<0.0001

Appendix: Illustrative regression results - collision frequency for Volvo XC60 age 0									
Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald 95% confidence limits		Chi-square	P-value
	West Virginia	1	0.0933	9.8%	0.0909	-0.0849	0.2715	1.05	0.3049
	Wisconsin	1	0.0866	9.0%	0.0518	-0.0149	0.1880	2.80	0.0944
	Wyoming	1	0.1283	13.7%	0.1771	-0.2188	0.4754	0.52	0.4688
	Alaska	1	0.2433	27.5%	0.1136	0.0207	0.4658	4.59	0.0322
	Texas	0	0	0	0	0	0		
Registered vehicle density	Unknown	1	-0.5253	-40.9%	0.4085	-1.3260	0.2753	1.65	0.1984
	<50	1	-0.2783	-24.3%	0.0313	-0.3396	-0.2169	79.03	<0.0001
	50–99	1	-0.2390	-21.3%	0.0247	-0.2874	-0.1906	93.65	<0.0001
	100–249	1	-0.2363	-21.0%	0.0178	-0.2711	-0.2014	176.64	<0.0001
	250–499	1	-0.1984	-18.0%	0.0161	-0.2300	-0.1669	152.04	<0.0001
	500–999	1	-0.0987	-9.4%	0.0129	-0.1241	-0.0734	58.29	<0.0001
	1,000+	0	0	0	0	0	0		
Deductible range	0 to 100	1	-0.0625	-6.1%	0.0190	-0.0997	-0.0253	10.83	0.0010
	101 to 250	1	0.2716	31.2%	0.0128	0.2465	0.2968	447.94	<0.0001
	501+	1	-0.3174	-27.2%	0.0122	-0.3412	-0.2936	682.52	<0.0001
	251 to 500	0	0	0	0	0	0		
Rated driver age group	15–19	1	0.0922	9.7%	0.0433	0.0073	0.1771	4.53	0.0333
	20–24	1	0.1255	13.4%	0.0314	0.0639	0.1870	15.95	<0.0001
	25–29	1	0.1150	12.2%	0.0233	0.0694	0.1606	24.42	<0.0001
	30–39	1	0.0684	7.1%	0.0138	0.0415	0.0954	24.72	<0.0001
	50–59	1	-0.1121	-10.6%	0.0136	-0.1388	-0.0854	67.80	<0.0001
	60–64	1	-0.0778	-7.5%	0.0172	-0.1116	-0.0440	20.40	<0.0001
	65–69	1	0.0152	1.5%	0.0186	-0.0213	0.0517	0.67	0.4135
	70–74	1	0.0769	8.0%	0.0225	0.0328	0.1210	11.67	0.0006
	75+	1	0.2087	23.2%	0.0229	0.1638	0.2535	83.18	<0.0001
	Unknown	1	-0.0438	-4.3%	0.0236	-0.0901	0.0025	3.44	0.0636
	40–49	0	0	0	0	0	0		
Rated driver gender	Male	1	-0.0542	-5.3%	0.0107	-0.0752	-0.0332	25.51	<0.0001
	Unknown	1	-0.1042	-9.9%	0.0274	-0.1579	-0.0504	14.44	0.0001
	Female	0	0	0	0	0	0		
Rated driver marital status	Single	1	0.1903	21.0%	0.0126	0.1657	0.215	229.92	<0.0001
	Unknown	1	0.1545	16.7%	0.0268	0.102	0.2071	33.20	<0.0001
	Married	0	0	0	0	0	0		
Risk	Nonstandard	1	0.1705	18.6%	0.0143	0.1426	0.1985	142.80	<0.0001
	Standard	0	0	0	0	0	0		

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