HLDI
Highway Loss Data Institute

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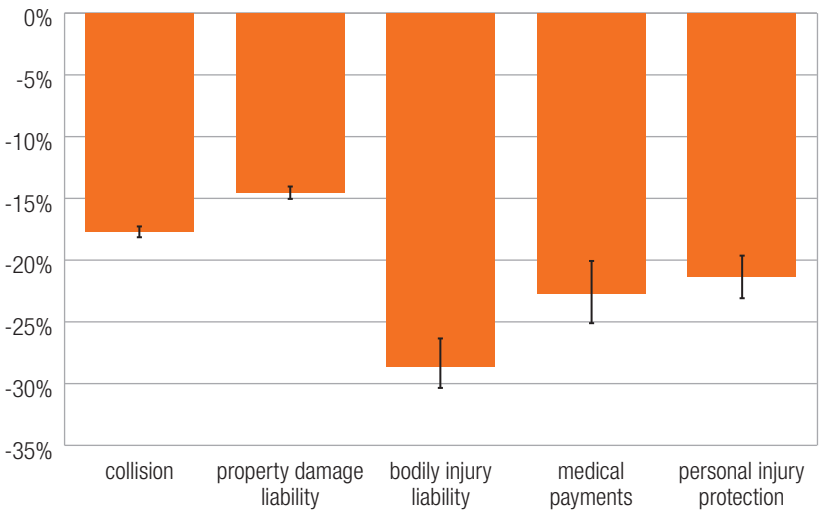
# Volvo City Safety loss experience – a long-term update

This Highway Loss Data Institute (HLDI) report updates two prior bulletins on the Volvo City Safety system. Benefits have been consistent across all three reports, and for the first time pooled estimates have been calculated that combine the XC60 and S60 results. This combined, or pooled, estimate is the best estimate of a general effect for City Safety. The earlier HLDI studies reported that Volvo XC60 and S60 models with City Safety, a low-speed collision avoidance technology, had lower loss frequencies for property damage liability, bodily injury liability, and collision coverages than similar models without such a system. In the latest study, updated results for the XC60 and S60 confirm that City Safety is reducing losses substantially. Property damage liability loss frequency was estimated to be 14 percent lower for the XC60 than for relevant control vehicles and 15 percent lower for the S60. Collision claim frequencies were reduced by an estimated 21 percent for the XC60 and 12 percent for the S60. Both vehicles also showed reductions in collision claim severity and overall losses for collision and property damage liability. Under bodily injury liability, claim frequency was 28 percent lower for the XC60 and 31 percent lower for the S60.

This report also examines the effect City Safety is having on personal injury protection (PIP) and medical payment (MedPay) coverages. Under PIP, claim frequency was 21 percent lower for the XC60 and 23 percent lower for the S60. Under MedPay, claim frequency was 19 percent lower for the XC60 and 30 percent lower for the S60.

**Pooled claim frequency for XC60 and S60 relative to comparison vehicles**



## Introduction

This Highway Loss Data Institute (HLDI) bulletin provides the third look at the effects of Volvo's City Safety technology on insurance losses for the XC60 and an updated look at the results for the S60. Prior HLDI results found that Volvo's City Safety system on the XC60 and S60 appeared to be preventing crashes (Vol. 28, No. 6 and Vol. 29, No. 23). For this bulletin, the loss experiences for Volvo XC60 and S60 models equipped with City Safety were compared with losses for comparable vehicles without the system. Updated losses under property damage liability, bodily injury liability, and collision coverages were examined and, for the first time, personal injury protection and medical payment. A supplementary analysis using Volvo vehicles as the comparison group was also conducted and served to verify City Safety's effect.

City Safety, a low-speed collision avoidance system, was 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. 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.

## Methods

### Insurance data

Automobile insurance covers damage 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, bodily injury liability, collision, personal injury protection, and medical payment coverages. Data are supplied to HLDI by its member companies.

Property damage liability coverage insures against physical damage that at-fault drivers cause to other people's vehicles and property in crashes. Bodily injury 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. In the current study, bodily injury liability losses were restricted to data from traditional tort states. Collision coverage insures against physical damage to an at-fault driver's vehicle sustained in a crash with an object or other vehicle. Personal injury protection insures against injuries sustained in crashes to insured drivers and other people in their vehicles, regardless of who is at fault in the collision. Medical payment is sold in states with traditional tort liability laws and insures against injuries sustained by occupants of the insured vehicle in crashes for which they are responsible.

## Subject vehicles

In the main analyses, loss results for the XC60 with City Safety were compared with other midsize luxury SUVs, while loss results for the S60 with City Safety were compared with other midsize luxury cars. A supplemental analysis was conducted to address the possibility that differences between the S60, XC60 and their respective comparison groups were due to the drivers of Volvo models being different from the drivers of the comparison models. Volvo cars have a reputation for safety that may attract safer drivers than its competitors. The supplemental analysis compares S60 and XC60 with contemporary Volvo models that did not have City Safety, thereby eliminating the chance of a Volvo driver effect.

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 2009-12. 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 2011-14. 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, for the XC60 and S60 are shown by insurance coverage type in **Table 1**. For comparison, exposure from the 2011 and 2012 reports are shown. Appendix A contains the current exposure and claims information for the comparison vehicles.

**Table 1: Exposure and claims by coverage type**

| | XC60 | | S60 | |
|---|---|---|---|---|
| Coverage | Claims | Exposure | Claims | Exposure |
| Property damage liability | 3,599 | 129,127 | 1,890 | 76,870 |
| Bodily injury liability | 304 | 51,628 | 159 | 26,930 |
| Collision | 7,310 | 129,127 | 5,597 | 76,870 |
| Medical payments | 288 | 40,013 | 166 | 20,925 |
| Personal injury protection | 523 | 59,965 | 416 | 37,565 |

Because previous HLDI analyses have shown them to have different loss patterns, hybrids, convertibles, and two-door vehicles were excluded from the control groups. Additionally, the XC60 analysis excluded City Safety-equipped S60s from the Volvo control group while the S60 analysis excluded XC60s from the Volvo comparison vehicles. For both the XC60 and S60, the Volvo comparison groups did not include the 2012 S80 or the 2012 XC70. Both of these vehicles were excluded because they had standard City Safety beginning in the 2012 model year. Vehicle models with two- and four-wheel drive versions were combined to provide sufficient data for analysis.

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 and severity 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 in the HLDI database. Furthermore, the take rate for these features is thought to be low.

### Analysis methods

Regression analysis was used to model claim frequency per insured vehicle year and average loss payment per claim (claim severity) while controlling for various covariates. Claim frequency was modeled using a Poisson distribution, and claim severity 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. They were calculated by multiplication because the estimate for the effect of City Safety on claim frequency and claim severity were in the form of ratios relative to the reference categories (baseline). The standard error for overall losses was calculated by taking the square root of the sum of the squared standard errors from the claim frequency and severity estimates. Based on the value of the estimate and the associated standard error, the corresponding two-sided p-value was derived from a standard normal distribution approximation.

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. To estimate the effect of City Safety, vehicle series was included as a variable in the regression models, with the Volvo XC60 or S60 assigned as the reference group. The model estimate corresponding to each comparison vehicle indicates the proportional increase or decrease in losses of that vehicle relative to the XC60 or S60, while controlling for differences in the distributions of drivers and garaging locations. For example, in the analysis of property damage liability claim frequency, the model estimate comparing the XC60 with the BMW X5 was 0.2610, which translates to an estimated increase in claim frequency of 30 percent for the X5 compared to the XC60 ($e^{0.2610} = 1.30$). Given that the actual property damage liability claim frequency for the Volvo XC60 equaled 2.8 claims per 100 insured vehicle years, the comparable claim frequency for the X5, if it had the same distribution of drivers and garaging locations as the XC60, is predicted to have been 2.8 x 1.30 = 3.6 claims per 100 insured vehicle years.

Weighted averages of the model estimates for individual vehicles in the analysis also were calculated for midsize luxury SUVs and for midsize luxury cars. The weights in the averages were proportional to the inverse variance of the respective estimates, meaning that the estimates with high variance (those with large confidence intervals, typically due to little exposure and/or claims) contributed less than estimates with low variance (those with small confidence intervals). These calculations estimate the average effect for each vehicle group of not having City Safety. Because it is often useful to state the results in terms of the estimated benefit of having a feature, the inverse of the average City Safety effect also was calculated. That is, the weighted average property damage liability loss frequency for other midsize luxury SUVs was 1.17 times that of the XC60; the inverse of that, (1/1.17)-1, or – 0.14, indicates that the estimated benefit of having City Safety is a 14 percent reduction in claim frequency compared with other SUVs. The estimated benefit for each overall comparison and the 95 percent confidence bounds are shown in **Tables 4–8**.

The estimated effects of City Safety 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. weigh $=1/SE^2$). 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

**Tables 2–3** illustrate the pattern of results available from the analyses performed. In **Table 2**, it can be seen that all independent variables in the model had statistically significant effects on property damage liability loss frequencies of midsize luxury SUVs. Most of the covariates in the regressions not shown were statistically significant. **Table 3** lists estimates and significance levels for the individual values of the categorical variables from the regression model. The intercept outlines losses for the reference (baseline) categories: the estimate corresponds to the claim frequency for a 2012 Volvo XC60, garaged in a high vehicle density area in Texas, and driven by a married female age 40-49 with standard risk during calendar year 2014. The remaining estimates are in the form of multiples, or ratios relative to the reference categories. **Table 3** includes only an abbreviated list of results by state. Only states with the five highest and five lowest estimates are listed, along with the comparison state of Texas.

| Table 2: Summary Wald statistics for type 3 analysis of property damage liability claim frequencies for XC60 vs. other midsize luxury SUVs | | | |
|---|---|---|---|
| | Degrees of freedom | Chi-Square | P-value |
| Calendar year | 5 | 116.45 | <0.0001 |
| Model year | 3 | 51.13 | <0.0001 |
| Vehicle make and series | 20 | 554.03 | <0.0001 |
| State | 50 | 2296.04 | <0.0001 |
| Registered vehicle density | 6 | 1488.79 | <0.0001 |
| Rated driver age | 10 | 1649.84 | <0.0001 |
| Rated driver gender | 2 | 191.26 | <0.0001 |
| Rated driver marital status | 2 | 503.19 | <0.0001 |
| Risk | 1 | 435.65 | <0.0001 |

| Table 3: Detailed results of linear regression analysis of property damage liability claim frequencies for Volvo XC60 vs. other midsize luxury SUVs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Parameter | Degrees of freedom | Estimate | Effect | Standard error | Wald 95% confidence limits | | Chi-square | P-value |
| Intercept | 1 | -9.2792 | | 0.0215 | -9.3214 | -9.2371 | 186003 | <0.0001 |
| Calendar year | | | | | | | | |
| 2009 | 1 | 0.0085 | 0.9% | 0.0171 | -0.0250 | 0.0420 | 0.25 | 0.6189 |
| 2010 | 1 | 0.0538 | 5.5% | 0.0119 | 0.0306 | 0.0771 | 20.56 | <0.0001 |
| 2011 | 1 | 0.0728 | 7.6% | 0.0100 | 0.0532 | 0.0924 | 52.82 | <0.0001 |
| 2012 | 1 | 0.0629 | 6.5% | 0.0092 | 0.0449 | 0.0808 | 47.02 | <0.0001 |
| 2013 | 1 | 0.0894 | 9.4% | 0.0089 | 0.0719 | 0.1069 | 100.51 | <0.0001 |
| 2014 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Model year | | | | | | | | |
| 2009 | 1 | 0.0472 | 4.8% | 0.0098 | 0.0280 | 0.0664 | 23.28 | <0.0001 |
| 2010 | 1 | -0.0007 | -0.1% | 0.0088 | -0.0179 | 0.0164 | 0.01 | 0.9326 |
| 2011 | 1 | -0.0106 | -1.1% | 0.0089 | -0.0280 | 0.0068 | 1.43 | 0.2322 |
| 2012 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Vehicle make and series | | | | | | | | |
| Acura MDX | 1 | 0.1510 | 16.3% | 0.0187 | 0.1144 | 0.1876 | 65.37 | <0.0001 |
| Acura RDX | 1 | 0.1409 | 15.1% | 0.0220 | 0.0977 | 0.1841 | 40.90 | <0.0001 |
| Acura ZDX | 1 | 0.2656 | 30.4% | 0.0495 | 0.1685 | 0.3627 | 28.74 | <0.0001 |
| Audi Q5 4WD | 1 | 0.0365 | 3.7% | 0.0209 | -0.0046 | 0.0775 | 3.03 | 0.0816 |
| BMW X3 | 1 | 0.0954 | 10.0% | 0.0233 | 0.0497 | 0.1411 | 16.75 | <0.0001 |
| BMW X5 | 1 | 0.2610 | 29.8% | 0.0193 | 0.2232 | 0.2988 | 182.93 | <0.0001 |
| BMW X6 | 1 | 0.2768 | 31.9% | 0.0314 | 0.2152 | 0.3383 | 77.62 | <0.0001 |
| Cadillac SRX | 1 | 0.1449 | 15.6% | 0.0191 | 0.1075 | 0.1823 | 57.59 | <0.0001 |
| Infiniti EX35 | 1 | 0.0001 | 0.0% | 0.0291 | -0.0569 | 0.0571 | 0.00 | 0.9982 |
| Infiniti FX35 | 1 | 0.2025 | 22.4% | 0.0234 | 0.1567 | 0.2483 | 75.01 | <0.0001 |
| Infiniti FX50 | 1 | 0.1870 | 20.6% | 0.0660 | 0.0577 | 0.3163 | 8.04 | 0.0046 |
| Land Rover LR2 | 1 | 0.2983 | 34.8% | 0.0314 | 0.2367 | 0.3599 | 90.19 | <0.0001 |
| Lexus RX 350 | 1 | 0.1382 | 14.8% | 0.0178 | 0.1034 | 0.1731 | 60.48 | <0.0001 |
| Lincoln MKT | 1 | 0.0843 | 8.8% | 0.0353 | 0.0150 | 0.1535 | 5.69 | 0.0171 |
| Lincoln MKX | 1 | 0.1139 | 12.1% | 0.0219 | 0.0710 | 0.1568 | 27.07 | <0.0001 |
| Mercedes-Benz GLK class | 1 | 0.1686 | 18.4% | 0.0203 | 0.1288 | 0.2084 | 68.92 | <0.0001 |
| Mercedes-Benz M class | 1 | 0.0876 | 9.2% | 0.0196 | 0.0492 | 0.1260 | 19.99 | <0.0001 |
| Saab 9-4X | 1 | 0.2053 | 22.8% | 0.1750 | -0.1377 | 0.5483 | 1.38 | 0.2407 |

**Table 3: Detailed results of linear regression analysis of property damage liability claim frequencies for Volvo XC60 vs. other midsize luxury SUVs**

| Parameter | Degrees of freedom | Estimate | Effect | Standard error | Wald 95% confidence limits | | Chi-square | P-value |
|---|---|---|---|---|---|---|---|---|
| Saab 9-7X | 1 | 0.1969 | 21.8% | 0.0662 | 0.0671 | 0.3266 | 8.84 | 0.0029 |
| Volvo XC90 | 1 | 0.2900 | 33.6% | 0.0230 | 0.2450 | 0.3350 | 159.31 | <0.0001 |
| Volvo XC60 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| State | | | | | | | | |
| Michigan | 1 | -1.4831 | -77.3% | 0.0417 | -1.5648 | -1.4013 | 1263.63 | <0.0001 |
| Wyoming | 1 | -0.4193 | -34.2% | 0.1391 | -0.6919 | -0.1468 | 9.09 | 0.0026 |
| Alaska | 1 | -0.3598 | -30.2% | 0.0882 | -0.5327 | -0.1869 | 16.64 | <0.0001 |
| North Carolina | 1 | -0.3691 | -30.9% | 0.0234 | -0.4149 | -0.3232 | 248.92 | <0.0001 |
| Utah | 1 | -0.3569 | -30.0% | 0.0485 | -0.4520 | -0.2618 | 54.12 | <0.0001 |
| California | 1 | -0.0503 | -4.9% | 0.0116 | -0.0729 | -0.0276 | 18.87 | <0.0001 |
| Louisiana | 1 | -0.0335 | -3.3% | 0.0266 | -0.0857 | 0.0186 | 1.59 | 0.2079 |
| Massachusetts | 1 | 0.0226 | 2.3% | 0.0219 | -0.0203 | 0.0655 | 1.06 | 0.3023 |
| District of Columbia | 1 | 0.0714 | 7.4% | 0.0459 | -0.0186 | 0.1614 | 2.42 | 0.1199 |
| North Dakota | 1 | 0.1772 | 19.4% | 0.1135 | -0.0454 | 0.3997 | 2.44 | 0.1186 |
| Texas | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Registered vehicle density | | | | | | | | |
| Unknown | 1 | -0.7956 | -54.9% | 0.3334 | -1.4491 | -0.1420 | 5.69 | 0.0170 |
| <50 | 1 | -0.5112 | -40.0% | 0.0213 | -0.5528 | -0.4695 | 578.32 | <0.0001 |
| 50–99 | 1 | -0.3749 | -31.3% | 0.0164 | -0.4070 | -0.3428 | 523.89 | <0.0001 |
| 100–249 | 1 | -0.2926 | -25.4% | 0.0113 | -0.3148 | -0.2704 | 665.31 | <0.0001 |
| 250–499 | 1 | -0.2216 | -19.9% | 0.0103 | -0.2417 | -0.2015 | 466.89 | <0.0001 |
| 500–999 | 1 | -0.1275 | -12.0% | 0.0082 | -0.1435 | -0.1115 | 243.49 | <0.0001 |
| 1,000+ | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Rated driver age | | | | | | | | |
| Unknown | 1 | -0.0578 | -5.6% | 0.0153 | -0.0878 | -0.0279 | 14.30 | 0.0002 |
| 15–19 | 1 | 0.3208 | 37.8% | 0.0243 | 0.2732 | 0.3684 | 174.53 | <0.0001 |
| 20–24 | 1 | 0.2366 | 26.7% | 0.0190 | 0.1993 | 0.2739 | 154.66 | <0.0001 |
| 25–29 | 1 | 0.1354 | 14.5% | 0.0152 | 0.1056 | 0.1653 | 79.00 | <0.0001 |
| 30–39 | 1 | 0.0384 | 3.9% | 0.0090 | 0.0208 | 0.0560 | 18.36 | <0.0001 |
| 50–59 | 1 | -0.1303 | -12.2% | 0.0089 | -0.1477 | -0.1129 | 215.09 | <0.0001 |
| 60–64 | 1 | -0.1330 | -12.5% | 0.0116 | -0.1557 | -0.1102 | 131.30 | <0.0001 |
| 65–69 | 1 | -0.0291 | -2.9% | 0.0122 | -0.0529 | -0.0052 | 5.71 | 0.0169 |
| 70–74 | 1 | 0.0603 | 6.2% | 0.0144 | 0.0322 | 0.0885 | 17.63 | <0.0001 |
| 75+ | 1 | 0.3031 | 35.4% | 0.0140 | 0.2757 | 0.3305 | 470.87 | <0.0001 |
| 40-49 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Rated driver gender | | | | | | | | |
| Male | 1 | -0.0774 | -7.4% | 0.0069 | -0.0910 | -0.0638 | 124.85 | <0.0001 |
| Unknown | 1 | -0.1689 | -15.5% | 0.0175 | -0.2032 | -0.1347 | 93.43 | <0.0001 |
| Female | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Rated driver marital status | | | | | | | | |
| Single | 1 | 0.1759 | 19.2% | 0.0081 | 0.1600 | 0.1918 | 469.79 | <0.0001 |
| Unknown | 1 | 0.1478 | 15.9% | 0.0171 | 0.1142 | 0.1813 | 74.64 | <0.0001 |
| Married | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Risk | | | | | | | | |
| Nonstandard | 1 | 0.2100 | 23.4% | 0.0101 | 0.1903 | 0.2297 | 435.65 | <0.0001 |
| Standard | 0 | 0 | 0 | 0 | 0 | 0 | | |

**Property damage liability: Figures 1–2** show the results from the analyses of property damage liability claim frequency for the XC60 and S60, respectively. In these figures, the actual property damage liability claim frequency (per 100 vehicle years of exposure) for the Volvo XC60 and S60 are plotted, along with the estimated claim frequencies of each comparison vehicle and the average of all comparison vehicles derived from the regression models. The results were very similar, with the XC60 having an actual claim frequency 14 percent lower than the average of midsize luxury SUVs, while the S60's claim frequency was 15 percent lower than the average of midsize luxury cars. Among comparison midsize luxury SUVs, none had a lower estimated claim frequency than the XC60, but the Infiniti EX35's claim frequency was equal to that of the XC60. Analogously, only the Audi S4 4WD and the BMW M3 had lower estimated claim frequencies than the S60, and both differences were statistically significant. These two vehicles are high-performance variants of the Audi A4 4WD and the BMW 3 that may be driven only recreationally and therefore may have low-mileage exposure. Notably, the S60 had a claim frequency that was significantly lower than the base variants of these vehicles (Audi A4 4WD and BMW 3). Note that the vertical I-bars for each comparison group are the 95 percent confidence limits for the comparison of that group with the Volvo study vehicle, not the 95 percent confidence interval for that group's claim frequency estimate. This is true for all of the figures.

**Figure 1: Property damage liability claim frequencies per 100 insured vehicle years for 2010–12 Volvo XC60 with City Safety vs. other 2009–12 midsize luxury SUVs**

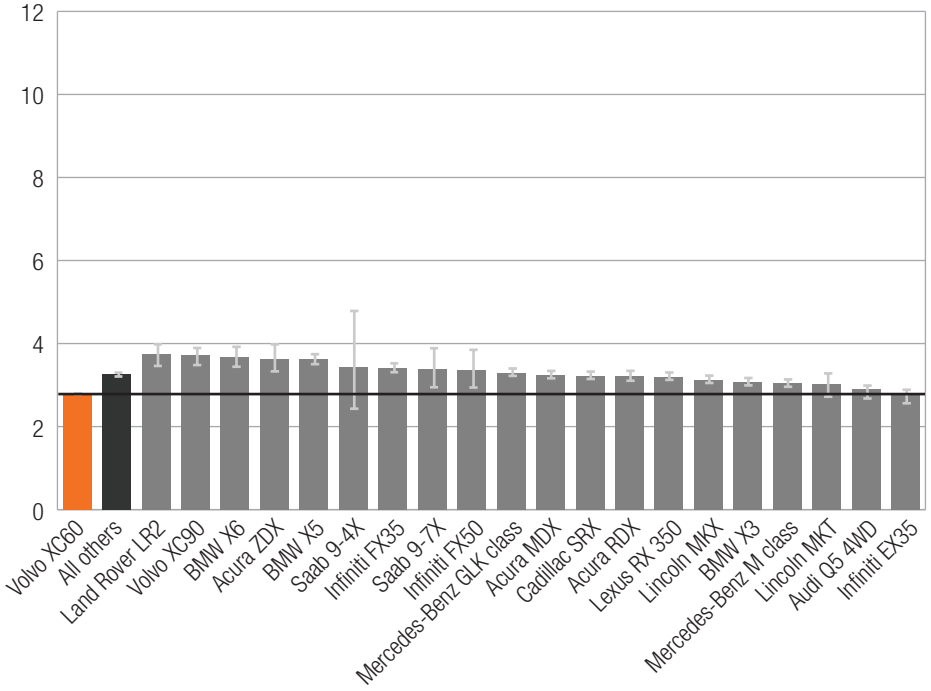
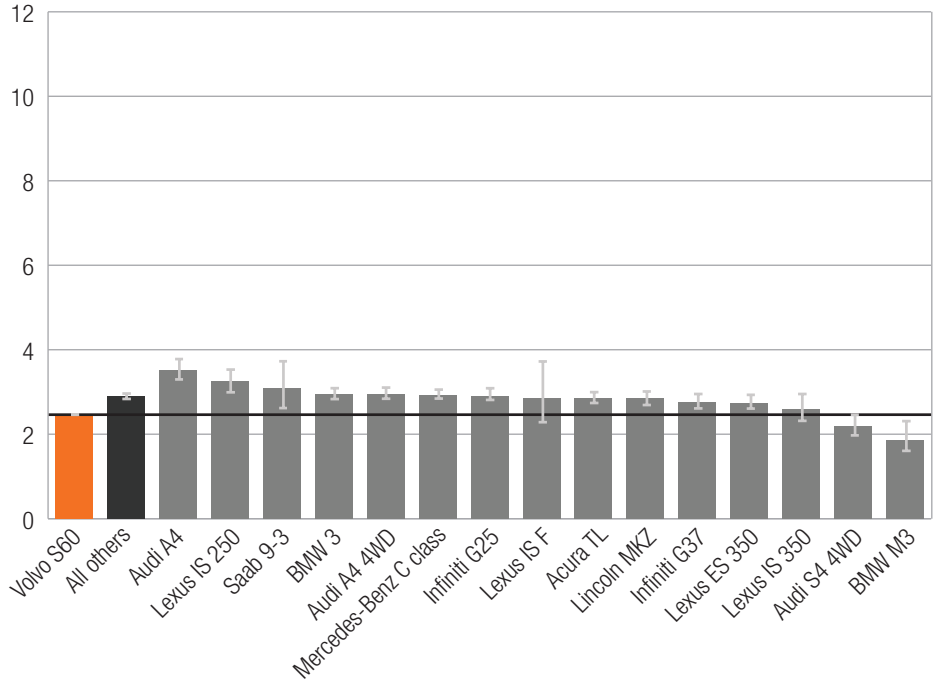


**Figure 2: Property damage liability claim frequencies per 100 insured vehicle years for 2011–12 Volvo S60 with City Safety vs. other 2011–12 midsize luxury cars**




**Figures 3–4** show the results of the analyses of property damage liability claim severity for the Volvo XC60 and S60, respectively. As for the frequency analyses above, the actual average cost per claim is plotted for the XC60 and S60 against the model-derived estimates for each of the comparison vehicles as well as their weighted average. The XC60 average loss per claim was lower than those for the other midsize luxury SUVs (7 percent lower than the average), and the S60 claim severity was also lower than those for other midsize luxury cars (6 percent lower than the average).

**Figure 3: Property damage liability claim severities for 2010–12 Volvo XC60 with City Safety vs. other 2009–12 midsize luxury SUVs**

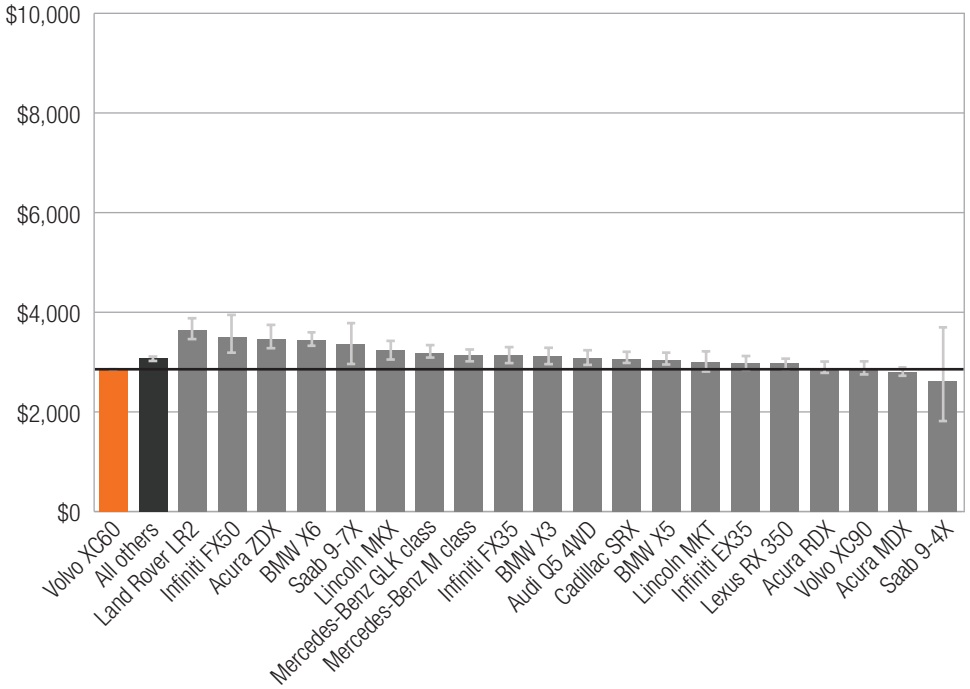
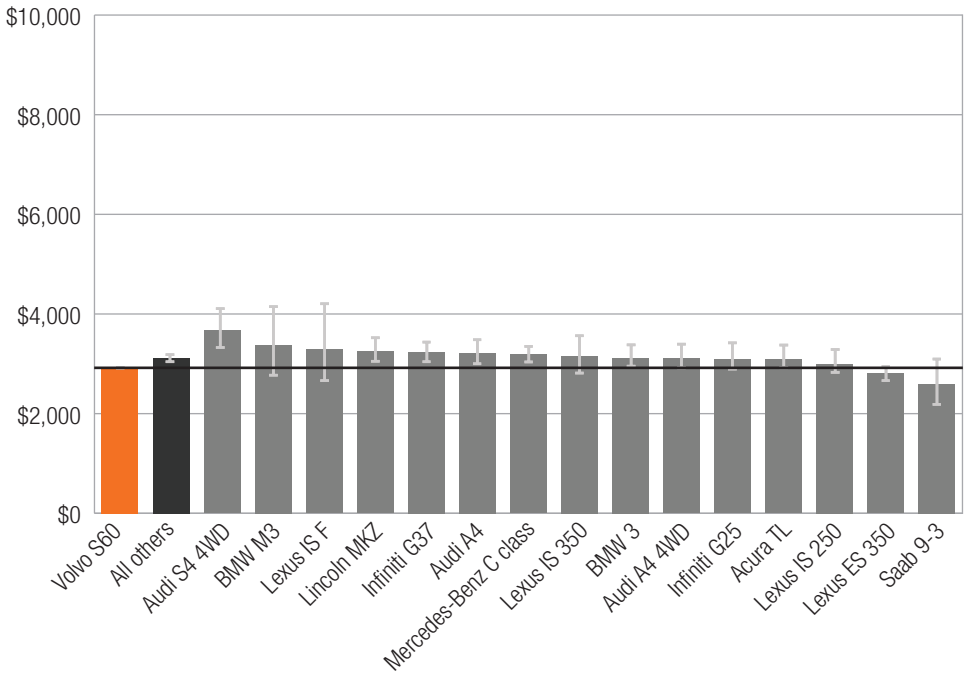


**Figure 4: Property damage liability claim severities for 2011–12 Volvo S60 with City Safety vs. other 2011–12 midsize luxury cars**




Figures 5–6 provide more detail about the differences in property damage liability claim severity results by examining the frequency of claims in different severity ranges. In Figure 5, the XC60, compared with other midsize luxury SUVs, had fewer claims in low-, medium- and high-severity ranges, with the greatest percentage reduction (26 percent) in claims costing at least $7,000. The S60 (Figure 6) also had lower claim frequencies in all three severity ranges, with the greatest reduction (27 percent) in claims costing at least $7,000. The differences at all claim severity ranges were statistically significant.

**Figure 5: Property damage liability claim frequencies by claim severity range, Volvo XC60 vs. other midsize luxury SUVs**

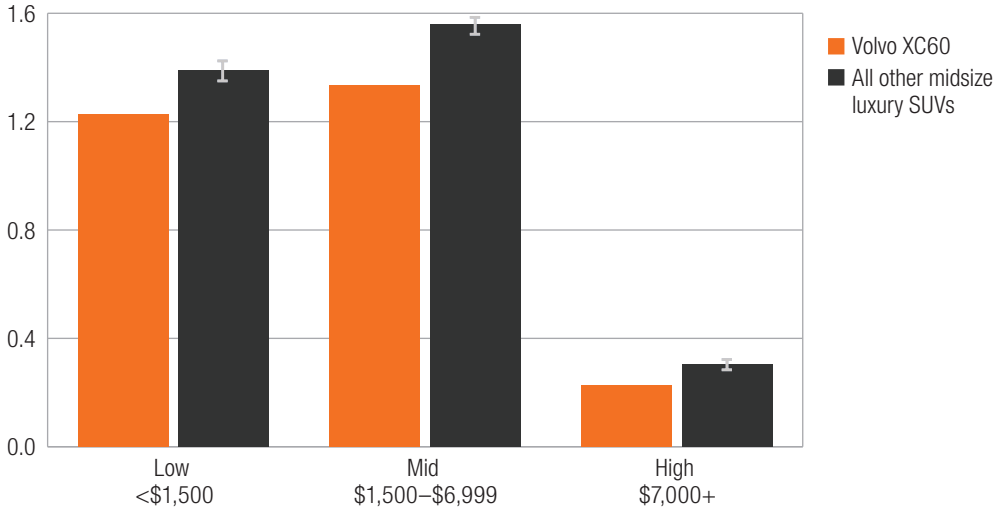
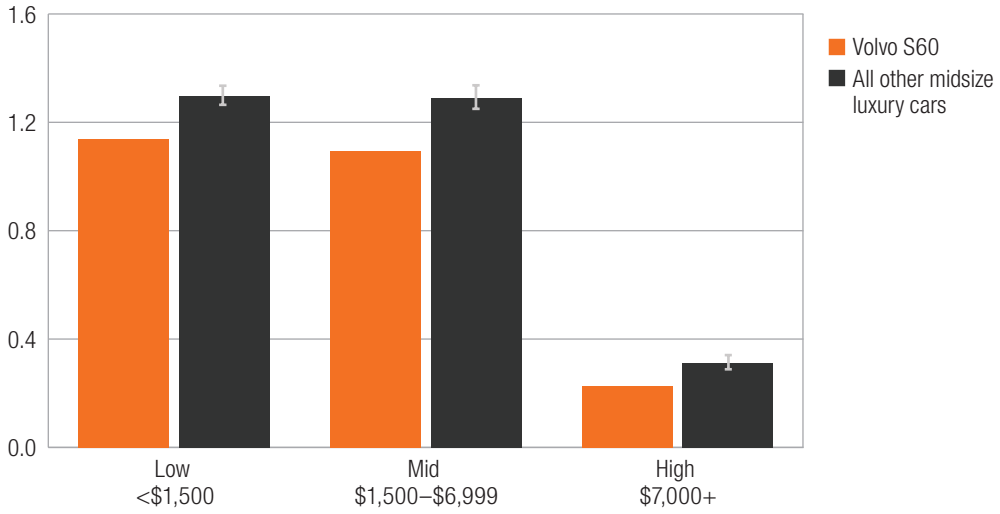


**Figure 6: Property damage liability claim frequencies by claim severity range, Volvo S60 vs. other midsize luxury cars**




Figures 7–8 show the result of combining the regression results from the claim frequency and severity analyses to obtain a comparison of overall property damage liability losses for the Volvo XC60 and S60 and their respective comparison vehicles. At $80 per insured vehicle year, the actual overall loss for the Volvo XC60 (Figure 7) was lower than those for all other midsize luxury SUVs and 20 percent lower than the weighted average of those vehicles. The actual overall loss for the Volvo S60 ($72 per insured vehicle year) was also 20 percent lower than the weighted average for all other midsize four-door luxury cars combined (Figure 8). Only the BMW M3 had a lower overall loss than the S60, although the difference was not significant.

**Figure 7: Property damage liability overall losses for 2010–12 Volvo XC60 with City Safety vs. other 2009–12 midsize luxury SUVs**

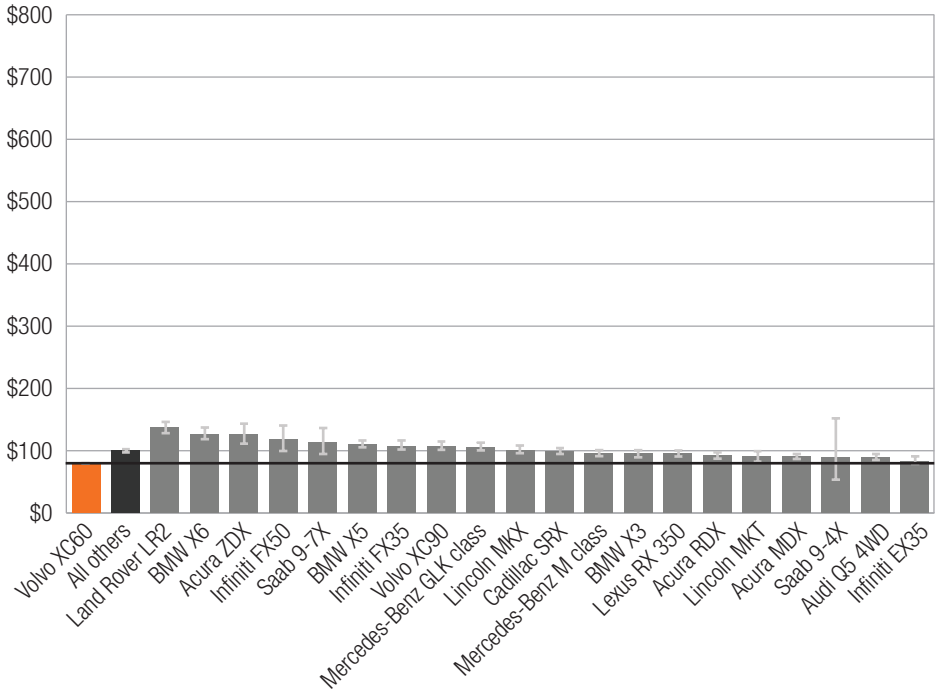


**Figure 8: Property damage liability overall losses for 2011–12 Volvo S60 with City Safety vs. other 2011–12 midsize luxury cars**

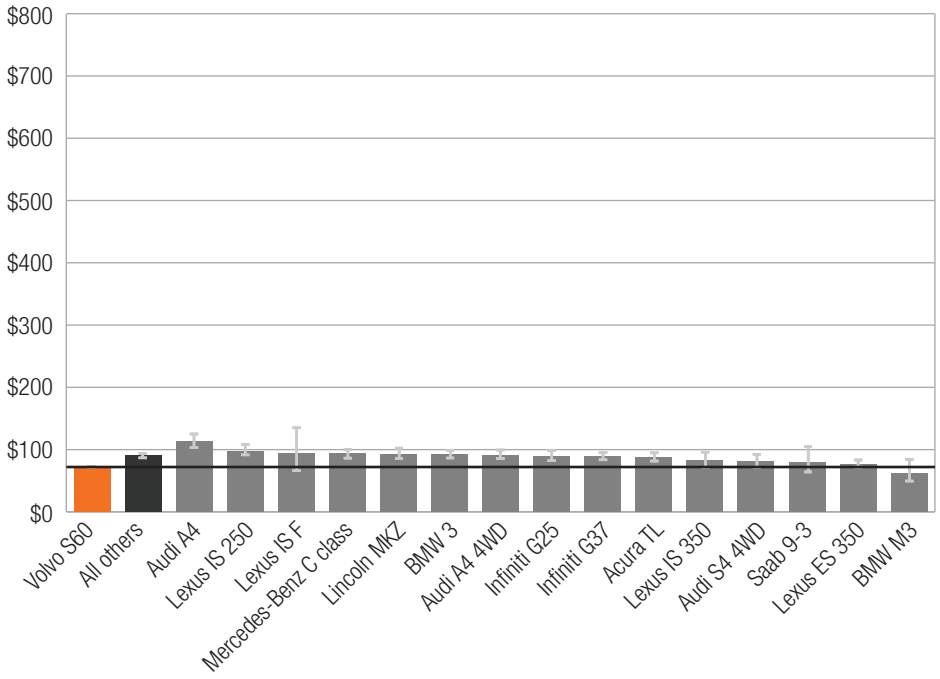



Table 4 summarizes the property damage liability results for the Volvo XC60 and S60 with City Safety. Note that the first two columns provide the weighted average estimates from the regressions and the standard error of those estimates. The third column is the effect estimate expressed as the percent increase or decrease in claim frequency, severity, and overall losses ($e^{*estimate}$); this is the effect of not having City Safety. In the final two columns, the effect of City Safety is expressed in terms of the estimated percent benefit of the technology (i.e., 100 x ($1/e^{estimate}$ - 1)) and the 95 percent confidence bounds of the estimated benefit.

**Table 4: Property damage liability loss results - City Safety versus weighted average of comparison vehicles**

| | | | | City Safety benefit | |
|---|---|---|---|---|---|
| | Estimate | Standard Error | Estimated change of control vehicles relative to study vehicles | Estimate | 95% confidence interval |
| **XC60 vs. midsize luxury SUVs** | | | | | |
| Claim frequency | -0.1547 | 0.0055 | 17% | -14% | -15%, -13% |
| Claim severity | -0.0739 | 0.0051 | 8% | -7% | -8%, -6% |
| Overall loss | -0.2285 | 0.0075 | 26% | -20% | -22%, -19% |
| Claims <$1,500 | -0.1236 | 0.0083 | 13% | -12% | -13%, -10% |
| Claims $1,500–$6,999 | -0.1566 | 0.0079 | 17% | -14% | -16%, -13% |
| Claims $7,000+ | -0.2956 | 0.0185 | 34% | -26% | -28%, -23% |
| **S60 vs. midsize luxury cars** | | | | | |
| Claim frequency | -0.1647 | 0.0090 | 18% | -15% | -17%, -14% |
| Claim severity | -0.0646 | 0.0089 | 7% | -6% | -8%, -5% |
| Overall loss | -0.2293 | 0.0127 | 26% | -20% | -22%, -18% |
| Claims <$1,500 | -0.1308 | 0.0134 | 14% | -12% | -15%, -10% |
| Claims $1,500–$6,999 | -0.1655 | 0.0135 | 18% | -15% | -17%, -13% |
| Claims $7,000+ | -0.3185 | 0.0289 | 38% | -27% | -31%, -23% |

**Bodily injury liability: Figures 9–10** show the results for the analyses of bodily injury liability claim frequency. The actual bodily injury liability claim frequency for the XC60 and S60 are typically lower than the estimated frequencies for their comparison vehicles. Only the Saab 9-4X had lower claim rates than the XC60, and the BMW M3 had lower claim rates than the S60.

**Figure 9: Bodily injury liability claim frequencies per 1,000 insured vehicle years for 2010–12 Volvo XC60 with City Safety vs. other 2009–12 midsize luxury SUVs**

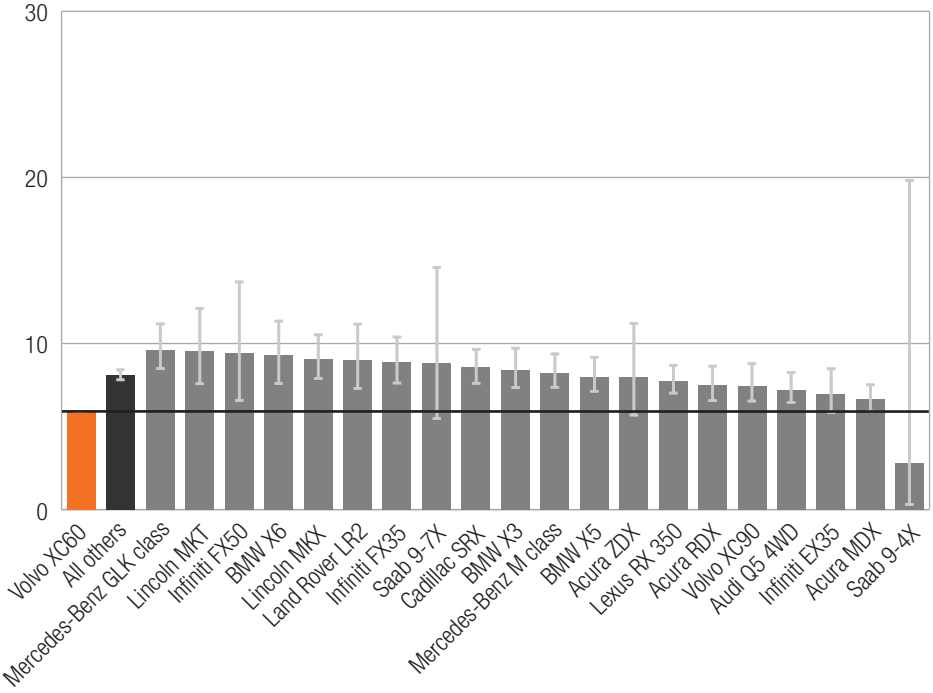



**Figure 10: Bodily injury liability claim frequencies per 1,000 insured vehicle years for 2011–12 Volvo S60 with City Safety vs. other 2011–12 midsize luxury cars**

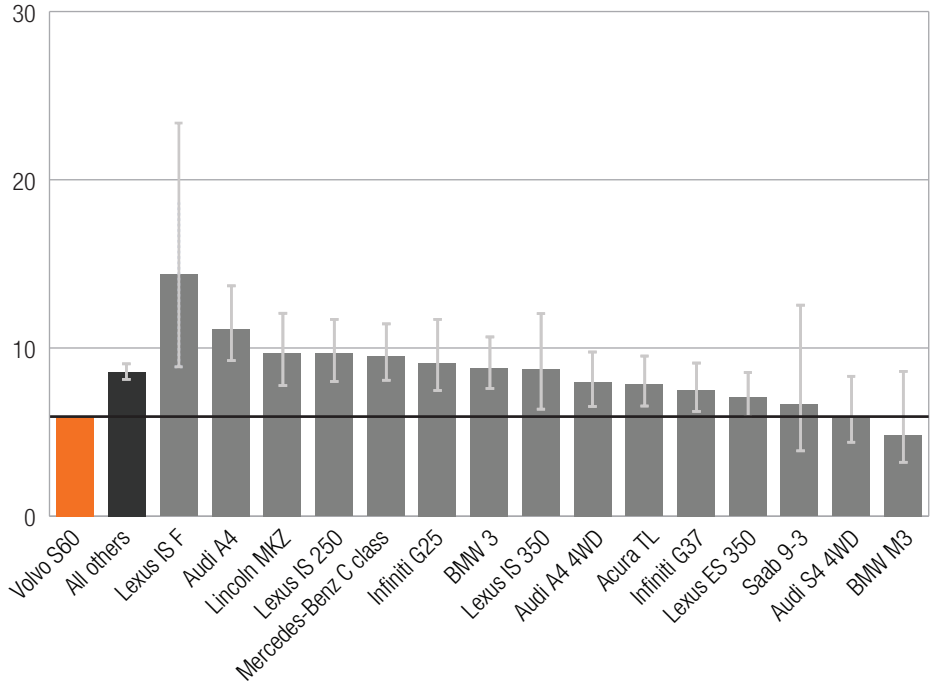


**Table 5** summarizes results of the regression analysis conducted for bodily injury liability coverage. Note that analyses of claim severity were not conducted because of the relative recency of these claims and the length of time it takes for claims costs to fully develop. The layout of **Table 5** is analogous to **Table 4**, with the estimated benefits of City Safety in the Volvo XC60 and S60 shown in the final two columns. Compared with other midsize luxury SUVs, it is estimated that the XC60 bodily injury liability claim frequency was reduced by 28 percent with City Safety. For the S60, bodily injury liability claim frequency was 31 percent lower than would have been expected based on the weighted average experience of other midsize luxury cars.

**Table 5: Bodily injury liability loss frequency results — City Safety versus weighted average of comparison vehicles**

| | | | | City Safety benefit | |
|---|---|---|---|---|---|
| | Estimate | Standard Error | Estimated change of control vehicles relative to study vehicles | Estimate | 95% confidence interval |
| XC60 vs. midsize luxury SUVs | -0.3219 | 0.0183 | 38% | -28% | -30%, -25% |
| S60 vs. midsize luxury cars | -0.3733 | 0.0294 | 45% | -31% | -35%, -27% |

**Collision damage: Figures 11–16** show the results for the analyses of collision damage claim frequency, claim severity, and overall losses for the XC60 and S60. For both vehicles fitted with City Safety, the actual loss frequency and severity are lower than the estimated frequencies and severities associated with most of the comparison vehicles. As a result, overall losses for the City Safety vehicles also are lower than the overall losses of most comparison vehicles.

**Figure 11: Collision claim frequencies per 100 insured vehicle years for 2010–12 Volvo XC60 with City Safety vs. other 2009–12 midsize luxury SUVs**

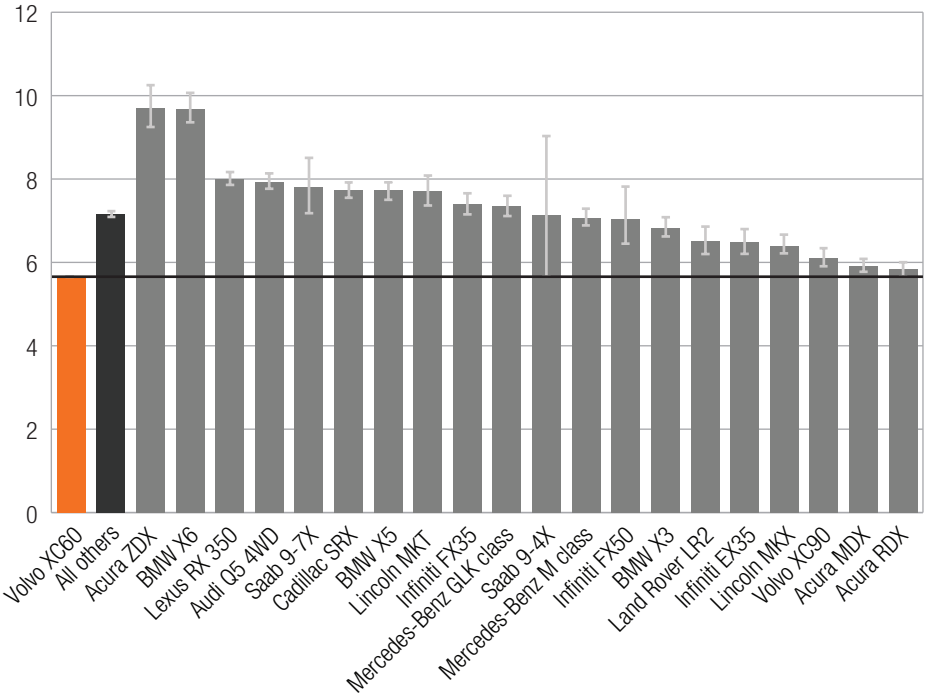


**Figure 12: Collision claim frequencies per 100 insured vehicle years for 2011–12 Volvo S60 with City Safety vs. other 2011–12 midsize luxury cars**

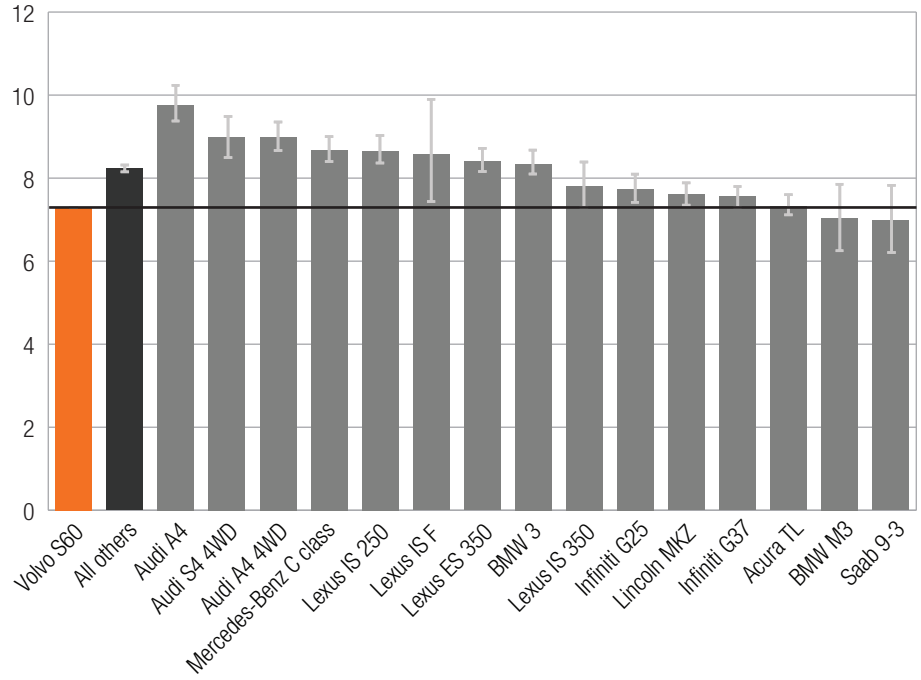



**Figure 13: Collision claim severities for 2010–12 Volvo XC60 with City Safety vs. other 2009–12 midsize luxury SUVs**

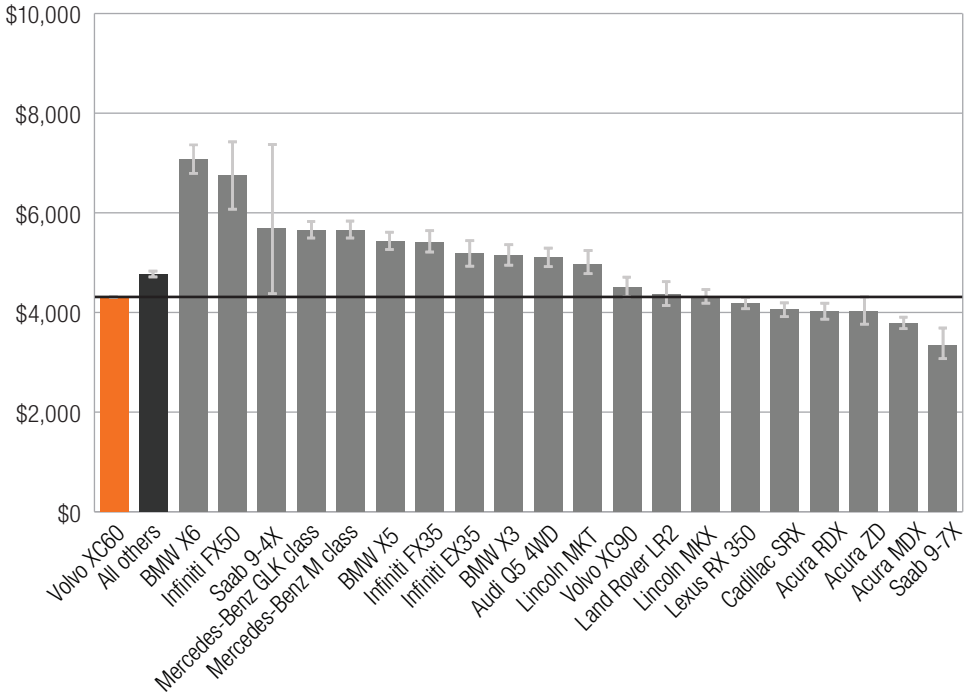


**Figure 14: Collision claim severities for 2011–12 Volvo S60 with City Safety vs. other 2011–12 midsize luxury cars**

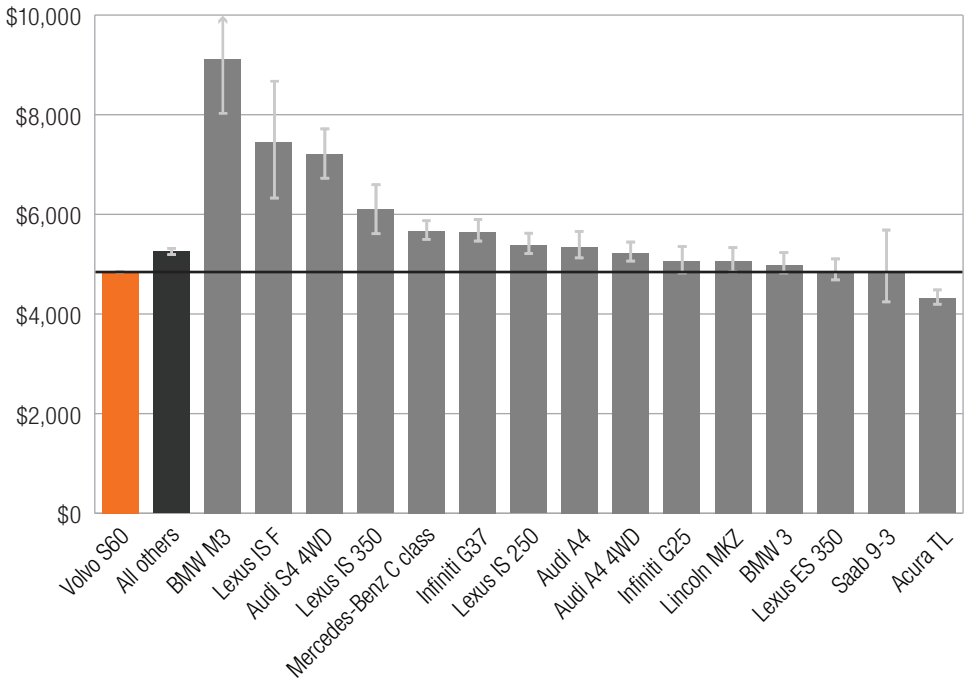



**Figure 15: Collision overall losses for 2010–12 Volvo XC60 with City Safety vs. other 2009–12 midsize luxury SUVs**

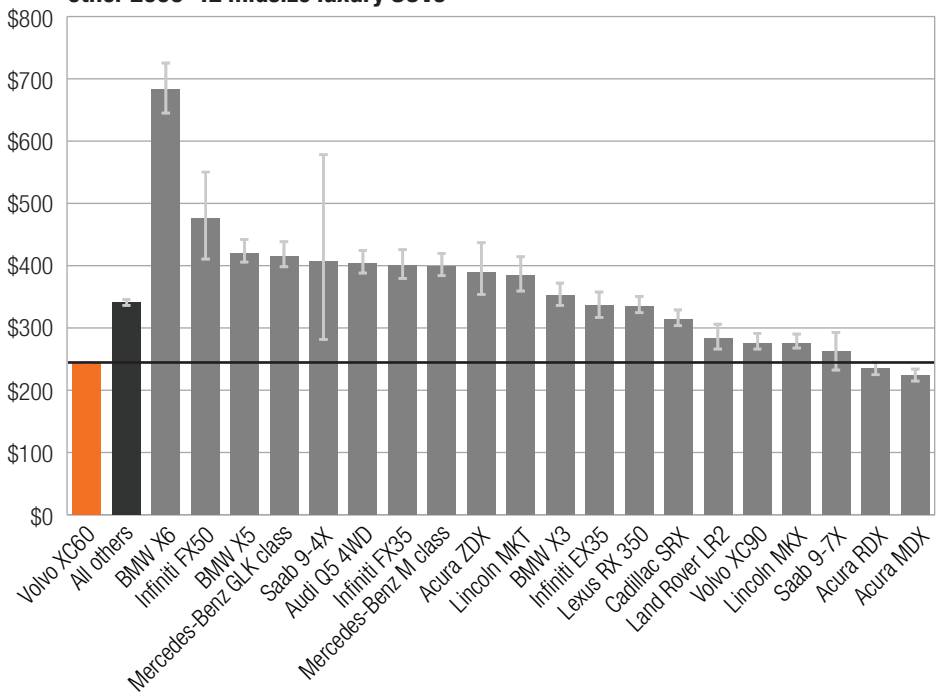


**Figure 16: Collision overall losses for 2011–12 Volvo S60 with City Safety vs. other 2011–12 midsize luxury cars**

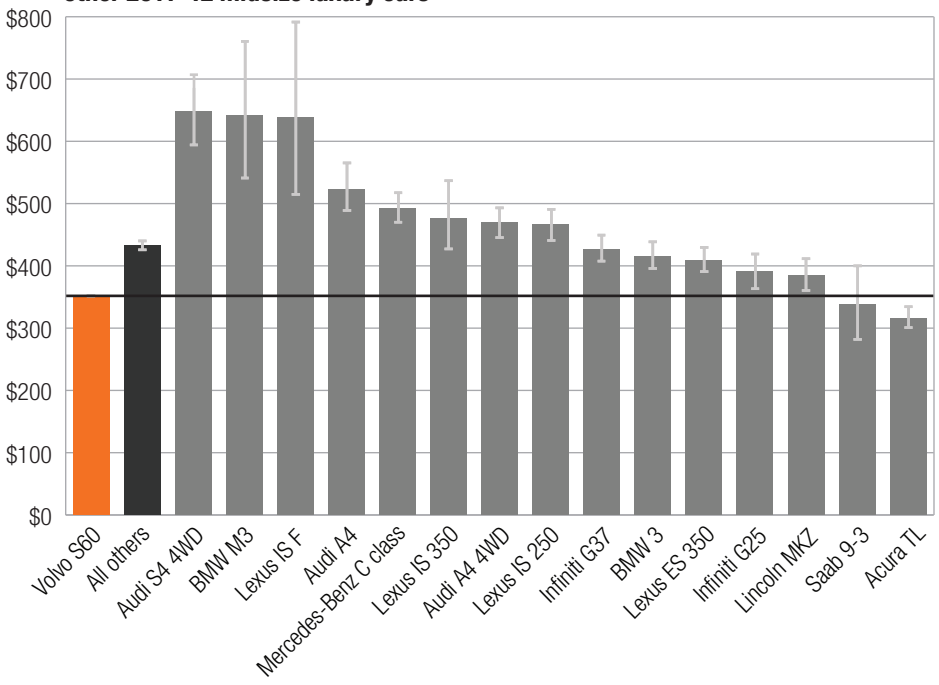



Table 6 summarizes the collision coverage results in an analogous manner to the property damage liability results. Compared with the weighted average estimate of comparison vehicles, the Volvo XC60's actual collision claim frequency was 21 percent lower, claim severity was 9 percent lower, and overall losses were reduced by 28 percent. Similarly, the S60's actual collision claim frequency was 12 percent lower than the weighted average of other midsize luxury cars, claim severity was 8 percent lower, and overall losses were 19 percent lower. Reductions in claims appear to have occurred across all of the severity spectrum, although the reductions in claims costing less than $2,000 are much less (only 13 percent for the XC60 and 1 percent for the S60).

**Table 6: Collision loss results - City Safety versus weighted average of comparison vehicles**

| | | | | City Safety benefit | |
|---|---|---|---|---|---|
| | Estimate | Standard Error | Estimated change of control vehicles relative to study vehicles | Estimate | 95% confidence interval |
| **XC60 vs. midsize luxury SUVs** | | | | | |
| Claim frequency | -0.2348 | 0.0038 | 26% | -21% | -22%, -20% |
| Claim severity | -0.0993 | 0.0043 | 10% | -9% | -10%, -9% |
| Overall loss | -0.3341 | 0.0058 | 40% | -28% | -29%, -28% |
| Claims <$2,000 | -0.1351 | 0.0054 | 14% | -13% | -14%, -12% |
| Claims $2,000–$4,999 | -0.2912 | 0.0078 | 34% | -25% | -26%, -24% |
| Claims $5,000–$11,999 | -0.3864 | 0.0100 | 47% | -32% | -33%, -31% |
| Claims $12,000+ | -0.3114 | 0.0115 | 37% | -27% | -28%, -25% |
| **S60 vs. midsize luxury cars** | | | | | |
| Claim frequency | -0.1232 | 0.0053 | 13% | -12% | -13%, -11% |
| Claim severity | -0.0816 | 0.0062 | 8% | -8% | -9%, -7% |
| Overall loss | -0.2048 | 0.0082 | 23% | -19% | -20%, -17% |
| Claims <$2,000 | -0.0085 | 0.0077 | 1% | -1% | -2%, 1% |
| Claims $2,000–$4,999 | -0.2122 | 0.0113 | 24% | -19% | -21%, -17% |
| Claims $5,000–$11,999 | -0.3565 | 0.0139 | 43% | -30% | -32%, -28% |
| Claims $12,000+ | -0.1156 | 0.0141 | 12% | -11% | -13%, -8% |

**Personal injury protection: Figures 17–18** show the results for the analyses of personal injury protection claim frequency. The actual personal injury protection claim frequency for the XC60 and S60 are typically lower than the estimated frequencies for their comparison vehicles. Only the Volvo XC90 and the Acura MDX had lower claim rates than the XC60 and neither difference was significant. The Audi A4 4WD, the BMW M3, and the Audi S4 4WD had lower claim rates than the S60, with only the Audi S4 4WD difference being significant.

**Figure 17: Personal injury protection claim frequencies per 1,000 insured vehicle years for 2010–12 Volvo XC60 with City Safety vs. other 2009–12 midsize luxury SUVs**

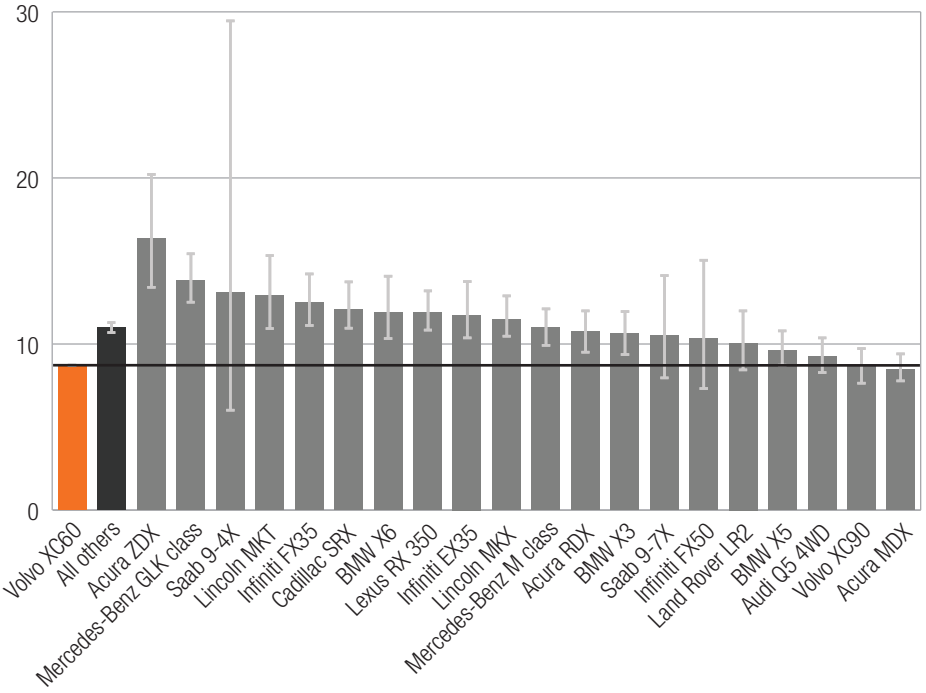



**Figure 18: Personal injury protection claim frequencies per 1,000 insured vehicle years for 2011–12 Volvo S60 with City Safety vs. other 2011–12 midsize luxury cars**

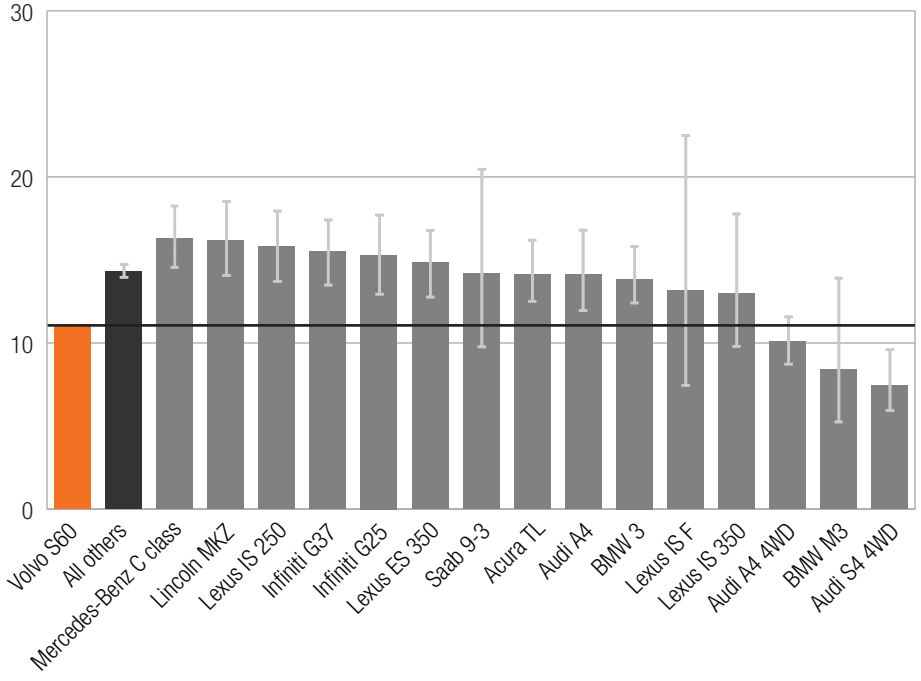


**Table 7** summarizes results of the regression analysis conducted for personal injury protection coverage. Note that analyses of claim severity were not conducted because of the relative recency of these claims and the length of time it takes for claims costs to fully develop. Compared with other midsize luxury SUVs, it is estimated that the XC60 personal injury protection claim frequency was reduced by 21 percent with City Safety. For the S60, personal injury protection claim frequency was 23 percent lower than would have been expected based on the weighted average experience of other midsize luxury cars.

**Table 7: Personal injury protection loss frequency results — City Safety versus weighted average of comparison vehicles**

| | | | | City Safety benefit | |
|---|---|---|---|---|---|
| | Estimate | Standard Error | Estimated change of control vehicles relative to study vehicles | Estimate | 95% confidence interval |
| XC60 vs. midsize luxury SUVs | -0.2297 | 0.0140 | 26% | -21% | -23%, -18% |
| S60 vs. midsize luxury cars | -0.2569 | 0.0192 | 29% | -23% | -26%, -20% |

**Medical payment: Figures 19–20** show the results for the analyses of medical payment claim frequency. The actual medical payment claim frequency for the XC60 and S60 are typically lower than the estimated frequencies for their comparison vehicles. Four vehicles had lower claim rates than the XC60, with only one difference being significant. The BMW M3, the Lexus IS F, and the Audi S4 4WD had lower claim rates than the S60, with only the Audi S4 4WD difference being significant.

**Figure 19: Medical payment claim frequencies per 1,000 insured vehicle years for 2010–12 Volvo XC60 with City Safety vs. other 2009–12 midsize luxury SUVs**

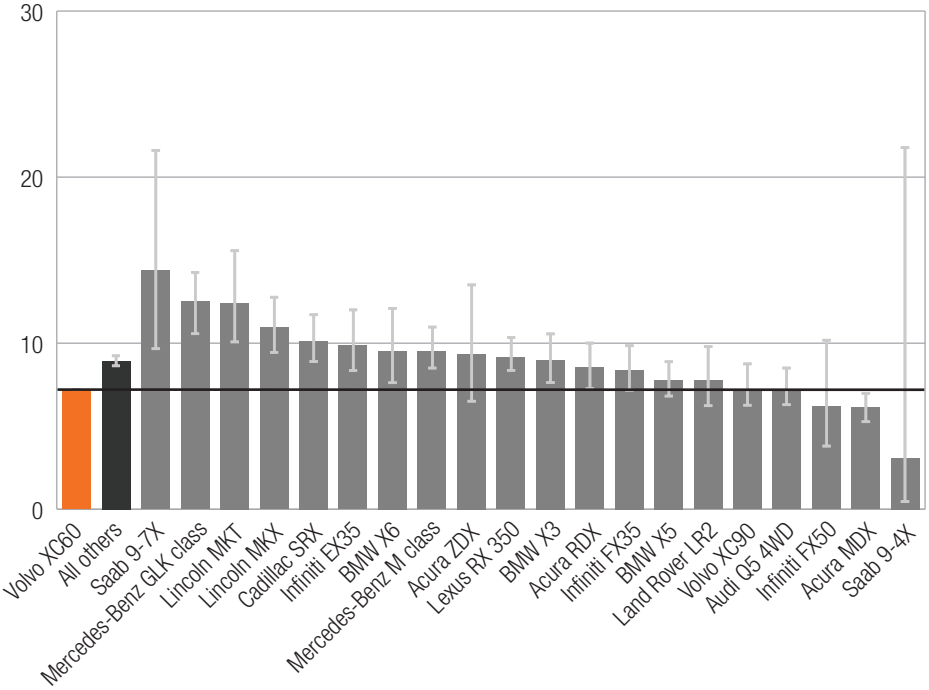


**Figure 20: Medical payment claim frequencies per 1,000 insured vehicle years for 2011–12 Volvo S60 with City Safety vs. other 2011–12 midsize luxury cars**

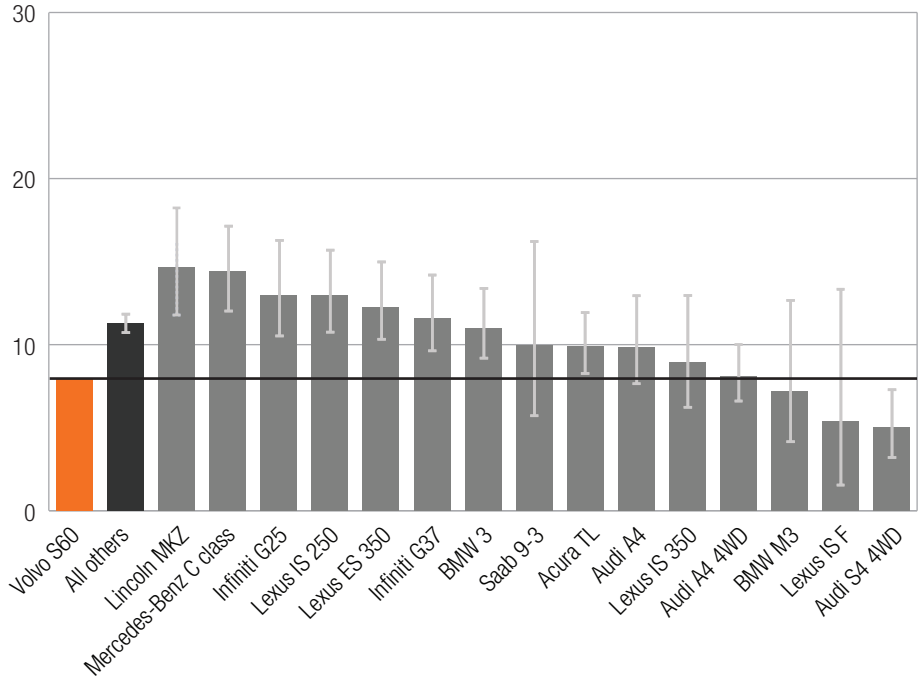



Table 8 summarizes results of the regression analysis conducted for medical payment coverage. Note that analyses of claim severity were not conducted because of the relative recency of these claims and the length of time it takes for claims costs to fully develop. Compared with other midsize luxury SUVs, it is estimated that the XC60 medical payment claim frequency was reduced by 19 percent with City Safety. For the S60, medical payment claim frequency was 30 percent lower than would have been expected based on the weighted average experience of other midsize luxury cars.

**Table 8: Medical payment loss frequency results — City Safety versus weighted average of comparison vehicles**

| | | | | City Safety benefit | |
|---|---|---|---|---|---|
| | Estimate | Standard Error | Estimated change of control vehicles relative to study vehicles | Estimate | 95% confidence interval |
| XC60 vs. midsize luxury SUVs | -0.2169 | 0.0194 | 24% | -19% | -22%, -16% |
| S60 vs. midsize luxury cars | -0.3523 | 0.0297 | 42% | -30% | -34%, -25% |

**Pooled results: Table 9** shows the combined, or pooled, XC60 and S60 estimates by coverage type. When the results are presented in this manner, it allows for easy interpretation. Insurance losses for the pooled results show significant reductions across all coverage types.

**Table 9: Combined XC60 and S60 summary loss results**

| Vehicle damage coverage type | Lower bound | FREQUENCY | Upper bound | Lower bound | SEVERITY | Upper bound | Lower bound | OVERALL LOSSES | Upper bound |
|---|---|---|---|---|---|---|---|---|---|
| Collision | -18.2% | **-17.7%** | -17.2% | -$474 | **-$440** | -$405 | -$96 | **-$93** | -$89 |
| Property damage liability | -15.3% | **-14.5%** | -13.8% | -$240 | **-$213** | -$186 | -$21 | **-$19** | -$18 |

| 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 | -30.7% | **-28.6%** | -26.4% | -38.9% | **-35.4%** | -31.7% | -32.0% | **-28.3%** | -24.4% |
| Medical payment | -25.1% | **-22.7%** | -20.2% | -28.3% | **-21.8%** | -14.7% | -31.4% | **-28.1%** | -24.6% |
| Personal injury protection | -23.0% | **-21.3%** | -19.5% | -15.3% | **-11.0%** | -6.5% | -28.5% | **-26.3%** | -24.0% |

## Discussion

This is the second update for Volvo XC60 and the first for S60 of analyses of the effects of the City Safety system on collision, property damage liability and bodily injury liability losses. In addition, the effects on losses under personal injury protection and medical payments coverage types are reported for the first time. Tables 10-11 show that the effects on collision and liability claim frequencies have been stable over time. Differences between the most recent results and those reported earlier are likely due to uncertainty associated with lower exposure and smaller claim counts in the earlier analyses. The property damage claim frequency estimates for XC60 suggest there is no diminution of the City Safety effect as vehicles age, since the oldest vehicles in the present analysis are now 4-7 years old.

The consistency of the results between analyses for both the S60 and XC60 suggests that the best estimate for a general effect of City Safety for all vehicle types would be the pooled estimates reported in Table 9. As with the underlying estimates for the individual models, these show significant reductions in all measures of loss for all coverage types analyzed. These results suggest that if all vehicles were equipped with a system like City Safety, more than one-sixth of all physical damage claims and more than one-fifth of all injury claims would be eliminated. This reduction in crashes and injuries could be achieved without increasing the cost to repair those vehicles that become crash damaged. This contrasts with the earliest HLDI report on City Safety in which an increase in property damage liability claim severity was found. Analysis of frequency reductions by claim size suggested that the increased severity was due to mean shifting associated with the elimination of a large number of the least expensive claims and little change in the frequency of more expensive claims. The present results, which are based on nearly 18 times the exposure and 21 times the number of PDL claims do not show an increase in average physical claim costs indicating that City Safety is preventing damage across the entire range analyzed.

Unlike the earlier analyses of City Safety on the XC60, the present one shows a larger reduction in claim frequency for collision coverage than for property damage liability. This is unexpected given that City Safety is intended to prevent front-to-rear collisions between two vehicles. Such crashes are a much larger proportion of the property damage claim universe than they are among collision claims since the collision universe would include many single-vehicle crashes. This would suggest that City Safety is preventing some single vehicle crashes, which is plausible as tests show that City Safety will activate automated braking when driven toward non-vehicle objects.

**Table 10: Change in claim frequencies for Volvo XC60, initial vs. updated results**

| Vehicle damage coverage types | Initial 2011 results | Updated 2012 results | Updated 2015 results |
|---|---|---|---|
| Collision | -22.0% | -20.2% | -20.9% |
| Property damage liability | -26.6% | -14.6% | -14.3% |

| Injury coverage types | Initial 2011 results | Updated 2012 results | Updated 2015 results |
|---|---|---|---|
| Bodily injury liability | -51.1% | -33.3% | -27.5% |

**Table 11: Change in claim frequencies for Volvo S60, initial vs. updated results**

| Vehicle damage coverage types | Initial 2012 results | Updated 2015 results |
|---|---|---|
| Collision | -8.7% | -11.6% |
| Property damage liability | -16.3% | -15.2% |

| Injury coverage types | Initial 2012 results | Updated 2015 results |
|---|---|---|
| Bodily injury liability | -18.2% | -31.2% |

**Loss results for City Safety compared with other Volvos:** As in past reports on City Safety, the present one compares S60 and XC60 to other Volvo models that were not yet equipped with City Safety. This was included to answer concerns that by comparing the S60 and the XC60 with similar models from other automakers, the results reported for City Safety may actually be due to a difference between drivers of Volvos and drivers of the models in the comparison groups that are not fully accounted for by the inclusion of rated driver covariates in the analyses. As before, nearly every measure of loss in every coverage type is lower for the S60 and XC60 than for other Volvo models without City Safety. The only exceptions are increases in the frequency of personal injury protection claims and high severity medical payments claims, but neither of these estimates is statistically significant. Thus, it seems that the reductions in losses associated with City Safety in the main analyses are not likely due to a Volvo driver effect. These results are summarized in **Appendix B**.

## 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.

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Volvo cars. 2008. Volvo cars presents City Safety — a unique system for avoiding collisions at low speeds (press release). Retrieved from https://www.media.volvocars.com/global/enhanced/en-gb/Media/Preview.aspx?mediaid=13829

## Appendix A: Exposure and claims by coverage type for comparison vehicles

| | Property damage liability | | Bodily injury liability | | Collision | | Personal injury protection | | Medical payments | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Exposure | Claims | Exposure | Claims | Exposure | Claims | Exposure | Claims | Exposure | Claims |
| **Midsize luxury SUVs** | | | | | | | | | | |
| Acura MDX | 470,005 | 15,614 | 191,324 | 1,282 | 470,005 | 26,809 | 217,881 | 2,022 | 146,948 | 933 |
| Acura RDX | 144,986 | 4,945 | 56,592 | 445 | 144,986 | 8,571 | 70,845 | 845 | 43,361 | 380 |
| Acura ZDX | 12,282 | 461 | 4,769 | 40 | 12,282 | 1,200 | 5,872 | 107 | 3,586 | 34 |
| Audi Q5 4WD | 210,105 | 6,371 | 85,982 | 676 | 210,105 | 16,620 | 96,956 | 971 | 63,289 | 501 |
| BMW X3 | 122,167 | 3,853 | 48,199 | 414 | 122,167 | 8,198 | 57,943 | 642 | 36,707 | 337 |
| BMW X5 | 306,557 | 11,541 | 122,446 | 1,043 | 306,557 | 22,569 | 147,938 | 1,563 | 88,338 | 763 |
| BMW X6 | 36,044 | 1,435 | 13,406 | 144 | 36,044 | 3,392 | 18,936 | 262 | 9,055 | 100 |
| Cadillac SRX | 419,965 | 12,576 | 160,216 | 1,231 | 419,965 | 31,070 | 200,259 | 2,100 | 136,511 | 1,092 |
| Infiniti EX35 | 60,872 | 1,773 | 24,250 | 179 | 60,872 | 3,946 | 29,097 | 359 | 17,789 | 180 |
| Infiniti FX35 | 108,882 | 3,889 | 42,771 | 405 | 108,882 | 7,646 | 52,693 | 734 | 31,325 | 275 |
| Infiniti FX50 | 7,193 | 247 | 3,311 | 32 | 7,193 | 451 | 3,136 | 35 | 2,611 | 17 |
| Land Rover LR2 | 35,283 | 1,433 | 13,907 | 135 | 35,283 | 2,256 | 16,619 | 186 | 10,754 | 87 |
| Lexus RX 350 | 969,669 | 31,845 | 398,145 | 3,044 | 969,669 | 74,406 | 457,025 | 5,293 | 311,076 | 2,659 |
| Lincoln MKT | 38,366 | 1,042 | 15,026 | 122 | 38,366 | 2,836 | 18,386 | 197 | 13,013 | 120 |
| Lincoln MKX | 188,276 | 5,276 | 69,275 | 528 | 188,276 | 11,522 | 94,828 | 924 | 60,650 | 491 |
| Mercedes-Benz GLK class | 220,877 | 7,539 | 92,759 | 959 | 220,877 | 16,196 | 98,527 | 1,358 | 66,425 | 860 |
| Mercedes-Benz M class | 319,744 | 10,107 | 119,339 | 1,041 | 319,744 | 21,743 | 163,878 | 1,942 | 88,153 | 897 |
| Saab 9-4X | 1,055 | 33 | 413 | 1 | 1,055 | 72 | 498 | 6 | 380 | 1 |
| Saab 9-7X | 8,939 | 248 | 2,419 | 19 | 8,939 | 712 | 5,883 | 61 | 2,118 | 25 |
| Volvo XC90 | 107,244 | 4,103 | 42,424 | 318 | 107,244 | 6,315 | 51,432 | 480 | 31,884 | 240 |
| **Midsize luxury cars** | | | | | | | | | | |
| Acura TL | 137,298 | 3,919 | 50,421 | 385 | 137,298 | 9,894 | 65,301 | 943 | 38,905 | 371 |
| Audi A4 | 29,519 | 1,246 | 13,498 | 213 | 29,519 | 3,065 | 11,753 | 211 | 7,202 | 109 |
| Audi A4 4WD | 89,931 | 2,795 | 31,939 | 269 | 89,931 | 8,447 | 45,757 | 488 | 23,540 | 199 |
| Audi S4 4WD | 18,439 | 426 | 7,690 | 50 | 18,439 | 1,681 | 8,107 | 64 | 5,620 | 32 |
| BMW 3 | 308,736 | 9,796 | 121,616 | 1,218 | 308,736 | 26,526 | 140,918 | 2,159 | 81,335 | 1,062 |
| BMW M3 | 4,992 | 98 | 2,410 | 13 | 4,992 | 347 | 1,873 | 17 | 1,561 | 14 |
| Infiniti G25 | 43,441 | 1,400 | 15,239 | 159 | 43,441 | 3,517 | 22,135 | 389 | 10,360 | 149 |
| Infiniti G37 | 141,256 | 4,124 | 48,638 | 389 | 141,256 | 10,857 | 71,273 | 1,196 | 35,314 | 440 |
| Lexus ES 350 | 160,968 | 4,710 | 60,036 | 419 | 160,968 | 13,332 | 76,703 | 1,051 | 48,352 | 548 |
| Lexus IS 250 | 89,446 | 3,326 | 34,679 | 421 | 89,446 | 8,190 | 40,694 | 763 | 22,326 | 385 |
| Lexus IS 350 | 11,447 | 317 | 5,360 | 51 | 11,447 | 902 | 4,229 | 60 | 3,928 | 40 |
| Lexus IS F | 2,342 | 72 | 1,064 | 18 | 2,342 | 198 | 896 | 13 | 761 | 5 |
| Lincoln MKZ | 90,668 | 2,416 | 24,349 | 201 | 90,668 | 7,290 | 53,970 | 689 | 22,140 | 225 |
| Mercedes-Benz C class | 251,357 | 7,989 | 95,972 | 1,048 | 251,357 | 22,545 | 118,067 | 2,071 | 65,018 | 1,105 |
| Saab 9-3 | 4,798 | 142 | 1,777 | 11 | 4,798 | 339 | 2,278 | 31 | 1,519 | 13 |

## Appendix B: Summary loss results

| XC60 summary loss results relative to other midsize luxury SUVs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Vehicle damage coverage type | Lower bound | FREQUENCY | Upper bound | Lower bound | SEVERITY | Upper bound | Lower bound | OVERALL LOSSES | Upper bound |
| Collision | -22% | **-21%** | -20% | -$492 | **-$451** | -$410 | -$101 | **-$97** | -$93 |
| Property damage liability | -15% | **-14%** | -13% | -$250 | **-$219** | -$188 | -$22 | **-$20** | -$19 |

| 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 | -30% | **-28%** | -25% | -40% | **-36%** | -32% | -30% | **-25%** | -21% |
| Medical payment | -22% | **-19%** | -16% | -21% | **-12%** | -3% | -30% | **-26%** | -22% |
| Personal injury protection | -23% | **-21%** | -18% | -11% | -5% | 1% | -33% | **-30%** | -27% |

| S60 summary loss results relative to other midsize luxury cars | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Vehicle damage coverage type | Lower bound | FREQUENCY | Upper bound | Lower bound | SEVERITY | Upper bound | Lower bound | OVERALL LOSSES | Upper bound |
| Collision | -13% | **-12%** | -11% | -$476 | **-$412** | -$348 | -$87 | **-$80** | -$73 |
| Property damage liability | -17% | **-15%** | -14% | -$249 | **-$195** | -$141 | -$21 | **-$18** | -$16 |

| 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 | -35% | **-31%** | -27% | -40% | **-33%** | -26% | -44% | **-37%** | -30% |
| Medical payment | -34% | **-30%** | -25% | -53% | **-44%** | -33% | -38% | **-33%** | -27% |
| Personal injury protection | -26% | **-23%** | -20% | -29% | **-23%** | -15% | -24% | **-20%** | -16% |

| XC60 summary loss results relative to other Volvos | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Vehicle damage coverage type | Lower bound | FREQUENCY | Upper bound | Lower bound | SEVERITY | Upper bound | Lower bound | OVERALL LOSSES | Upper bound |
| Collision | -15% | **-14%** | -12% | -$144 | -$68 | $7 | -$49 | **-$43** | -$36 |
| Property damage liability | -9% | **-7%** | -5% | $35 | **$94** | $152 | -$6 | **-$3** | $0 |

| 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 | -28% | **-23%** | -17% | -45% | **-37%** | -29% | -25% | **-15%** | -3% |
| Medical payment | -16% | **-9%** | -2% | -35% | **-21%** | -4% | -17% | -6% | 6% |
| Personal injury protection | -18% | **-13%** | -8% | -32% | **-24%** | -14% | -21% | **-14%** | -7% |

| S60 summary loss results relative to other Volvos | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Vehicle damage coverage type | Lower bound | FREQUENCY | Upper bound | Lower bound | SEVERITY | Upper bound | Lower bound | OVERALL LOSSES | Upper bound |
| Collision | 6% | **9%** | 12% | $359 | **$507** | $651 | $50 | **$63** | $76 |
| Property damage liability | -19% | **-16%** | -12% | $30 | **$149** | $263 | -$14 | **-$9** | -$4 |

| 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 | -37% | **-27%** | -15% | -42% | **-25%** | -3% | -56% | **-41%** | -22% |
| Medical payment | -23% | -10% | 6% | -59% | -35% | 2% | -18% | 5% | 34% |
| Personal injury protection | -2% | 10% | 22% | -38% | **-22%** | -1% | 16% | **34%** | 56% |

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The Highway Loss Data Institute is a nonprofit public service organization that gathers, processes, and publishes insurance data on the human and economic losses associated with owning and operating motor vehicles. DW201412 SK