HLDI
Highway Loss Data Institute

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Insurance losses of electric vehicles and their conventional counterparts while adjusting for mileage

Summary

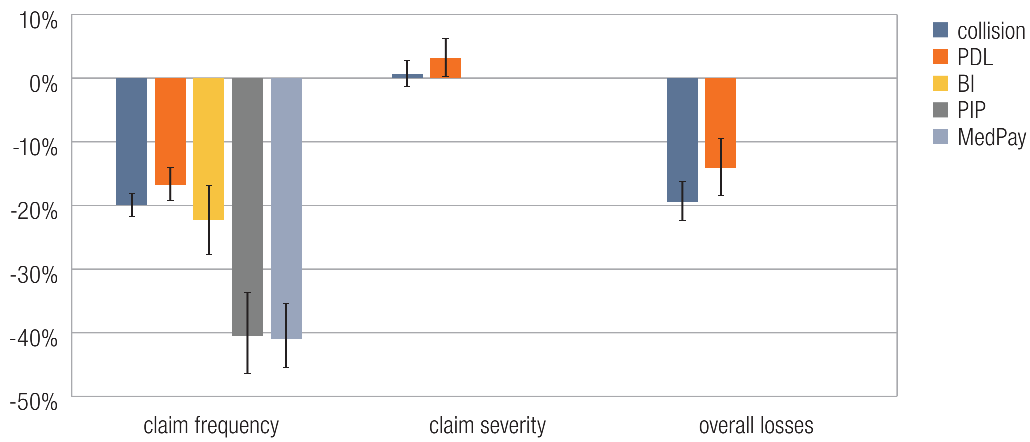
Unlike conventional and hybrid vehicles, electric vehicles are powered exclusively by electricity stored in batteries. In the United States, the number of electric vehicles on the road has increased significantly since the introduction of the Tesla Roadster in 2008, and this growth is projected to continue. Therefore, it is important to understand how the insurance losses of electric vehicles differ from conventional vehicles.

The current study is an update of previous Highway Loss Data Institute (HLDI) studies on insurance losses for electric vehicles in 2015, 2016, and 2017. The current study expands on the prior studies by looking at injury coverages for the first time and exploring the differences and changes in claim severities in more detail. The prior study (HLDI, 2017) found collision and property damage liability (PDL) claim frequencies for electric vehicles to be significantly lower than their conventional counterparts, while claim severity tended to be higher. However, the higher claim severity associated with electric vehicles from the earlier studies (HLDI, 2015; 2016) has attenuated over time.

This analysis compares insurance losses for electric vehicles with their conventional counterparts under collision, PDL, and injury-related coverages. Claim frequencies were calculated both with and without miles per day as a control. HLDI obtained the mileage information through a cooperative agreement with CARFAX, a unit of IHS Markit. In comparison to the 2017 bulletin, this study adds one new vehicle pair (2019–20 Hyundai Kona), two additional calendar years (2018–19), and more than twice the exposure.

The results of the current study (shown below) are consistent with the findings of the prior research. Electric vehicles continue to show significantly lower collision and PDL claim frequencies compared with their conventional counterparts. The increases in collision and PDL claim severity associated with electric vehicles have continued to attenuate, with the collision result no longer statistically significant. Electric vehicles were also associated with lower claim frequencies under all three injury coverages.

Estimated insurance losses of electric vehicles versus conventional counterparts, controlling for mileage



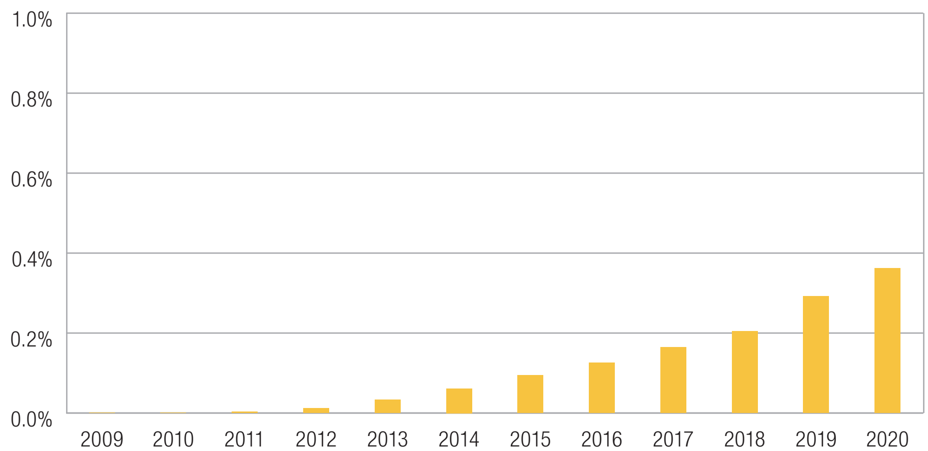
HLDI will continue to monitor the changing landscape of electric vehicles. Based on vehicle history reports from CARFAX, the electric vehicle series in this analysis were driven 39 percent fewer miles per day than their conventional counterparts. However, when mileage was included in the model, the magnitude of the claim frequency and overall loss benefits declined somewhat but remained significant. This indicates that the lower losses for electric vehicles are due only partly to fewer exposure miles.

Note that this report does not include information on Tesla losses because Tesla has no conventionally-powered counterpart; previous HLDI analyses have indicated that Tesla losses are higher than other large luxury vehicles with conventional gas engines, and that difference increases when adjusted for exposure miles.

Introduction

The first all-electric vehicle available for sale to consumers in the United States was the 2008 Tesla Roadster electric convertible. Since then, the number of all-electric vehicles in the registered vehicle fleet, while still very small, has been growing rapidly. **Figure 1** shows the rise of electric vehicles in the vehicle fleet since 2009, as a proportion of the registered vehicle fleet. In 2009, there were only around 500 electric vehicles registered in the fleet and by 2020, there were more than 1 million (less that 0.4 percent of the total registered vehicle fleet).

Figure 1: Proportion of electric vehicles in the registered vehicle fleet by calendar year



HLDI has published the loss experience of electric cars in direct comparison with their nonelectric counterparts in 2015, 2016, and 2017. This bulletin is similar to the prior analyses and continues to include results adjusted for miles traveled. Results for the corresponding conventional versions were included for comparison. A conventional counterpart shares the same platform and nameplate with its electric version and is produced by the same manufacturer. Only true electric vehicles were included in this study. The Chevrolet Volt, which can be powered by electricity or gasoline (when the battery is depleted), was not included. Other all-electric vehicles, such as the Chevrolet Bolt, Nissan Leaf, and Tesla vehicles, were also not included in the analysis, as they have no direct gasoline-powered counterparts.

Method

Insurance data

Automobile insurance covers damage to vehicles and property in crashes plus injuries to the people involved in the crashes. Different insurance coverages pay for vehicle damage versus injuries, and different coverages may apply depending on who is at fault. This study is based on collision, property damage liability (PDL), bodily injury (BI) liability, personal injury protection (PIP), and medical payment (MedPay) coverage data.

Collision coverage insures against physical damage to a driver's vehicle sustained in a crash with an object or other vehicle, generally when the driver is at fault. PDL coverage insures against vehicle damage that at-fault drivers cause to other people's vehicles and property in crashes. This coverage exists in all states except Michigan, where vehicle damage is covered on a no-fault basis (each insured vehicle pays for its own damage in a crash, regardless of who is at fault).

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 liability coverage, this information was only analyzed for the 33 states with traditional tort insurance systems where the at-fault driver has first obligation to pay for injuries. MedPay coverage also is sold in the 33 states with traditional tort insurance systems and covers injuries to insured drivers and the passengers in their vehicles, but not injuries to people in other vehicles involved in the crash. The 17 other states without traditional tort insurance systems employ no-fault injury systems where PIP coverage pays 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 was excluded from each injury analysis.

Exposure is measured in insured vehicle years. An insured vehicle year is equivalent to one vehicle insured for one year, two vehicles insured for six months, etc. Comprehensive coverage was not included in this analysis. Injury-related coverages were included in this analysis for the first time. Due to the small number of claims associated with the electric vehicles under injury coverages, only the frequencies for all claims were analyzed in this study.

Mileage data

The linking of mileage data and HLDI insurance data was made possible through a cooperative agreement with CARFAX. Vehicle identification numbers (VINs) from the HLDI database were matched to odometer readings from CARFAX. Odometer readings came from multiple sources, including title transfers, yearly inspections, and routine maintenance service. The frequency of odometer readings varied widely. Some vehicles had just one or two odometer readings, while others had numerous readings (e.g., every oil change and state inspection).

Miles per day (MPD) was computed for each day of exposure by taking the ratio of the increase in miles from two consecutive odometer readings to the number of days between the two readings. When more than one mileage reading was available, MPD was calculated for each pair. For example, the days between the first and second mileage readings could be assigned different MPD than the days between the second and third mileage readings. The different daily averages were assigned to the corresponding periods of matching collision coverage.

Vehicles studied

The vehicles included in this study were electric vehicles and their exact conventional counterparts. The conventional counterpart had to have a gasoline-powered engine and the same platform and nameplate as the electric vehicle. Model years were limited to those where both the electric and conventional versions were available. A total of nine vehicle pairs were included, with model years ranging from 2012 to 2020. These vehicle pairs are listed in **Table 1**. One vehicle pair was added to this study: the Hyundai Kona.

The earlier analyses (HLDI, 2015, 2016, 2017) included the 2011 BMW 1 series and 2011 Smart ForTwo vehicles. The electric versions of both these vehicles were available as lease only. As a larger pool of electric vehicles with conventional counterparts are now available to study, both the 2011 BMW and Smart ForTwo were excluded from the current analysis.

Table 1: Electric vehicles and their conventional counterparts

Model years	Make	Electric series	Conventional series
2012–14	Toyota	RAV4 EV electric 5dr 2WD	RAV4 4dr 2WD
2012–18	Ford	Focus electric 5dr	Focus 5dr
2013–17	Smart	Electric driver 2dr	ForTwo 2dr
2013–19	Fiat	500 electric 2dr	500 2dr
2013–15, 2017	Smart	Electric drive convertible	ForTwo convertible
2014–16	Chevrolet	Spark EV electric 5dr	Spark 5dr
2015–19	Volkswagen	E-Golf electric 4dr	Golf 4dr
2015–19	Kia	Soul electric station wagon	Soul station wagon
2019–20	Hyundai	Kona electric 4dr	Kona 4dr

Analysis methods

Regression analysis was used to quantify the difference between the electric vehicles and their conventional counterparts while controlling for other covariates. Estimates for claim frequency, claim severity, and overall losses are presented for collision and PDL coverage types. The frequencies for all claims of BI, PIP, and MedPay coverages are also reported. MPD was included in the analyses for claim frequencies, and thus overall losses. Average MPD was included in all models, except for the claim severity models. Prior HLDI research (2016c) found much higher average claim severity for vehicles with low average MPD than those with moderate-to-high average MPD. The analysis indicated that the more costly claims were responsible for lower average MPD—low MPD did not cause higher dollar claims. We hypothesized that the crashes that result in high severity claims cause extensive damage associated with increased repair times. Those increased repair times keep vehicles off of the road and decrease the amount of miles that they travel. Due to this phenomenon, all HLDI studies only add average MPD to the claim frequency control variables and not to the claim severity control variables.

HLDI normally separates vehicles of the same nameplate but with conventional or electric engines into different series. For example, the Ford Focus five-door is a separate vehicle series from the Ford Focus electric five-door series. For this analysis, the conventional and electric counterparts with the same nameplate were combined into one series, the Ford Focus five-door. Combining these into a single series allowed for the regression model to control for factors common to both the conventional and electric versions. Based on the model year and the combined series, a single variable called SERIESMY was created for inclusion in the regression model. Effectively, this variable controlled for the variation caused by vehicle design changes that occur from model year to model year.

Other covariates included calendar 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 only), and risk. Categories with the largest exposure were assigned as the reference category as follows: engine = conventional, vehicle model year and series = 2012 Ford Focus 5dr, miles driven per day = 40–49.9, rated driver age group = 50–59, risk = standard, state = California, rated driver gender = female, rated driver marital status = married, deductible range = $251–500, density = 1,000+, and calendar year = 2018.

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 for collision and PDL were derived from the claim frequency and claim severity models. Estimates for claim frequency are presented for collision, PDL, BI liability, PIP, and MedPay coverage types. The frequencies of BI liability, PIP, and MedPay claims are for all claims, including those that have been paid and those for which money has been set aside for possible payment in the future, known as claims with reserves. For space reasons, illustrative full regression results for collision claim frequency with mileage are shown in the **Appendix**.

To further simplify the presentation here, the exponent of the parameter estimate was calculated, 1 was subtracted, and the results multiplied by 100. The resulting number corresponds to the effect of a given model variable on a loss measure. For example, the estimate of collision claim frequency with mileage for electric vehicles was −0.2222; thus, collision claim frequency is expected to be 20 percent lower than that of their conventional counterparts ((exp(−0.2222)−1) × 100 = −20).

Illustrated vehicle information

Table 2 shows the exposure of the electric series and their conventional counterparts, sorted by conventional exposure in descending order. Electric series exposure ranged from 1 percent to 17 percent. The Ford Focus pair had the highest exposure (over 2 million years combined). Note that the model years applied for each pair were not identical; thus, exposure across the series pairs should not be compared directly.

Table 2: Exposure summary

	Electric exposure	Conventional exposure	Percent electric
Ford Focus 5dr	24,487	1,985,703	1%
Kia Soul	13,332	1,246,284	1%
Toyota Rav4	8,771	974,846	1%
Fiat 500 2dr	61,290	330,272	16%
Chevrolet Spark 5dr	20,959	306,510	6%
Volkswagen Golf	33,122	162,376	17%
Smart ForTwo 2dr	13,908	97,879	12%
Hyundai Kona 4dr	1,142	15,854	7%
Smart ForTwo Convertible	1,260	8,118	13%
Total	**178,271**	**5,127,842**	**3%**

Figure 2 compares the exposure weighted average base price, curb weight, and miles per day (MPD) of the electric series with their conventional counterparts. The weights in the average were proportional to the exposure of each record in the dataset. Vehicles with high exposure contribute more than vehicles with low exposure in the final average results. For analyses using the current exposure-weighted average method, the base price of electric vehicles was 62 percent higher than their conventional counterparts. The curb weight of electric vehicles was 9 percent higher than their conventional counterparts, and the MPD of electric vehicles was 39 percent lower than their conventional counterparts.

Figure 2: Exposure-weighted base price, curb weight, and mileage, electric versus conventional counterparts

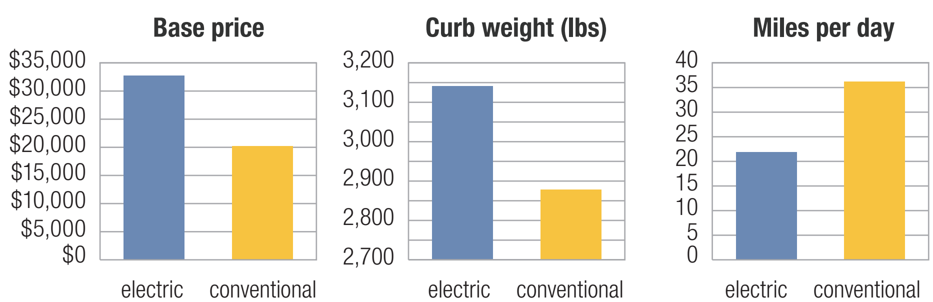
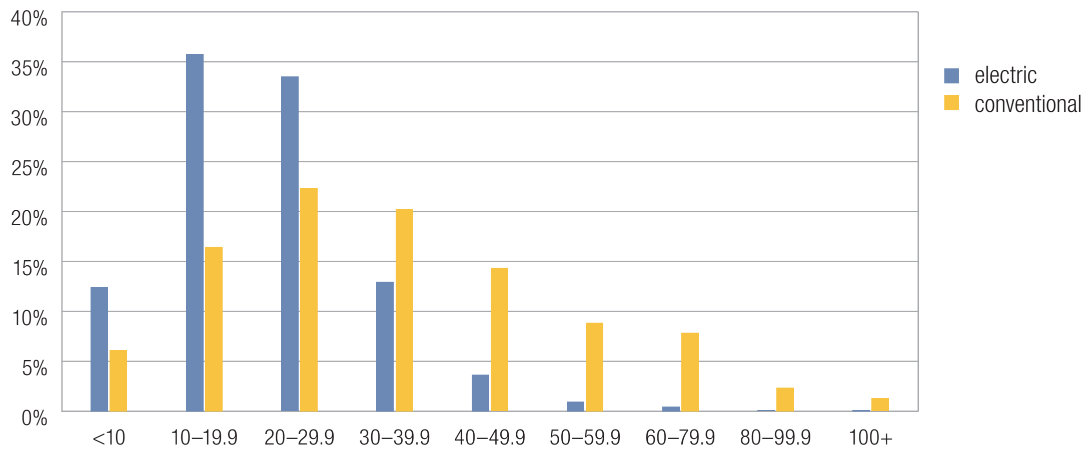


Figure 3 compares the exposure distribution of miles per day (MPD) between electric vehicles and their conventional counterparts when MPD is known. The proportion of exposure for vehicles with unknown or invalid MPD was higher for electric vehicles compared with their conventional counterparts (35 percent vs 28 percent). This is likely due to electric vehicles not needing oil changes, and therefore they are less likely to have CARFAX data compared with conventional vehicles. Among vehicles with known MPD, 82 percent of the electric vehicle exposure was for vehicles averaging fewer than 30 MPD compared with only 44 percent of the exposure for conventional vehicles. The availability of charging stations and limited battery range can make electric vehicles less suitable for longer trips.

Figure 3: Miles per day distribution, electric vehicles versus conventional counterparts



Results

Estimated insurance losses for studied coverages

Figure 4 shows the estimated collision and PDL losses for the electric series versus their conventional counterparts. When controlling for mileage, electric vehicles were estimated to have lower collision claim frequency (–20 percent) and overall losses (–19 percent). Claim severity does not take mileage into account and resulted in an insignificant 1 percent increase for collision.

For PDL, a similar pattern emerged, showing claim frequency and overall loss reductions of 17 percent and 14 percent, respectively, taking mileage into account. Claim severity showed a 3 percent increase. All estimates for both collision and PDL were statistically significant except for collision claim severity.

Figure 4: Estimated collision and PDL losses of electric vehicles versus conventional counterparts, controlling for mileage

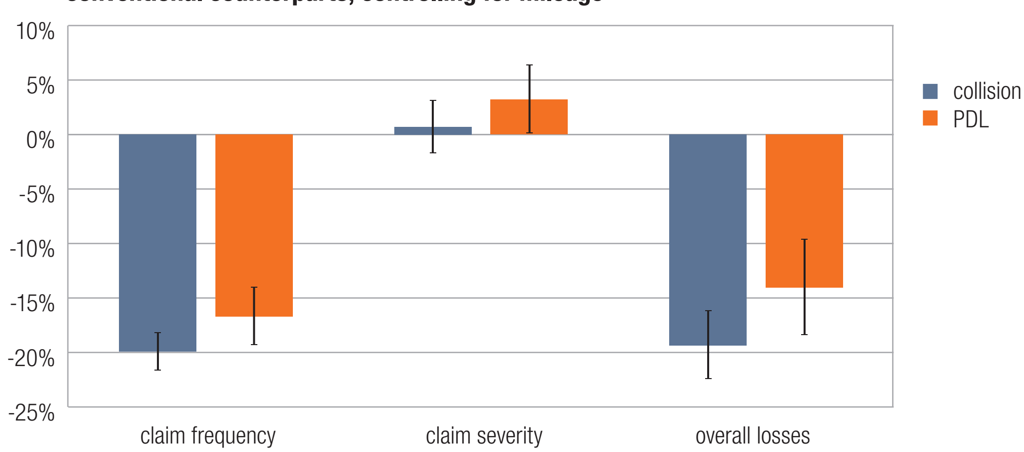


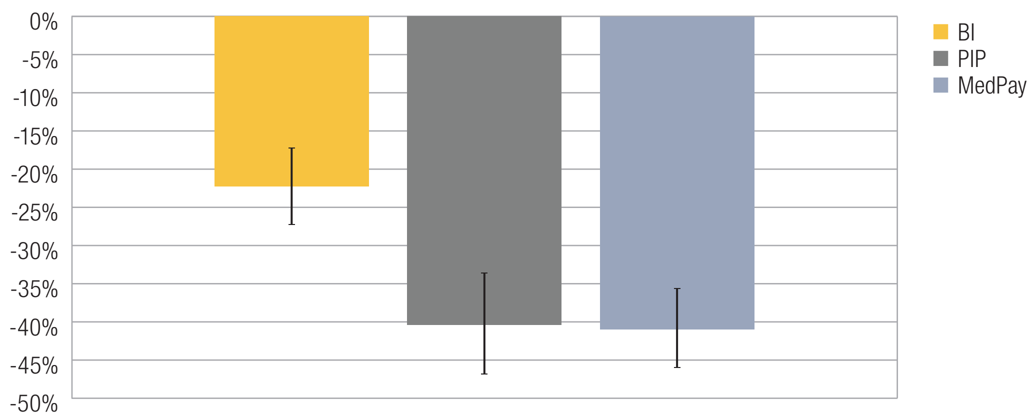
Table 3 shows a summary of the results for the collision and PDL coverage types. All results are statistically significant, except for collision claim severity. This table compares the claim frequency and overall loss results with and without mileage as well as the uncontrolled severity estimates. Claim frequencies and overall losses for the electric vehicles were lower than their conventional counterparts, but once mileage was included in the model, the reductions were not as large.

Table 3: Change in insurance losses, electric versus conventional counterparts

	Claim frequency not controlling for mileage	Claim frequency controlling for mileage	Percent difference	Claim severity not controlling for mileage	Overall losses not controlling for mileage	Overall losses controlling for mileage
Collision	-23%	-20%	-15%	1%	-23%	-19%
Property damage liability	-21%	-17%	-21%	3%	-19%	-14%

Figure 5 shows the estimated injury coverage claim frequencies for electric vehicles versus their conventional counterparts. When controlling for mileage, electric vehicles were estimated to have lower claim frequencies for BI, PIP, and MedPay with 22 percent, 40 percent, and 41 percent, respectively. All these results were statistically significant. Due to the small number of claims associated with the electric vehicles under injury coverages, only the frequency for all claims were analyzed here.

Figure 5: Estimated injury coverage claim frequencies for electric vehicles versus conventional counterparts, controlling for mileage



In 2017, HLDI analyzed electric vehicles and their conventional counterparts, taking mileage into account for claim frequency and overall losses. **Figures 6–7** compare the results from the 2017 report with the current report for collision and PDL coverages (HLDI, 2017). For collision, the largest change was in claim severity, which showed a significant 7 percent increase in the 2017 report, and is now a much smaller, insignificant, 1 percent increase. PDL claim severity showed a similar trend, declining from an 8 percent increase to only a 3 percent increase. Both collision and PDL claim frequency results showed slight attenuation but remained consistent with the prior study. Consequently, overall losses for both coverages showed a slightly larger reduction when compared with prior results.

Figure 6: Estimated collision losses of electric vehicles versus conventional counterparts, December 2017 and December 2020 reports, controlling for mileage

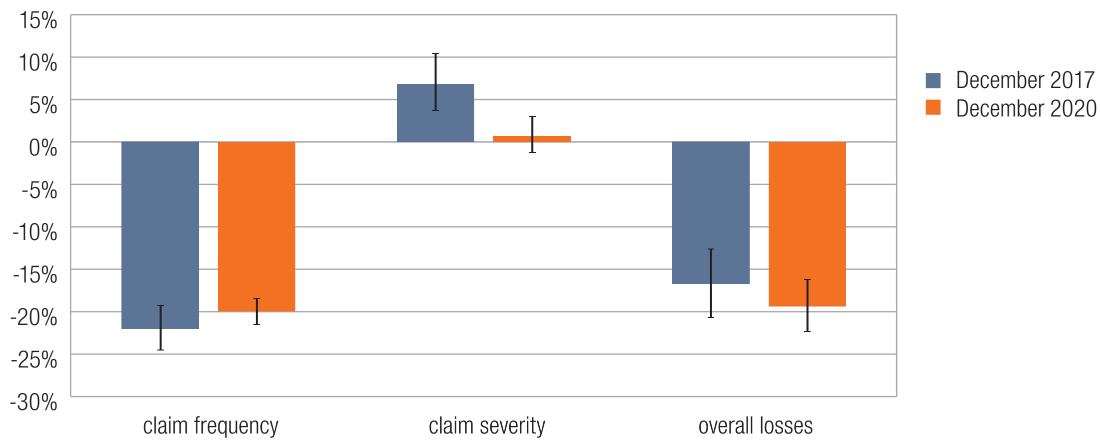
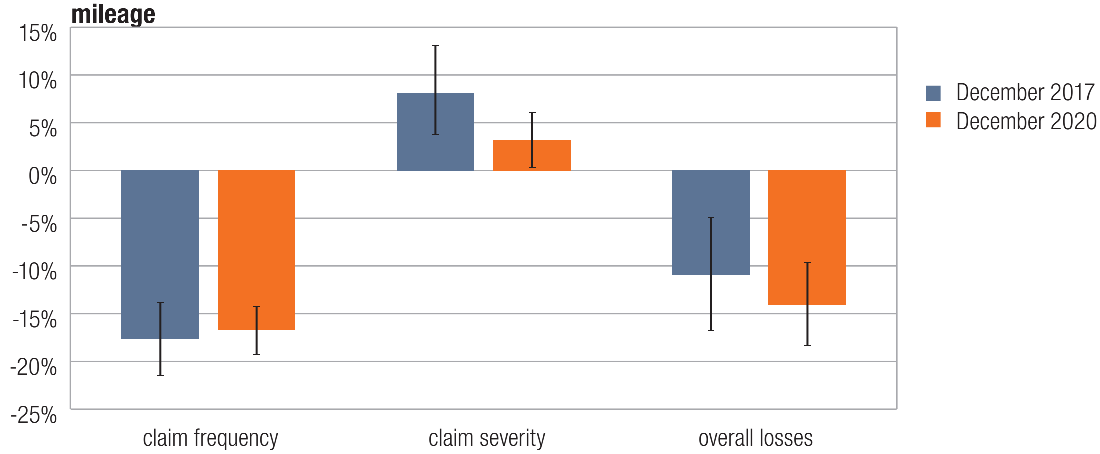


Figure 7: Estimated PDL losses of electric vehicles versus conventional counterparts, December 2017 and December 2020 reports, controlling for mileage



Discussion

HLDI's first study (2015) on electric vehicles and their conventional counterparts found that electric vehicles were associated with fewer collision and PDL claims, but increased collision and PDL claim severity. Although the frequency results have remained consistent over time, the increases in claim severity for both collision and PDL have attenuated, as shown in **Figure 8** (collision) and **Figure 9** (PDL). **Figure 8** shows the estimated (modeled) collision losses for electric vehicles and their counterparts by adding 1 calendar year at a time starting from 2016. Each year, the increase in collision claim severity diminished, until it reached 1 percent in the current report. This result is not statistically significant. Claim frequency results remained consistent over time. The overall losses had a slightly larger reduction each year, due mainly to the change in claim severity.

Figure 8: Estimated collision losses over time, electric vehicles versus conventional counterparts, controlling for mileage

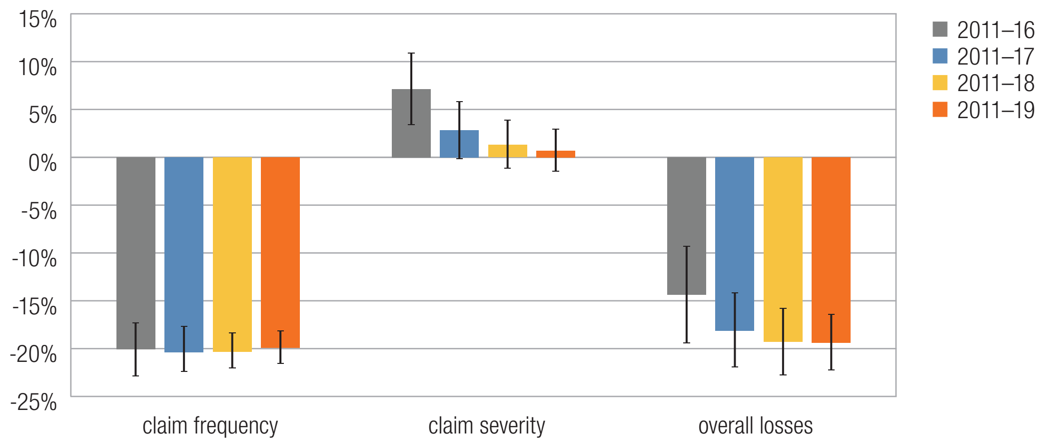


Figure 9 shows the estimated (modeled) PDL losses for electric vehicles and their counterparts by adding 1 calendar year at a time starting from 2016. The pattern for PDL losses was similar to collision losses, with claim frequency results remaining consistent over time while the increase in claim severity declined until it reached 3 percent in 2019.

Figure 9: Estimated PDL losses over time, electric vehicles versus conventional counterparts, controlling for mileage

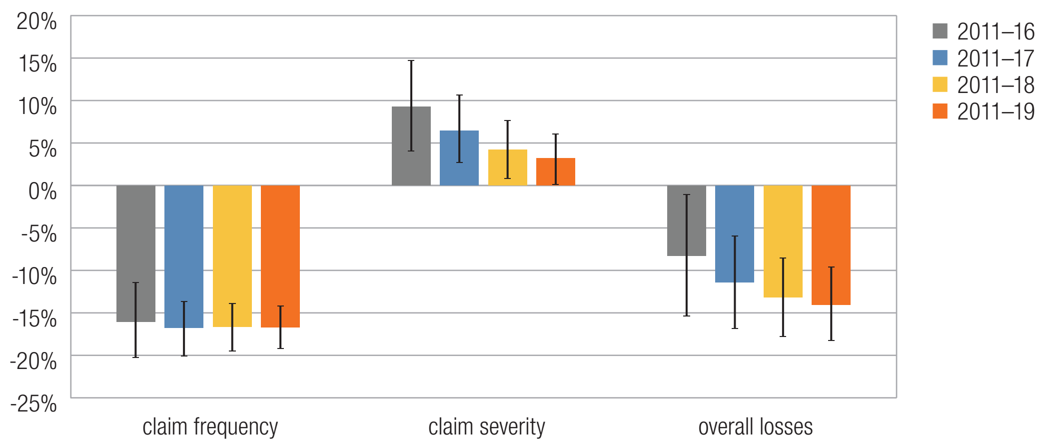
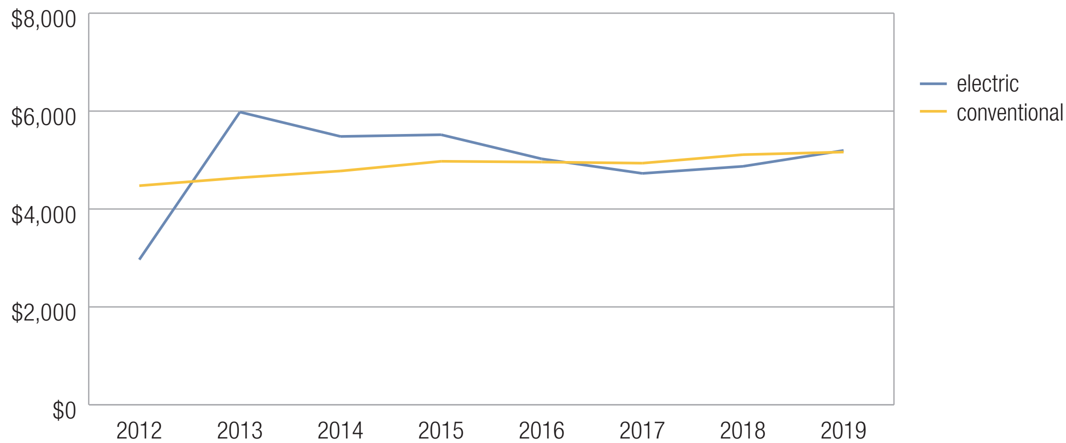


Figure 10 shows the average observed collision claim severities for electric vehicles and their conventional counterparts by calendar year. In 2013, collision claim severity was over $1,300 higher for electric vehicles compared with their conventional counterparts. However, claim severity for electric vehicles steadily dropped over the next 4 years while claim severity for the conventional vehicles increased. In 2017, collision claim severity for the electric vehicles was actually lower than their conventional counterparts. Electric vehicle claim severity began increasing again in 2018 and as of 2019 were on par with their conventional counterparts.

Figure 10: Observed collision claim severities by calendar year, electric vehicles versus conventional counterparts

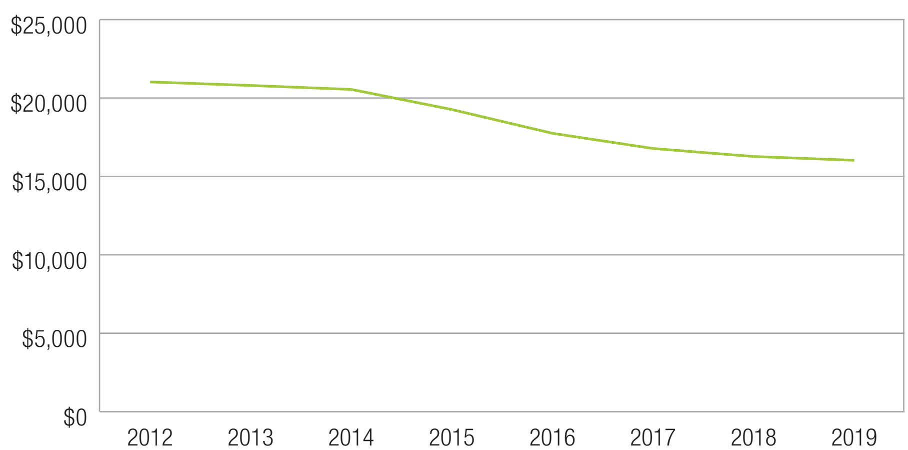


Vehicle base price

One contributing factor to claim severity is the price of the vehicle. An exposure-weighted base price difference was calculated to present the overall change of the difference in base price over time. The base price difference between the electric vehicles and their exact conventional counterpart with the same platform and nameplate by model year was first calculated. These differences were then weighted by the total conventional and electric exposure for that model year and series in a given calendar year and then averaged.

Figure 11 shows the exposure-weighted base price difference by calendar year for electric vehicles and their conventional counterparts. The base price difference between electric and conventional vehicles has decreased since 2012. In 2012, the exposure-weighted base price difference was $21,025. In 2017, it was $16,779. Throughout the study period, the difference in base price continued to decline, reaching a difference of $16,029 in 2019.

Figure 11: Exposure-weighted base price difference by calendar year



The changes in the base price difference are the result of two factors. One is that the distribution of vehicles included in the study has changed over time. **Figures 12–13** show the exposure distribution by manufacturer and calendar year for electric and conventional vehicles. In 2012, there were four vehicles in the study from Ford, Fiat, Smart, and Toyota. Over time, more makes and series were added, resulting in a larger mix of vehicles.

Figure 12: Exposure distribution for electric vehicles by calendar year and make

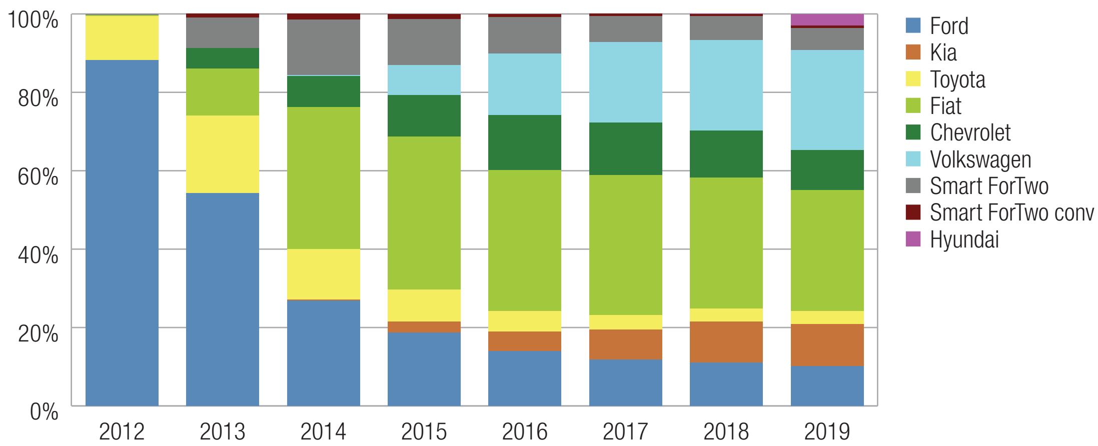
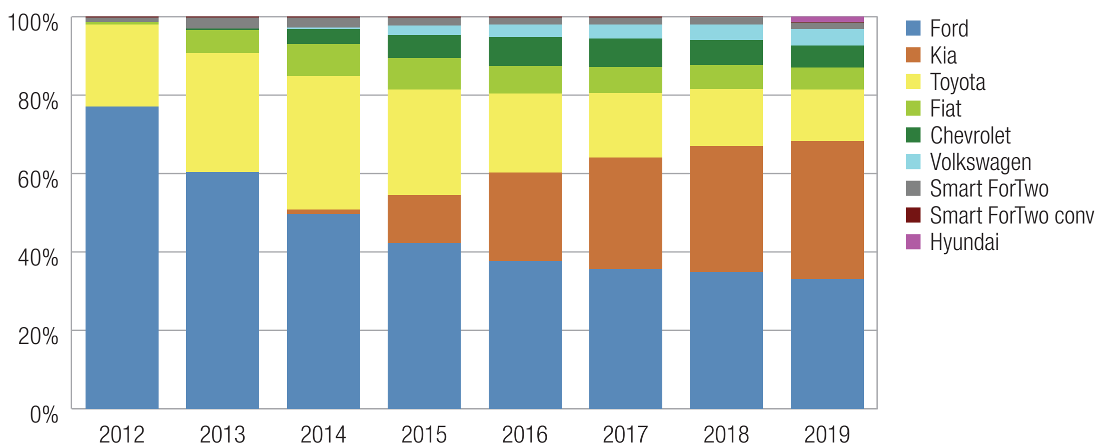
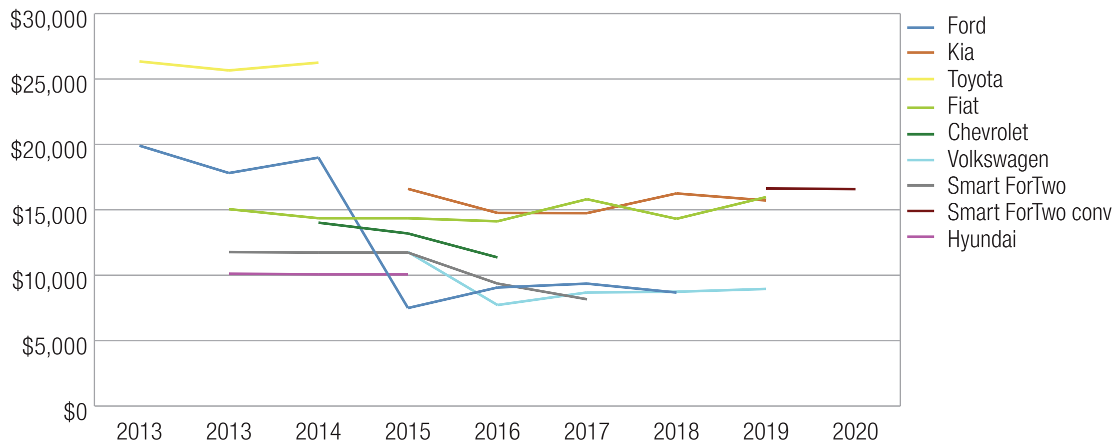


Figure 13: Exposure distribution for conventional vehicles by calendar year and make



The other factor is that for some vehicle series, the difference between the base price of an electric vehicle and its conventional counterpart declined for newer model years, as shown in **Figure 14**. For example, the base price difference for the Ford Focus declined from $18,990 in the 2014 model year to $7,490 in the 2015 model year. Similarly, the price difference for the Volkswagen Golf declined from $11,775 in the 2015 model year to $7,720 in the 2016 model year. However, not all vehicle pairs experienced a reduction in their price differences. For example, the base price difference between the electric vehicles and their conventional counterparts for Kia, Fiat, and Toyota remained relatively constant.

Figure 14: Base price difference for makes by model year, electric vehicles versus conventional counterparts



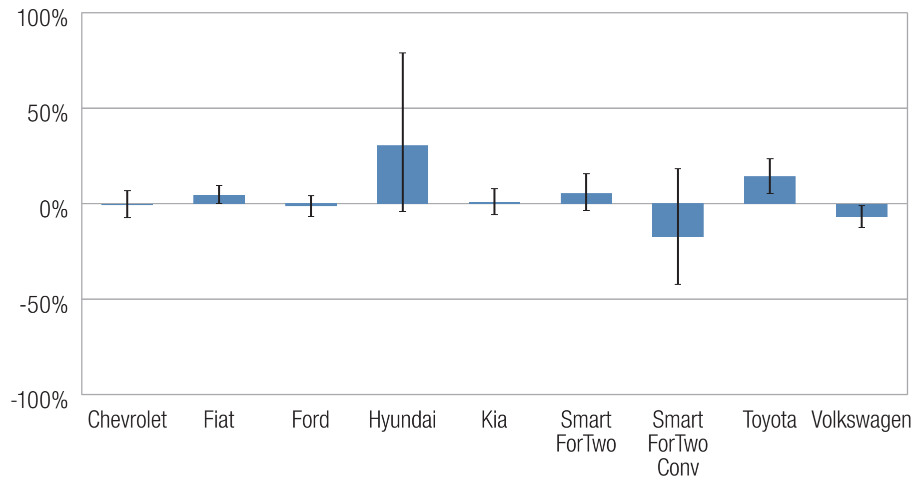
These two factors explain why the difference in base price between electric vehicles and their conventional counterparts in this study have been declining over time. This may also partly explain why the difference in collision claim severity has diminished. However, although less than before, the base price for electric vehicles was still $16,029 higher than their conventional counterparts in 2019. Typically, more expensive vehicles are associated with higher collision severities (HLDI, 2016a). Thus, it is puzzling why there is no statistically significant difference in collision claim severity between electric vehicles and their conventional counterparts. Note that this study uses the base price (i.e., the MSRP of the base model with destination charges) and not sale price and, therefore, does not include the price of optional equipment or higher end trim levels. Consequently, it is possible that differences in the actual sale price between electric and conventional vehicles are much smaller.

Exploration of collision claim severity

Several additional analyses were conducted to try and better understand why there was no significant difference in collision claim severity for electric vehicles, despite being more expensive compared with their conventional counterparts.

Figure 15 shows the estimated (modeled) collision claim severity for electric vehicles and their conventional counterparts by make. The estimated results vary among different makes. Across manufacturers, the Fiat and Toyota electric series were associated with a significant increase in collision claim severity compared with their conventional counterparts by 5 and 14 percent, respectively, while the Volkswagen electric series was associated with a significant decrease in collision claim severity by 7 percent.

Figure 15: Estimated collision claim severity by make, electric vehicles versus conventional counterparts



Another hypothesis investigated whether the age of the vehicle impacted the severity results. Batteries lose their effectiveness over time, so it is possible that electric vehicles depreciate faster over time compared with their conventional counterparts, which could affect collision claim severity. **Figure 16** compares suggested used car prices (from Kelley Blue Book) by model year for the Fiat 500 series and displays the base price for new 2019 Fiat 500 series vehicles. The new 2019 Fiat 500 electric depreciated much faster than its conventional counterpart did as shown in the figure. For example, the brand-new 2019 Fiat 500 electric sells for $34,705. In the first year, it depreciated to $13,510, losing 61 percent of its value (based on the price for a used 2018 Fiat 500 electric). By contrast, the Fiat 500 conventional sells new for $18,735 and depreciated to $12,499 in the first year, losing only 33 percent of its value. In the next year, the Fiat 500 electric depreciated from $13,510 to $8,971 (a 36 percent drop in value), while the Fiat 500 conventional lost much less: from $12,499 to $10,410 (a 17 percent drop in value). The suggested used car prices of the Fiat electric vehicles and its conventional counterparts converged over time. At the 6-year mark, the prices were almost the same: $6,457 for the electric and $6,102 for the conventional.

Figure 16: Comparison of suggested used car prices from Kelley Blue Book, for the Fiat 500

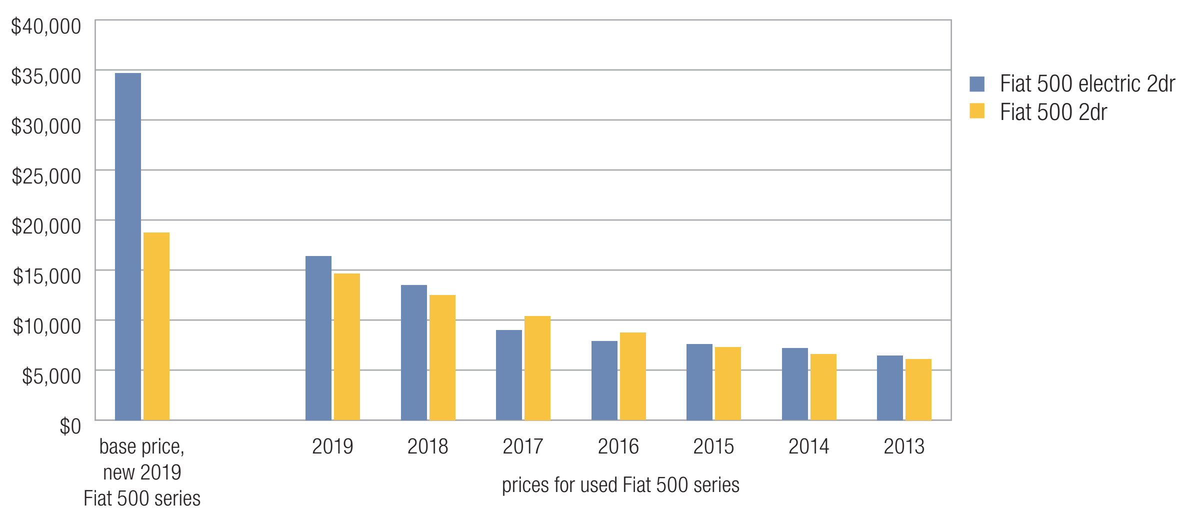
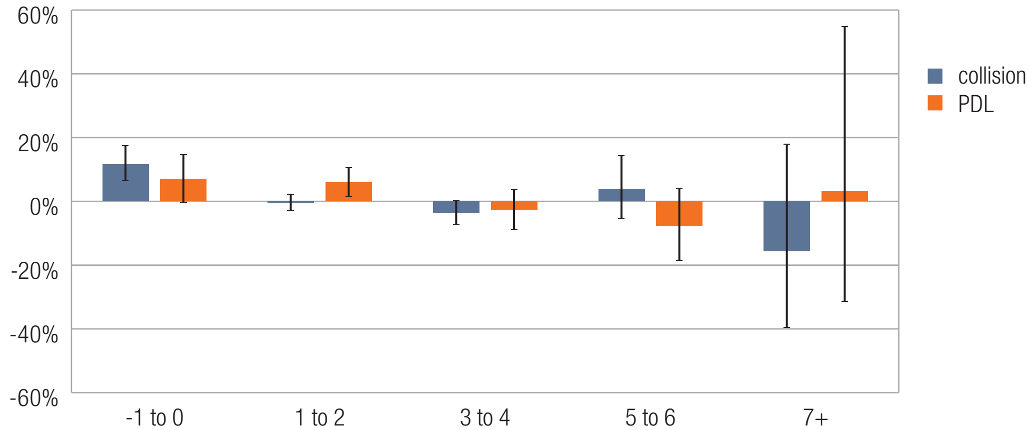


Figure 17 shows the estimated (modeled) differences in collision and PDL claim severities for electric vehicles and their conventional counterparts by vehicle age group. Collision claim severity for new electric vehicles was a significant 12 percent higher compared with their conventional counterparts. However, for older vehicles, there was no significant difference. Thus, it is possible that depreciation played a role in the severity results, but more research is needed to better understand the relationship between collision claim severity, vehicle price, and depreciation. PDL claim severity was 6 percent higher for vehicles aged 1 to 2 years old and significant. Results were not significant for the other age groups, and it is unclear how the age of the striking vehicle would affect the repair costs of the struck vehicle.

Figure 17: Estimated collision and PDL claim severities by vehicle age group, electric vehicles versus conventional counterparts



Total losses may also have played a role in the severity results. A vehicle is determined to be a total loss when the estimated cost to repair it plus the salvage amount is greater than the value of the repaired vehicle. **Figures 18–19** show that total losses as a percentage of all collision claims and the percentage of collision dollars paid for total losses for conventional vehicles were always higher than those for their electric vehicle counterparts. While conventional vehicles are typically less expensive, when involved in a crash, they are much more likely to be a total loss than electric vehicles.

Figure 18: Total losses as a percentage of collision claims by calendar year, electric vehicles versus conventional counterparts

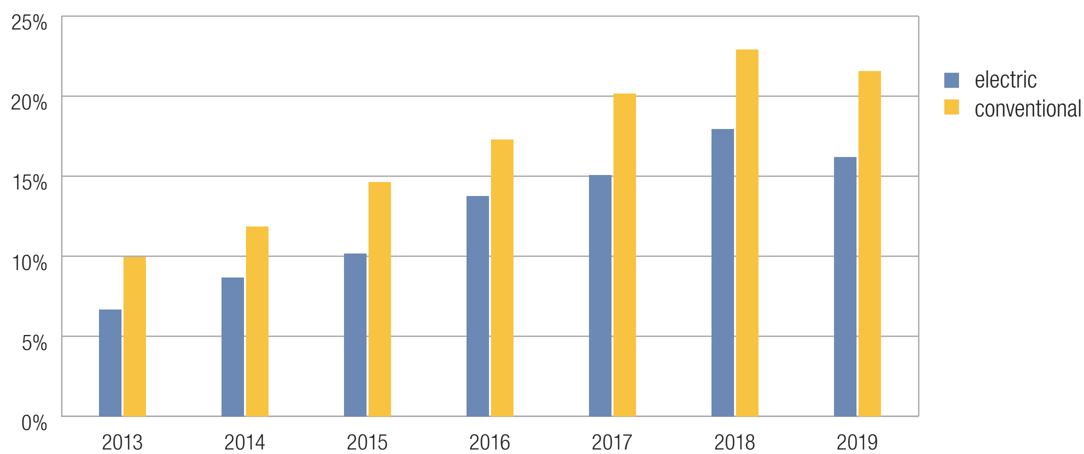
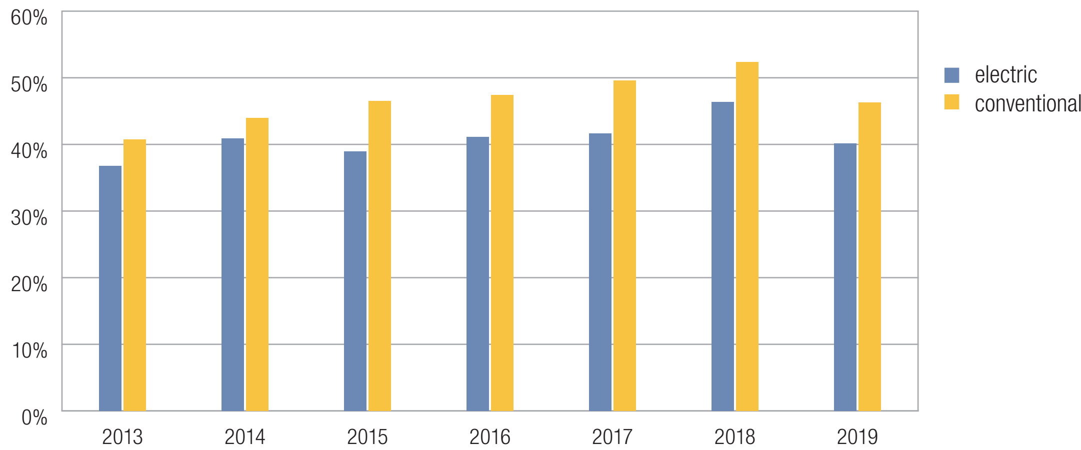
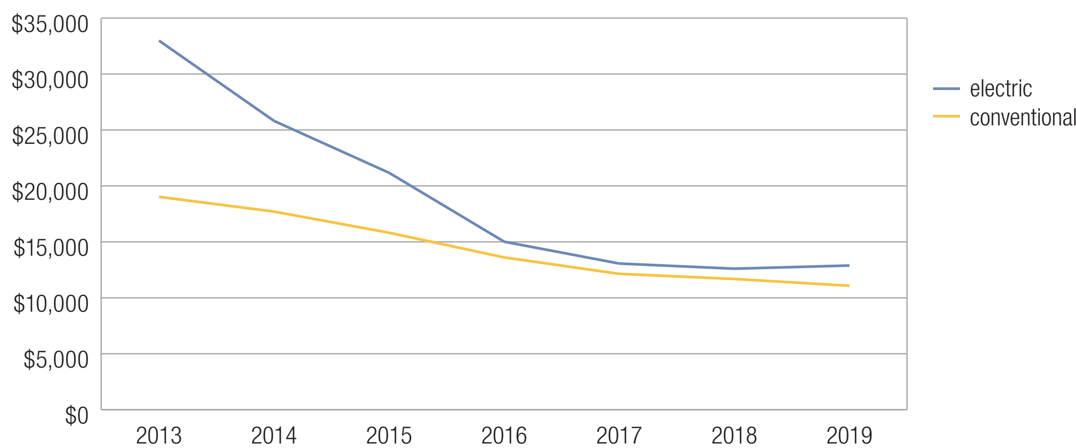


Figure 19: Percentage of collision dollars paid for total losses by calendar year, electric vehicles versus conventional counterparts



The average payment for total losses was higher for electric vehicles than their conventional counterparts from 2013 to 2019 (**Figure 20**). The largest difference is in 2013, where the average payment for total losses is $32,988 for electric vehicles and $19,025 for their conventional counterparts. This difference has gradually diminished over time, declining to only a $1,810 difference between electric vehicles and their conventional counterparts in 2019. This might also help to explain why the higher collision claim severity results associated with electric vehicles has decreased over time.

Figure 20: Average dollars paid for total losses by calendar year, electric vehicles versus conventional counterparts



Finally, the types of crashes these vehicles are involved in may also play a role. **Figure 21** shows the distribution of collision claims by point of impact for electric vehicles and their conventional counterparts during calendar years 2011 to 2019. Interestingly, compared with conventional vehicles, electrics had fewer frontal claims (45 percent vs. 51 percent) and more rear claims (32 percent vs. 27 percent). Claims for frontal impacts, on average, tend to have higher severities than claims for rear impacts, as shown in **Figure 22** ($5,540 in the front vs $3,092 in the rear for electric vehicles; $5,257 in the front vs. $3,298 in the rear for conventional vehicles). This could also help explain the insignificant collision claim severity result; however, it is unclear why electric vehicles would have fewer frontal and more rear impacts. Advanced driver assistance systems such as automatic emergency braking or rear cameras could affect the point-of-impact distribution, but the presence or absence of these systems on a vehicle was not known.

Figure 21: Distribution of collision claims by point of impact for electric vehicles and their conventional counterparts, 2011–19

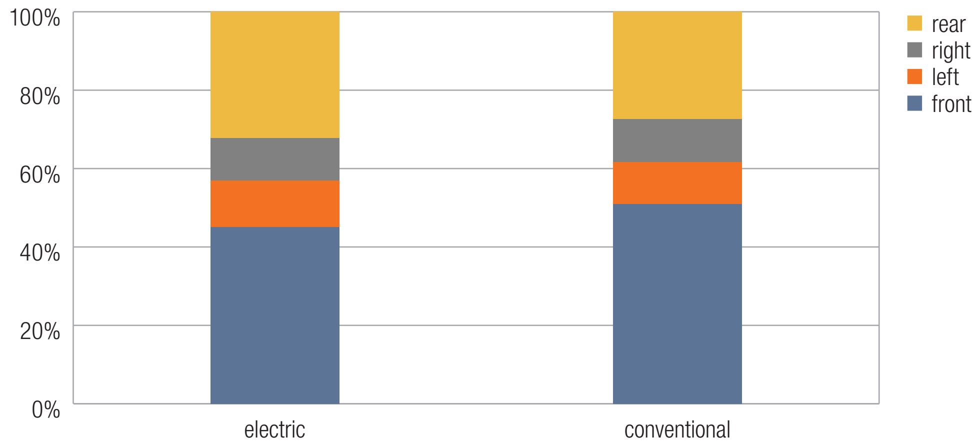
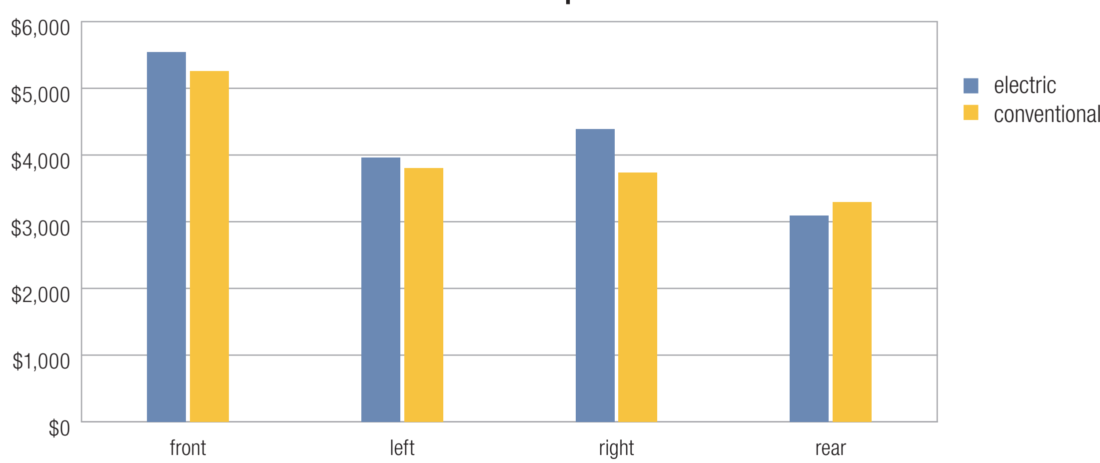


Figure 22: Average dollars paid by point of impact for collision coverage, electric vehicles versus conventional counterparts



In summary, the differences in both collision and PDL claim severities between electric vehicles and their conventional counterparts has diminished over time. Some of this reduction may be attributable to changes in the distribution of vehicles in the study as well as price reductions for newer models of some electric vehicles. Further analyses also found that differences in claim severity diminished as the vehicles aged, conventional vehicles were more likely to be totaled, and that electric vehicles had relatively fewer frontal- and more rear-impact claims. While these new analyses may help explain the collision severity results, the mechanism through which these factors affect PDL severity remains unclear. HLDI will continue to monitor the differences and changes in claim severity and explore other contributors associated with the changes.

Limitations

While ADAS features are offered on both electric and conventional vehicles, the availability of these features varies among electric vehicles and their conventional counterparts. It is not always the case that electric vehicles have more systems available than nonelectric vehicles. The presence or absence of ADAS on the vehicles in this study was unknown, and analyses did not control for the difference in ADAS availability, which could affect the estimated results for claim frequencies and insurance losses.

Additionally, electric vehicles are typically more expensive than their conventional counterparts. The type of person who selects an electric vehicle may be different from the person who selects a conventional vehicle. While the analysis controls for several driver characteristics, there may be other uncontrolled attributes associated with the people who select electric vehicles.

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Appendix

Appendix: Illustrative regression results — collision claim frequency									
Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald 95% confidence limits		Chi-square	P-value
Intercept		1	-8.3260		0.0103	-8.3461	-8.3059	659259.00	<0.0001
Engine	Electric	1	-0.2222	-19.9%	0.0112	-0.2442	-0.2002	392.38	<0.0001
	Conventional	0	0	0	0	0	0		
Vehicle model year and series	2013 Fiat 500 2dr	1	-0.1073	-10.2%	0.0104	-0.1276	-0.0870	106.97	<0.0001
	2014 Fiat 500 2dr	1	-0.0213	-2.1%	0.0196	-0.0598	0.0172	1.17	0.2786
	2015 Fiat 500 2dr	1	-0.0336	-3.3%	0.0133	-0.0597	-0.0075	6.35	0.0118
	2016 Fiat 500 2dr	1	0.0076	0.8%	0.0286	-0.0484	0.0636	0.07	0.7901
	2017 Fiat 500 2dr	1	0.0236	2.4%	0.0275	-0.0302	0.0775	0.74	0.3894
	2018 Fiat 500 2dr	1	0.1899	20.9%	0.0786	0.0358	0.3441	5.83	0.0157
	2019 Fiat 500 2dr	1	-0.0925	-8.8%	0.2295	-0.5423	0.3574	0.16	0.6870
	2013 Ford Focus 5dr	1	0.0410	4.2%	0.0075	0.0264	0.0556	30.17	<0.0001
	2014 Ford Focus 5dr	1	0.0605	6.2%	0.0072	0.0463	0.0747	69.70	<0.0001
	2015 Ford Focus 5dr	1	0.1232	13.1%	0.0099	0.1038	0.1427	154.06	<0.0001
	2016 Ford Focus 5dr	1	0.1697	18.5%	0.0101	0.1499	0.1895	282.62	<0.0001
	2017 Ford Focus 5dr	1	0.2056	22.8%	0.0136	0.1789	0.2323	227.77	<0.0001
	2018 Ford Focus 5dr	1	0.2215	24.8%	0.0183	0.1857	0.2573	147.28	<0.0001
	2013 Smart Fortwo 2dr	1	-0.2688	-23.6%	0.0204	-0.3087	-0.2288	173.88	<0.0001
	2014 Smart Fortwo 2dr	1	-0.2638	-23.2%	0.0332	-0.3289	-0.1988	63.20	<0.0001
	2015 Smart Fortwo 2dr	1	-0.2703	-23.7%	0.0308	-0.3307	-0.2098	76.76	<0.0001
	2016 Smart Fortwo 2dr	1	-0.0948	-9.0%	0.0324	-0.1582	-0.0313	8.57	0.0034
	2017 Smart Fortwo 2dr	1	-0.0290	-2.9%	0.0798	-0.1854	0.1275	0.13	0.7166
	2013 Smart Fortwo convertible	1	-0.3717	-31.0%	0.0644	-0.4978	-0.2456	33.37	<0.0001
	2014 Smart Fortwo convertible	1	-0.0991	-9.4%	0.1100	-0.3146	0.1165	0.81	0.3678
	2015 Smart Fortwo convertible	1	-0.6496	-47.8%	0.1797	-1.0018	-0.2974	13.07	0.0003
	2017 Smart Fortwo convertible	1	-0.3008	-26.0%	0.1282	-0.5520	-0.0496	5.51	0.0189
	2015 Volkswagen Golf 4dr	1	0.0155	1.6%	0.0134	-0.0108	0.0417	1.34	0.2478
	2016 Volkswagen Golf 4dr	1	0.1018	10.7%	0.0166	0.0692	0.1344	37.46	<0.0001
	2017 Volkswagen Golf 4dr	1	0.0811	8.4%	0.0191	0.0437	0.1185	18.05	<0.0001
	2018 Volkswagen Golf 4dr	1	0.1373	14.7%	0.0456	0.0479	0.2267	9.06	0.0026
	2019 Volkswagen Golf 4dr	1	0.0789	8.2%	0.0757	-0.0694	0.2273	1.09	0.2971
	2019 Hyundai Kona 4dr	1	-0.0851	-8.2%	0.0343	-0.1523	-0.0180	6.17	0.0130
	2020 Hyundai Kona 4dr	1	-0.2362	-21.0%	0.1488	-0.5278	0.0554	2.52	0.1124
	2012 Toyota RAV4 4dr 2WD	1	0.0376	3.8%	0.0085	0.0209	0.0543	19.53	<0.0001
	2013 Toyota RAV4 4dr 2WD	1	-0.0581	-5.6%	0.0083	-0.0744	-0.0418	48.76	<0.0001
	2014 Toyota RAV4 4dr 2WD	1	-0.0055	-0.5%	0.0086	-0.0224	0.0113	0.41	0.5215
	2015 Kia Soul SW	1	-0.0114	-1.1%	0.0075	-0.0261	0.0032	2.34	0.1261
	2016 Kia Soul SW	1	0.0265	2.7%	0.0078	0.0113	0.0417	11.66	0.0006
	2017 Kia Soul SW	1	0.1328	14.2%	0.0117	0.1099	0.1557	128.83	<0.0001
	2018 Kia Soul SW	1	0.1966	21.7%	0.0131	0.1709	0.2223	224.98	<0.0001
	2019 Kia Soul SW	1	0.2483	28.2%	0.0177	0.2136	0.2830	196.94	<0.0001
	2014 Chevrolet Spark 5dr	1	0.1002	10.5%	0.0100	0.0806	0.1197	100.62	<0.0001
	2015 Chevrolet Spark 5dr	1	0.1419	15.2%	0.0134	0.1157	0.1681	112.89	<0.0001

Appendix: Illustrative regression results — collision claim frequency

Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald 95% confidence limits		Chi-square	P-value
	2016 Chevrolet Spark 5dr	1	0.1314	14.0%	0.0151	0.1018	0.1610	75.56	<0.0001
	2012 Ford Focus 5dr	0	0	0	0	0	0		
Miles driven per day	Unknown	1	-0.3001	-25.9%	0.0068	-0.3134	-0.2868	1959.18	<0.0001
	<10	1	-0.2273	-20.3%	0.0098	-0.2465	-0.2080	537.29	<0.0001
	10–19.9	1	-0.1531	-14.2%	0.0070	-0.1668	-0.1395	483.41	<0.0001
	20–29.9	1	-0.0962	-9.2%	0.0064	-0.1086	-0.0837	229.16	<0.0001
	30–39.9	1	-0.0509	-5.0%	0.0064	-0.0635	-0.0383	62.89	<0.0001
	50–59.9	1	0.0362	3.7%	0.0078	0.0209	0.0516	21.38	<0.0001
	60–79.9	1	0.1188	12.6%	0.0080	0.1032	0.1344	222.49	<0.0001
	80–99.9	1	0.2379	26.9%	0.0119	0.2145	0.2613	397.35	<0.0001
	100+	1	0.4263	53.2%	0.0142	0.3984	0.4541	899.90	<0.0001
	40–49.9	0	0	0	0	0	0		
Rated driver age group	20–24	1	0.3551	42.6%	0.0069	0.3416	0.3686	2654.95	<0.0001
	25–29	1	0.1666	18.1%	0.0065	0.1538	0.1794	653.35	<0.0001
	30–39	1	0.0482	4.9%	0.0059	0.0367	0.0597	67.91	<0.0001
	40–49	1	0.0503	5.2%	0.0058	0.0389	0.0618	74.26	<0.0001
	60–64	1	-0.0378	-3.7%	0.0073	-0.0522	-0.0235	26.72	<0.0001
	65–69	1	-0.0062	-0.6%	0.0079	-0.0216	0.0092	0.62	0.4302
	70+	1	0.0943	9.9%	0.0068	0.0809	0.1076	191.87	<0.0001
	<20	1	0.4868	62.7%	0.0107	0.4657	0.5078	2055.80	<0.0001
	Unknown	1	0.071	7.4%	0.0101	0.0512	0.0908	49.37	<0.0001
	50–59	0	0	0	0	0	0		
Risk	Nonstandard	1	0.2151	24.0%	0.0067	0.2019	0.2282	1027.15	<0.0001
	Standard	0	0	0	0	0	0		
State	Alabama	1	-0.1692	-15.6%	0.0152	-0.1989	-0.1395	124.65	<0.0001
	Alaska	1	0.0654	6.8%	0.0433	-0.0195	0.1503	2.28	0.1313
	Arizona	1	-0.1597	-14.8%	0.0113	-0.1818	-0.1375	199.39	<0.0001
	Arkansas	1	-0.1523	-14.1%	0.0210	-0.1935	-0.1112	52.60	<0.0001
	Colorado	1	-0.0672	-6.5%	0.0146	-0.0958	-0.0386	21.17	<0.0001
	Connecticut	1	-0.2442	-21.7%	0.0215	-0.2865	-0.2020	128.52	<0.0001
	Delaware	1	-0.145	-13.5%	0.0288	-0.2015	-0.0886	25.34	<0.0001
	District of Columbia	1	0.1291	13.8%	0.0302	0.0699	0.1884	18.24	<0.0001
	Florida	1	-0.2961	-25.6%	0.0072	-0.3102	-0.2820	1696.18	<0.0001
	Georgia	1	-0.2199	-19.7%	0.0100	-0.2394	-0.2004	488.18	<0.0001
	Hawaii	1	-0.1208	-11.4%	0.0201	-0.1602	-0.0813	36.05	<0.0001
	Idaho	1	-0.3203	-27.4%	0.0278	-0.3749	-0.2658	132.38	<0.0001
	Illinois	1	-0.2563	-22.6%	0.0100	-0.2758	-0.2368	661.47	<0.0001
	Indiana	1	-0.2163	-19.5%	0.0141	-0.2439	-0.1886	234.58	<0.0001
	Iowa	1	-0.289	-25.1%	0.0229	-0.3338	-0.2441	159.35	<0.0001
	Kansas	1	-0.2692	-23.6%	0.0190	-0.3065	-0.2319	199.77	<0.0001
	Kentucky	1	-0.2795	-24.4%	0.0157	-0.3103	-0.2486	315.83	<0.0001
	Louisiana	1	-0.0452	-4.4%	0.0148	-0.0743	-0.0162	9.31	0.0023
	Maine	1	-0.1505	-14.0%	0.0291	-0.2075	-0.0935	26.75	<0.0001
	Maryland	1	-0.1176	-11.1%	0.0114	-0.1400	-0.0952	105.88	<0.0001

Appendix: Illustrative regression results — collision claim frequency									
Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald 95% confidence limits		Chi-square	P-value
	Massachusetts	1	0.1795	19.7%	0.0145	0.1512	0.2079	154.05	<0.0001
	Michigan	1	0.0304	3.1%	0.0104	0.0101	0.0507	8.62	0.0033
	Minnesota	1	-0.3327	-28.3%	0.0152	-0.3625	-0.3030	479.11	<0.0001
	Mississippi	1	-0.113	-10.7%	0.0238	-0.1596	-0.0663	22.56	<0.0001
	Missouri	1	-0.2462	-21.8%	0.0128	-0.2714	-0.2210	367.67	<0.0001
	Montana	1	-0.1675	-15.4%	0.0535	-0.2724	-0.0626	9.80	0.0017
	Nebraska	1	-0.3152	-27.0%	0.0304	-0.3747	-0.2557	107.79	<0.0001
	Nevada	1	-0.0971	-9.3%	0.0167	-0.1299	-0.0644	33.80	<0.0001
	New Hampshire	1	-0.1522	-14.1%	0.0262	-0.2035	-0.1009	33.84	<0.0001
	New Jersey	1	-0.2391	-21.3%	0.0131	-0.2647	-0.2135	334.67	<0.0001
	New Mexico	1	-0.0733	-7.1%	0.0211	-0.1147	-0.0320	12.07	0.0005
	New York	1	-0.152	-14.1%	0.0104	-0.1724	-0.1316	213.59	<0.0001
	North Carolina	1	-0.3446	-29.1%	0.0108	-0.3657	-0.3235	1021.17	<0.0001
	North Dakota	1	-0.0323	-3.2%	0.0555	-0.1410	0.0764	0.34	0.5601
	Ohio	1	-0.3573	-30.0%	0.0100	-0.3769	-0.3376	1271.17	<0.0001
	Oklahoma	1	-0.1741	-16.0%	0.0171	-0.2077	-0.1405	103.26	<0.0001
	Oregon	1	-0.2527	-22.3%	0.0147	-0.2816	-0.2238	293.96	<0.0001
	Pennsylvania	1	-0.0844	-8.1%	0.0095	-0.1030	-0.0658	79.31	<0.0001
	Rhode Island	1	-0.1343	-12.6%	0.0338	-0.2006	-0.0680	15.75	<0.0001
	South Carolina	1	-0.2816	-24.5%	0.0140	-0.3091	-0.2542	405.13	<0.0001
	South Dakota	1	-0.1823	-16.7%	0.0475	-0.2755	-0.0892	14.71	0.0001
	Tennessee	1	-0.1479	-13.7%	0.0121	-0.1715	-0.1243	150.64	<0.0001
	Texas	1	-0.2002	-18.1%	0.0068	-0.2135	-0.1868	860.37	<0.0001
	Utah	1	-0.2633	-23.1%	0.0207	-0.3040	-0.2227	161.26	<0.0001
	Vermont	1	-0.1163	-11.0%	0.0386	-0.1919	-0.0408	9.11	0.0025
	Virginia	1	-0.2256	-20.2%	0.0105	-0.2460	-0.2051	465.52	<0.0001
	Washington	1	-0.1694	-15.6%	0.0114	-0.1918	-0.1470	219.67	<0.0001
	West Virginia	1	-0.2405	-21.4%	0.0248	-0.2891	-0.1918	93.82	<0.0001
	Wisconsin	1	-0.3413	-28.9%	0.0150	-0.3707	-0.3120	518.94	<0.0001
	Wyoming	1	-0.0177	-1.8%	0.0608	-0.1369	0.1015	0.08	0.7712
	California	0	0	0	0	0	0		
Rated driver gender	Male	1	-0.0275	-2.7%	0.0036	-0.0345	-0.0206	59.90	<0.0001
	Unknown	1	-0.1711	-15.7%	0.0164	-0.2033	-0.1389	108.39	<0.0001
	Female	0	0	0	0	0	0		
Rated driver marital status	Single	1	0.1625	17.6%	0.0038	0.1550	0.1700	1805.51	<0.0001
	Unmarried	1	0.1463	15.8%	0.0158	0.1153	0.1773	85.57	<0.0001
	Married	0	0	0	0	0	0		
Deductible range	0–100	1	0.0444	4.5%	0.0076	0.0296	0.0593	34.53	<0.0001
	101–250	1	0.2076	23.1%	0.0050	0.1977	0.2175	1697.58	<0.0001
	501+	1	-0.2438	-21.6%	0.0047	-0.2530	-0.2346	2700.27	<0.0001
	251–500	0	0	0	0	0	0		
Density	<50	1	-0.3789	-31.5%	0.0081	-0.3947	-0.3631	2204.67	<0.0001
	50–99	1	-0.3017	-26.0%	0.0069	-0.3151	-0.2882	1931.71	<0.0001
	100–249	1	-0.2415	-21.5%	0.0055	-0.2522	-0.2308	1961.39	<0.0001
	250–499	1	-0.1918	-17.5%	0.0053	-0.2023	-0.1814	1303.22	<0.0001

Appendix: Illustrative regression results — collision claim frequency									
Parameter		**Degrees of freedom**	**Estimate**	**Effect**	**Standard error**	**Wald 95% confidence limits**		**Chi-square**	**P-value**
	500–999	1	-0.132	-12.4%	0.0050	-0.1418	-0.1222	701.21	<0.0001
	1,000+	0	0	0	0	0	0		
Calendar year	2011	1	-0.0411	-4.0%	0.0384	-0.1164	0.0342	1.14	0.2848
	2012	1	-0.0001	0.0%	0.0148	-0.0291	0.0289	0.00	0.9941
	2013	1	0.0148	1.5%	0.0097	-0.0042	0.0338	2.34	0.1262
	2014	1	0.0484	5.0%	0.0076	0.0336	0.0632	40.92	<0.0001
	2015	1	0.0603	6.2%	0.0063	0.0479	0.0726	91.95	<0.0001
	2016	1	0.0516	5.3%	0.0056	0.0406	0.0626	84.75	<0.0001
	2017	1	0.0095	1.0%	0.0053	-0.0009	0.0199	3.24	0.0721
	2019	1	0.0689	7.1%	0.0059	0.0573	0.0805	134.70	<0.0001
	2018	0	0	0	0	0	0		

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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. DW202012 DH