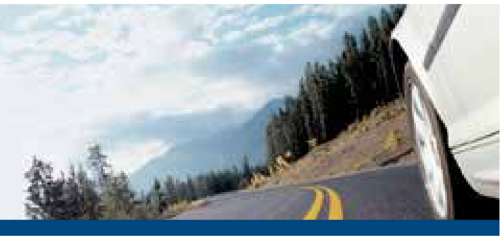
HIGHWAY LOSS DATA INSTITUTE

Bulletin | Vol. 30, No. 10 : April 2013



Evaluation of motorcycle antilock braking systems, alone and in conjunction with combined control braking systems

Previous studies have shown that antilock braking systems (ABS) systems reduce insurance claim rates and fatal crash rates for motorcycles. The purpose of this study was to update prior analysis on the relationship between ABS and insurance losses under collision, medical payments, and bodily injury liability coverages and to conduct a similar evaluation of motorcycles equipped with both ABS and combined control braking systems (CCBS). For all of the motorcycles in the study, either ABS or ABS and CCBS were available as optional equipment and the presence of ABS systems could be determined from the VIN. Losses for motorcycles with the systems were compared with losses for those without. The method used in this analysis could not estimate the effect of CCBS alone.

For the motorcycles in the study group used to evaluate the effects of ABS alone, ABS was associated with large reductions in claim rates for all three coverage types studied — 20 percent for collision, 28 percent for medical payment, and 22 percent for bodily injury liability. Due to the limited number of motorcycles in ABS/CCBS study population, analysis of these systems was limited to collision coverage. The reduction in collision claim frequency associated with ABS/CCBS (31 percent) was larger than the reduction for ABS alone.

Introduction

According to the National Highway Traffic Safety Administration (NHTSA) motorcycle registrations more than doubled between 1997 and 2010 (NHTSA, 2012). Analysis by the Insurance Institute for Highway Safety of data from the Fatality Analysis Reporting System shows that, during the same time period, fatalities in motorcycle crashes increased by 110 percent. Motorcyclist deaths began to increase in 1998 and continued to increase and peaked in 2008. Motorcyclist deaths decreased by 16 percent in 2009 compared with 2008 and increased only slightly in 2010 and in 2011. It is not known to what extent the overall decrease from 2008 is related to improvements in highway safety or due to the significant drop in new motorcycle sales from more than 1.1 million in 2008 to only 560,000 in 2010 (MIC, 2011). Compared with automobiles, motorcycles offer much less occupant protection in the event of a crash. Only 20 percent of automobile crashes result in injury or death, whereas 80 percent of motorcycle crashes do (NHTSA, 2005). Therefore, any countermeasure aimed at reducing the likelihood of motorcycle crashes should significantly reduce the risk of injury or death.

In addition to antilock braking systems (ABS), motorcycles increasingly are equipped with systems that integrate the control of the front and rear brakes. In this study, these systems will be referred to as combined control braking systems (CCBS). These systems can apply force from both brakes even if only one brake control is actuated by the rider. There are a variety of implementations. One implementation can be found on the 2013 Yamaha FJR1300. The FJR1300 has eight brake pistons on the front wheel and two on the rear. When a rider actuates the front brake control, six of the front brake pistons activate, while none of the rear activate. When a rider actuates the rear brake control, all of the rear brake pistons activate and two of the front brake pistons activate. All eight front brake pistons are activated only when the rider actuates both brake controls. Honda utilizes a different type of CCBS that electronically distributes brake force over both wheels with either control. The system electronically measures rider input on the brake controls and applies both brakes or only the front or rear.

The purpose of this study was to update prior analysis on the relationship between ABS and insurance losses under collision, medical payments, and bodily injury liability coverages and to conduct a similar evaluation of motorcycles equipped with ABS and CCBS. For all of the motorcycles in the study either ABS alone or ABS and CCBS were available as optional equipment. The presence of the ABS system could be determined from the VIN. Losses for motorcycles with the systems were compared to those without.

Methods

Insurance data

Motorcycle insurance covers damage to vehicles and property as well as injuries to people involved in crashes. Different insurance coverages pay for physical damage versus injuries. Also, different coverages may apply depending on who is at fault. In the present study, collision coverage, medical payment and bodily injury liability was examined. Collision coverage insures against physical damage to a motorcycle sustained in a crash when the rider is at fault. Medical payment coverage (MedPay) covers injuries to insured riders. For motorcycles, bodily injury liability (BI) coverage insures against injuries that at-fault operators cause to other people, including their own passengers.

Rated drivers (riders)

For insurance purposes, a rated driver is assigned to each motorcycle on a policy. The rated driver is the one who typically is considered to represent the greatest loss potential for the insured vehicle. In a household with multiple vehicles and/or drivers, the assignment of drivers to vehicles can vary by insurance company and by state, but typically it reflects the driver most likely to operate the vehicle. Information on the actual driver at the time of a loss is not available in the Highway Loss Data Institute (HLDI) database.

HLDI collects a number of factors about rated drivers. For the present study, data were stratified by rated driver age group (<25, 25-39, 40-64, 65+, or unknown), rated driver gender (male, female, or unknown), and rated driver marital status (married, single, or unknown). Additionally, risk (nonstandard or standard) and deductible range for collision coverage only (0-100, 101-250, 251-500, or 501+) were included.

Motorcycles

For motorcycles to be included in the present study, their vehicle identification numbers (VINs) had to have an ABS indicator. This allowed for very tight control over the study population. Only motorcycles with optional ABS and with loss data for both ABS and non-ABS versions were included. This restriction produced 44 pairs of ABS/non-ABS motorcycles. Furthermore, only pairs with at least one claim for both the ABS version and the non-ABS version were included to make it possible to analyze claim severity. A total of 35 pairs of ABS/non-ABS motorcycles were ultimately included in the study.

The 35 bike pairs were separated into two groups: a group to evaluate the effect of ABS and a group to evaluate the effect of ABS in conjunction with CCBS. The ABS group included 25 pairs, and the ABS/CCBS group included 10 pairs. It should be noted that some of the motorcycles in the ABS study population were also equipped with CCBS. However, in that group both the ABS and non-ABS motorcycles had CCBS. In the ABS/CCBS group the ABS equipped motorcycles had CCBS but the non-ABS motorcycles did not. **Table 1** displays the exposure breakdown for the bikes by ABS and ABS/CCBS status. It should be noted that in the previous HLDI study on motorcycle ABS, five of the ABS equipped motorcycles evaluated had CCBS while the non-ABS motorcycles did not. Consequently, the effect of ABS in that study was confounded with CCBS. The five ABS/CCBS motorcycles comprised approximately 7 percent of the collision exposure in that study.

Total exposure measured in insured vehicle years and the total number of claims in this analysis are shown by insurance coverage type in **Table 2**.

Table 1: Distribution of exposure for antilock and combined control brake systems, collision coverage			
Make and series	Exposure	Percent ABS	Percent non-ABS
Aprilia Mana 850	494	20%	80%
Aprilia Scarabeo 500	1,406	49%	51%
Honda Gold Wing	217,874	22%	78%
Honda Interceptor 800	14,806	25%	75%
Honda NT700V	1,300	21%	79%
Honda Reflex	15,070	13%	87%
Honda Silver Wing	18,258	17%	83%
Honda ST1300	22,596	36%	64%
Kawasaki Ninja 1000	88	39%	61%
Kawasaki Ninja 650R	16	29%	71%
Kawasaki Ninja ZX-10R	138	20%	80%
Suzuki Bandit 1250	4,382	23%	77%
Suzuki B-King	1,873	3%	97%
Suzuki Burgman 400	1,075	24%	76%
Suzuki Burgman 650	20,333	27%	73%
Suzuki SV650	11,113	6%	94%
Suzuki V-Strom 650	12,525	23%	77%
Triumph Rocket III	1,773	21%	79%
Triumph Speed Triple	290	33%	67%
Triumph Sprint ST	6,232	39%	61%
Triumph Thunderbird	1,953	50%	50%
Triumph Tiger	6,093	28%	72%
Triumph Tiger 800	910	84%	16%
Victory Cross Country	340	91%	9%
Yamaha FJR1300	18,723	50%	50%
Total	**379,660**	**24%**	**76%**
Make and series	Exposure	Percent ABS/CCBS	Percent non-ABS/CCBS
Honda CBR1000RR	4,091	8%	92%
Honda CBR600RR	8,985	8%	92%
Honda Fury	7,660	2%	98%
Honda Interstate	441	1%	99%
Honda NC700X	122	18%	82%
Honda Shadow Aero 750	99	41%	59%
Honda Stateline	916	5%	95%
Kawasaki Concours 14	14,553	56%	44%
Kawasaki Vulcan 1700 Voyager	3,374	63%	37%
Victory Vision	7,638	15%	85%
Total	**47,878**	**26%**	**74%**

Table 2 : Exposure and claims by coverage type		
	Exposure	Claims
Collison - ABS only		
With ABS	91,823	1,587
Without ABS	287,836	5,899
Total	**379,660**	**7,486**
Collision - ABS/CCBS only		
With ABS/CCBS	12,675	393
Without ABS/CCBS	35,202	1,983
Total	**47,878**	**2,376**
MedPay - ABS only		
With ABS	23,080	238
Without ABS	79,029	1,077
Total	**102,109**	**1,315**
BI-ABS only		
With ABS	84,202	121
Without ABS	266,507	459
Total	**350,709**	**580**

Geographic factors

Geographic characteristics included garaging state and registered vehicle density. Registered vehicle density was defined as the number of registered vehicles per square mile (<100, 100-499, and 500+). State was used in the analysis to control for their potential impacts on losses.

Statistical methods

Data were collected by motorcycle make and series, rated driver age, gender, marital status, vehicle age, vehicle density, risk, deductible range, calendar year and state. Vehicle age was defined as the difference between the calendar year and model year (age -1 was grouped with age 0). Calendar years 2003-12 were used in the analysis for the ABS/non-ABS groups of bikes. Calendar years were limited to 2007-12 for the ABS/CCBS group, as these bikes are newer and not available in the prior calendar years.

Regression analysis was used to quantify the effect of ABS and the combination of ABS and CCBS on motorcycle losses while controlling for other covariates. Claim frequency was modeled using a Poisson distribution, whereas 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. Reference categories for all coverage types for the categorical independent variables were assigned to the values with the highest collision exposure. The reference categories for the ABS analysis were as follows: make/series=Honda Gold Wing, ABS=without ABS, rated driver age range=40-64, vehicle density=100-499 vehicles per square mile, rated driver gender=male, marital status=married, risk=standard, deductible range=$251-$500, state=California, and calendar year=2011. The reference categories for the ABS/CCBS analysis were as follows: make/series=Kawasaki Concours 14, ABS/CCBS=without ABS/CCBS, rated driver age range=40-64, vehicle density=100-499 vehicles per square mile, rated driver gender=male, marital status=married, risk=standard, deductible range=$251-$500, state=California, and calendar year=2011.

Results

Collision coverage analysis was completed to determine the effect of ABS and the combination of ABS and CCBS. Twelve regression models were calculated to produce the results in this study. For the sake of illustration collision frequency results for the ABS group are presented while all other models and the derived results for overall losses appear in a separate **Appendix**. Tables summarizing the estimated effects of the systems for each coverage type are presented. Summary results of the regression analysis of motorcycle collision claim frequencies for the ABS bikes using the Poisson distribution are listed in **Table 3**. Results for all independent variables with the exception of gender had p-values less than 0.05, indicating their effects on claim frequencies were statistically significant.

Table 3 : Summary results of linear regression analysis of collision claim frequencies, ABS effect

	Degrees of freedom	Chi-square	P-value
ABS	1	58.94	<0.0001
Vehicle make/series	24	515.14	<0.0001
Vehicle age	1	302.26	<0.0001
Rated driver age	4	177.31	<0.0001
Rated driver gender	2	5.44	0.0659
Rated driver marital status	2	37.15	<0.0001
Risk	1	34.01	<0.0001
Deductible	3	202.49	<0.0001
Vehicle density	2	69.21	<0.0001
State	50	242.78	<0.0001
Calendar year	9	46.37	<0.0001

Detailed results of the regression analysis of the ABS bikes using claim frequency as the dependent variable are listed in **Table 4**. The table shows the estimates and significance levels for the individual values of the categorical variables. To make results more illustrative, a column was added that contains the exponents of the estimates. The intercept outlines losses for the reference (baseline) categories: The estimate in **Table 4** for the ABS effect corresponds to the claim frequency for a Honda Gold Wing without ABS, with vehicle age 0, garaged in a medium vehicle density area in California in 2011, and whose rider was a 40-64-year-old married male classified as standard risk with a policy deductible of $251-$500. The remaining estimates are in the form of multiples, or ratios relative to the reference categories. For example, the estimate corresponding to drivers aged 25-39 in **Table 4** equals 0.2638, so younger rated drivers had estimated claim frequencies 30 percent higher than those for 40-64 year old drivers ($e^{0.2638}$=1.3019). **Table 4** includes only an abbreviated list of results by state. The states with the five highest and five lowest estimates are listed, along with the comparison state of California. Detailed results for all states and all regressions are available in a separate **Appendix**.

The estimate corresponding to motorcycle ABS (-0.22) was highly significant (p<0.0001). The estimate corresponded to a 20.1 percent reduction in claim frequencies for motorcycles equipped with ABS. Twenty of the 24 make/series estimates were significant at the p=0.05 level. The reference category for the make/series variable was the Honda Gold Wing. Significant predictions for make/series ranged from 1.2 for the Triumph Tiger to 8.2 for the Kawasaki Ninja 650R. Vehicle age significantly affected collision claim frequency. Claim frequencies were estimated to decrease 12 percent (p<0.0001) for each one-year increase in vehicle age.

Driver age, marital status, risk, deductible and vehicle density significantly predicted motorcycle collision claim frequency for ABS bikes. Compared with losses for rated drivers ages 40-64 (reference category), estimated claim frequencies were significantly higher for all other age groups. Compared with losses for married drivers (reference category), estimated claim frequencies were 23 percent higher (p<0.0001) for rated single drivers. Estimated collision claim frequency for drivers classified as nonstandard risk was 18 percent higher (p<0.0001) than standard risk drivers. Estimated collision claim frequencies decreased as policy deductible increased. Compared with losses for male rated drivers (reference category), estimated claim frequencies were 10 percent lower (p=0.06) for rated female drivers. Motorcycle collision claim frequencies increased with vehicle density. Compared with California (reference category), significant collision claim frequency estimates ranged from 54 percent lower (p=0.015) for Delaware to 15 percent lower (p=0.02) for Michigan. Calendar year, also in **Table 4** has 2011 set as the reference category. Collision claim frequencies for 2009 were significantly different from that of 2011.

Table 4 : Detailed results of linear regression analysis of collision claim frequencies, ABS effect

	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Intercept	-9.4890		0.0646	21601.70	<0.0001
ABS					
With ABS	-0.2244	0.7990	0.0297	56.92	<0.0001
Without ABS	0	1	0		
Make and series					
Aprilia Mana 850	0.9441	2.5704	0.1919	24.21	<0.0001
Aprilia Scarabeo 500	0.6531	1.9215	0.1436	20.70	<0.0001
Honda Interceptor 800	0.6326	1.8826	0.0542	136.44	<0.0001
Honda NT700V	0.3267	1.3864	0.1658	3.89	0.0487
Honda Reflex	0.2419	1.2737	0.0621	15.16	<0.0001
Honda ST1300	0.1979	1.2188	0.0534	13.74	0.0002
Honda Silver Wing	0.5239	1.6886	0.0501	109.31	<0.0001
Kawasaki Ninja 1000	0.8650	2.3751	0.4117	4.41	0.0356
Kawasaki Ninja 650R	2.1024	8.1861	0.4136	25.84	<0.0001
Kawasaki Ninja ZX-10R	1.8303	6.2355	0.1984	85.08	<0.0001
Suzuki B-King	0.8697	2.3863	0.1133	58.90	<0.0001
Suzuki Bandit 1250	0.5566	1.7448	0.0883	39.73	<0.0001
Suzuki Burgman 400	0.7960	2.2167	0.1479	28.99	<0.0001
Suzuki Burgman 650	0.3942	1.4832	0.0478	67.93	<0.0001
Suzuki SV650	0.6900	1.9938	0.0566	148.60	<0.0001
Suzuki V-Strom 650	-0.0722	0.9303	0.0711	1.03	0.3098
Triumph Rocket III	0.6282	1.8742	0.1265	24.65	<0.0001
Triumph Speed Triple	0.6880	1.9897	0.2546	7.30	0.0069
Triumph Sprint ST	0.8092	2.2461	0.0695	135.47	<0.0001
Triumph Thunderbird	0.2227	1.2494	0.1442	2.39	0.1225
Triumph Tiger	0.1910	1.2104	0.0913	4.37	0.0365
Triumph Tiger 800	-0.1346	0.8740	0.2405	0.31	0.5755
Victory Cross Country	0.1957	1.2162	0.3373	0.34	0.5617
Yamaha FJR1300	0.2986	1.3479	0.0588	25.80	<0.0001
Honda Gold Wing	0	1	0		
Vehicle age	-0.1317	0.8766	0.0076	303.50	<0.0001
Rated driver age group					
14-24	1.0275	2.7941	0.0792	168.28	<0.0001
25-39	0.2638	1.3019	0.038	48.15	<0.0001
65+	0.1129	1.1195	0.0344	10.78	0.0010
Unknown	0.2869	1.3322	0.0561	26.10	<0.0001
40-64	0	1	0		

Table 4 : Detailed results of linear regression analysis of collision claim frequencies, ABS effect					
	Estimate	Exponent estimate	Standard error	Chi-square	P-value
Rated driver gender					
Female	-0.1011	0.9039	0.0532	3.61	0.0575
Unknown	-0.0990	0.9057	0.0663	2.23	0.1351
Male	0	1	0		
Rated driver marital status					
Single	0.2088	1.2322	0.0347	36.17	<0.0001
Unknown	0.1509	1.1629	0.0642	5.53	0.0187
Married	0	1	0		
Risk					
Non Standard	0.1667	1.1814	0.0285	34.32	<0.0001
Standard	0	1	0		
Deductible					
0-100	0.3641	1.4392	0.0511	50.70	<0.0001
101-250	0.2245	1.2518	0.0268	70.04	<0.0001
501+	-0.3170	0.7283	0.0416	58.04	<0.0001
251-500	0	1	0		
Registered vehicle density					
0-99	-0.1288	0.8792	0.0305	17.82	<0.0001
500+	0.1450	1.1561	0.0286	25.79	<0.0001
100-499	0	1	0		
State					
Delaware	-0.7742	0.4611	0.3183	5.92	0.0150
Louisiana	0.0018	1.0018	0.0898	0.00	0.9838
Massachusetts	-0.6271	0.5342	0.1156	29.42	<0.0001
Mississippi	-0.1298	0.8783	0.1154	1.26	0.2607
New Hampshire	-0.1021	0.9029	0.1645	0.39	0.5347
North Dakota	-0.6730	0.5102	0.2618	6.61	0.0102
Texas	-0.0206	0.9797	0.0557	0.14	0.7121
Vermont	-0.0979	0.9067	0.2387	0.17	0.6817
West Virginia	-0.5962	0.5509	0.1524	15.31	<0.0001
Wisconsin	-0.6684	0.5126	0.0791	71.46	<0.0001
California	0	1	0		
Calendar year					
2003	-0.3041	0.7378	0.2718	1.25	0.2633
2004	-0.1081	0.8975	0.1324	0.67	0.4142
2005	-0.0729	0.9297	0.0889	0.67	0.4125
2006	-0.0674	0.9349	0.0657	1.05	0.3054
2007	0.0361	1.0368	0.0491	0.54	0.4617
2008	0.0572	1.0589	0.0434	1.74	0.1875
2009	-0.1796	0.8356	0.0432	17.32	<0.0001
2010	-0.0184	0.9818	0.0405	0.21	0.6493
2012	0.0430	1.0439	0.0415	1.07	0.3006
2011	0	1	0		

Table 5 summarizes the collision results for the ABS and ABS/CCBS groups. Claim frequency declined significantly for both groups of bikes, 20.1 percent for the ABS group and 31.3 percent for the ABS/CCBS group (**Figure 1**). **Figure 1** includes the 95 percent confidence bounds for both frequency estimates. The lower bound for the ABS effect overlaps slightly with the upper bound of the ABS/CCBS estimate. To test if these two estimates are statistically different, the arithmetic difference between the two estimates was calculated. Their variances were summed to obtain the variance of the difference. Finally, assuming a normal distribution, a Z-test was conducted for this difference which yielded a p-value of 0.03, meaning that the difference of the two effects is statistically significant. Claim severity also declined for both groups but not significantly (**Figure 2**). Finally, collision overall losses declined significantly for the ABS (20.3 percent) and the ABS/CCBS (34.2 percent) groups (**Figure 3**).

Table 5 : Detailed results of linear regression analysis of collision losses

	Estimate	Effect	Standard error	Chi-square	p-value
ABS only					
Claim frequency	-0.2244	-20.1%	0.0297	56.92	<0.0001
Claim severity	-0.0025	-0.2%	0.0245	0.01	0.9194
Overall losses	-0.2268	-20.3%	0.0385		<0.0001
ABS /CCBS					
Claim frequency	-0.3752	-31.3%	0.0657	32.61	<0.0001
Claim severity	-0.0441	-4.3%	0.0466	0.90	0.3441
Overall losses	-0.4193	-34.2%	0.0805		<0.0001

Figure 1 : Changes in collision claim frequencies for motorcycles with ABS and CCBS

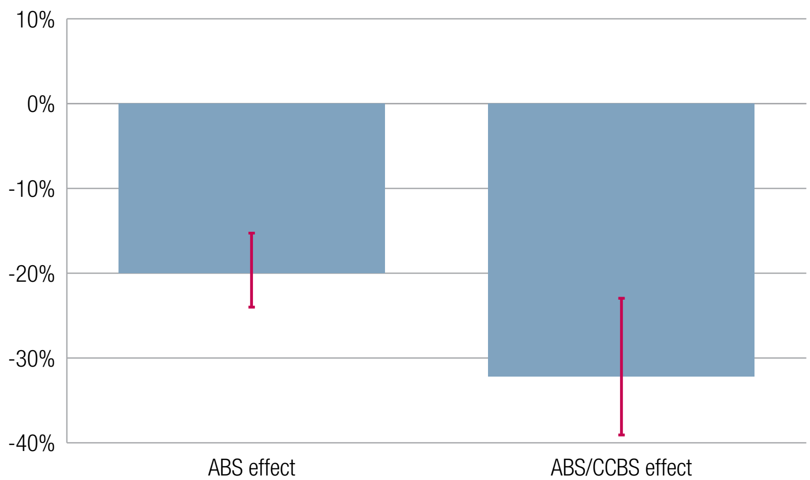


Figure 2 : Changes in collision claim severities for motorcycles with ABS and CCBS

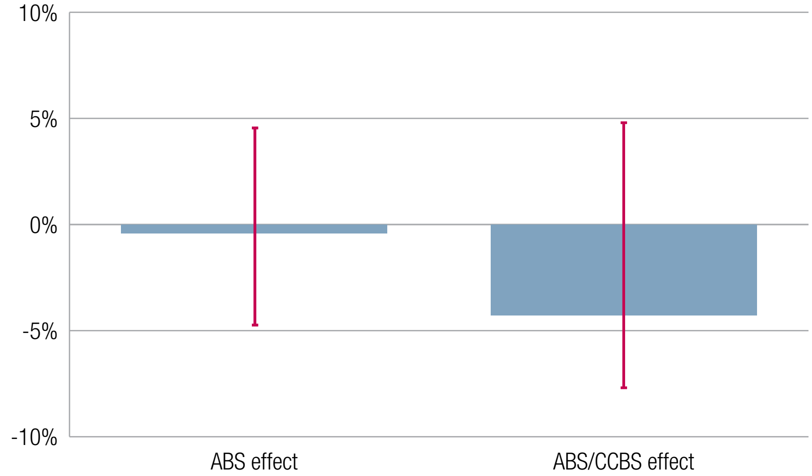


Figure 3 : Changes in collision overall losses for motorcycles with ABS and CCBS

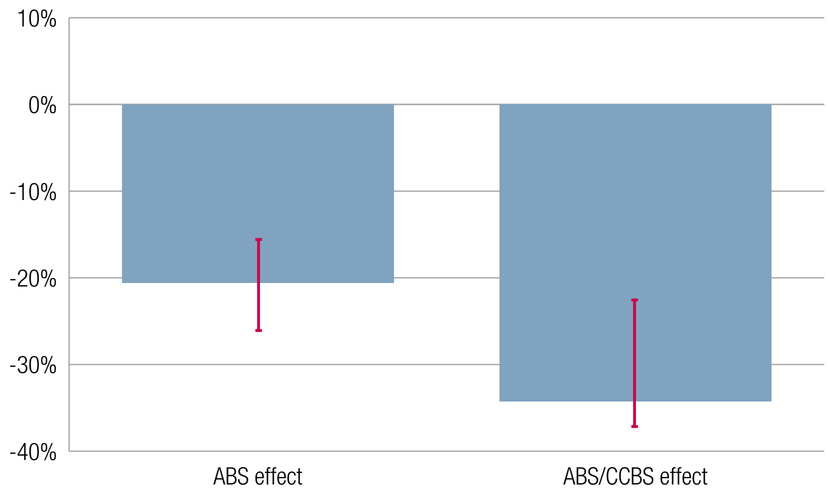


Table 6 summarizes the medical payment results for the ABS only motorcycles. MedPay claim frequencies and severities changed significantly. Frequency declined 28.1 percent and severities increased 24.9 percent. MedPay overall losses declined 10.2 percent but not significantly (**Figure 4**).

Table 6 : Detailed results of linear regression analysis of medical payment losses, ABS effect

	Estimate	Effect	Standard error	Chi-square	p-value
Claim frequency	-0.3298	-28.1%	0.0751	19.30	<0.0001
Claim severity	0.2222	24.9%	0.0788	7.95	0.0048
Overall losses	-0.1076	-10.2%	0.1088		0.3229

Figure 4 : Changes in medical payment losses for motorcycles with ABS

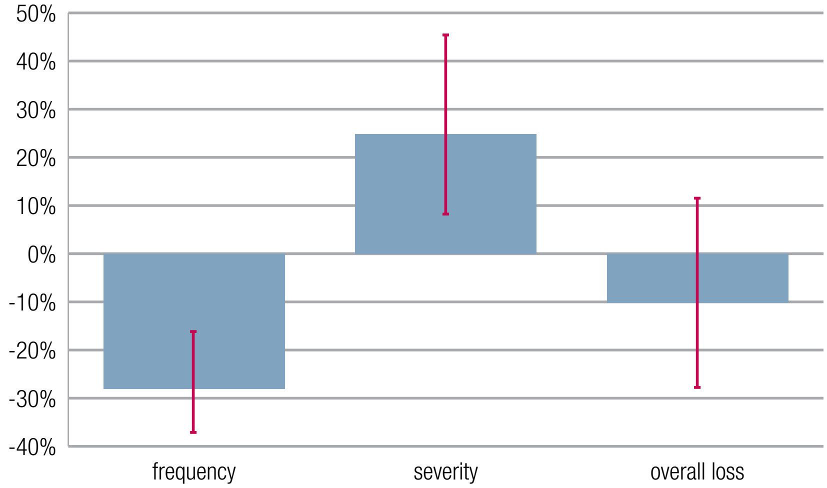
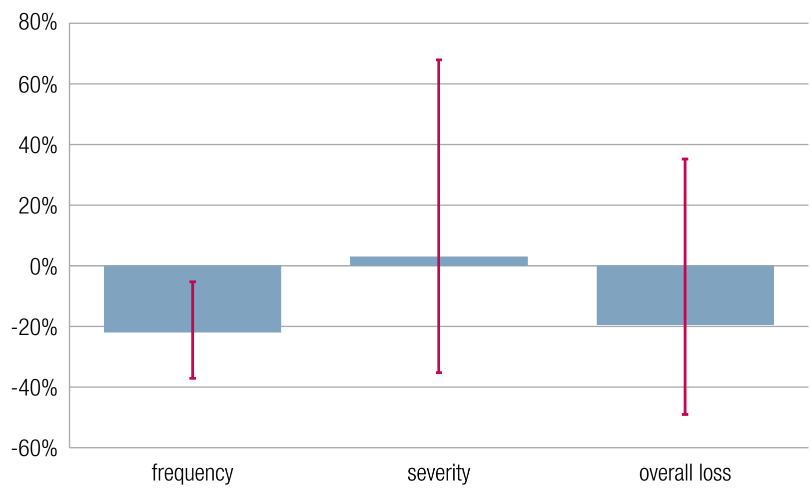


Table 7 summarizes the bodily injury liability results for the ABS only motorcycles. BI claim frequencies declined significantly (22.0 percent) while severities increased a nonsignificant 3.1 percent. BI overall losses declined 19.6 percent but not significantly (**Figure 5**).

Table 7 : Detailed results of linear regression analysis of bodily injury liability losses, ABS effect

	Estimate	Effect	Standard error	Chi-square	p-value
Claim frequency	-0.2487	-22.0%	0.1063	5.48	0.0192
Claim severity	0.0308	3.1%	0.2458	0.02	0.9002
Overall losses	-0.2179	-19.6%	0.2678		0.4157

Figure 5 : Changes in bodily injury liability losses for motorcycles with ABS



Discussion

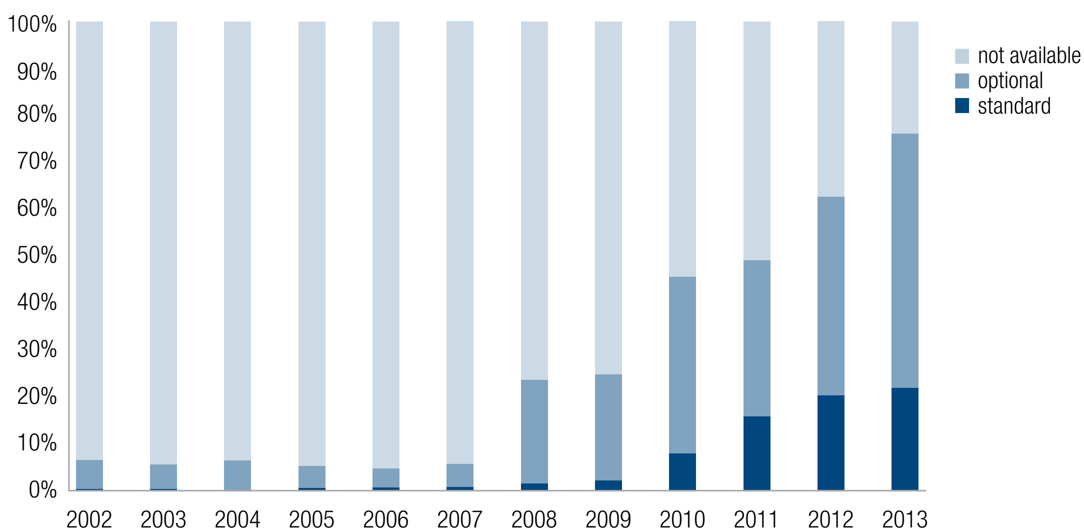
Prior HLDI studies have shown that antilock braking systems (ABS) on motorcycles are effective in reducing collision losses. This study updates the prior study with additional loss experience and new additional motorcycles. This study is the first to look at the effectiveness of ABS in conjunction with combined control brake systems on collision losses. The combined control brake system (CCBS) along with ABS showed larger reductions in collision claim frequency, severity, and overall losses than ABS by itself. The benefits for CCBS are encouraging but the amount of available data is still small. Additional data will further refine this result.

It should be noted that in the previous HLDI study on motorcycle ABS, five of the ABS equipped motorcycles evaluated had CCBS while the non-ABS motorcycles did not. Consequently, the effect of ABS in that study was confounded with CCBS. However, those five motorcycles represented just over 7 percent of the collision exposure in the study so their contribution to the overall findings of the study was relatively small. Collision claim frequencies in that study were reduced by 22 percent. This reduction is much closer to the result for the ABS group (20 percent) than the ABS/CCBS group (31 percent).

Injury coverage losses were also examined. Antilock brakes are associated with significant reductions in Medpay (28.1 percent) and BI claim frequencies (22.0 percent).

Although previous studies have shown the benefit of antilock brakes for motorcycles, ABS is not currently required in the United States. Beginning in 2016 in the European Union, it will be mandatory for motorcycles that have an engine displacement greater than 125 cc to be fit with ABS. Manufacturers have taken the initiative to increase the availability of ABS on new motorcycles in the U.S. over the past few years. More than 90 percent of 2002 bikes did not have ABS available (Figure 6). This is in stark contrast to the 2013 model year, in which more than three-quarters of new bikes either have standard (22 percent) or optional (54 percent) ABS. These are unique motorcycle VIN data and are not exclusive to the study population used in this analysis.

Figure 6: Motorcycle ABS availability by model year



References

Motorcycle Industry Council. 2011. Statistical annual. Irvine, CA.

National Highway Traffic Safety Administration. 2012. Traffic Safety Facts, 2010. Report no. DOT HS-811-659. Washington, DC: US Department of Transportation.

National Highway Traffic Safety Administration. 2005. Without motorcycle helmets we all pay the price. Washington, DC: US Department of Transportation.

HIGHWAY LOSS
DATA INSTITUTE

1005 N. Glebe Road, Suite 700
Arlington, VA 22201 USA
tel 703/247-1600
fax 703/247-1595
iihs-hldi.org

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.